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THE HOW-TO HOMEBREW BEER MAGAZINE

SEPTEMBER 2018, VOL.24, NO.5

MALT MADNESS

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  10 Models Compared
- Understand Malt Specs
- Base Malt Roundup

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SEPTEMBER 2018, VOL. 24 NO.5

features

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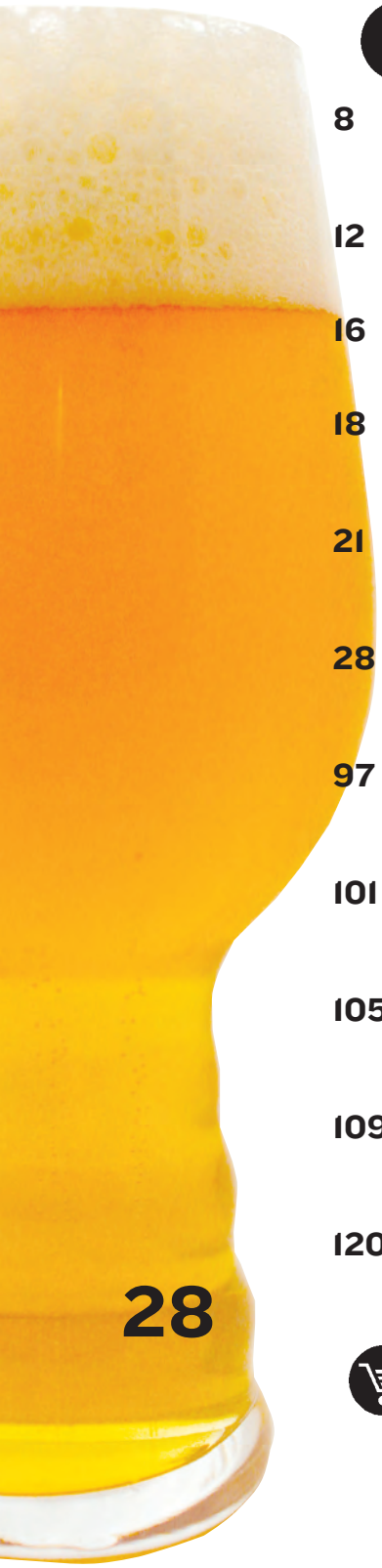

departments

where to find it

RECIPE INDEX

RECIPE STANDARDIZATION

EXTRACT EFFICIENCY: 65%
(i.e. — 1 pound of 2-row malt, which has a potential extract value of 1.037 in one US gallon of water, would yield a wort of 1.024.)

EXTRACT VALUES FOR MALT EXTRACT:
liquid malt extract (LME) = 1.033–1.037
dried malt extract (DME) = 1.045

POTENTIAL EXTRACT FOR GRAINS:
2-row base malts = 1.037–1.038
wheat malt = 1.037
6-row base malts = 1.035
Munich malt = 1.035
Vienna malt = 1.035
crystal malts = 1.033–1.035
chocolate malts = 1.034
dark roasted grains = 1.024–1.026
flaked maize and rice = 1.037–1.038

HOPS:
We calculate IBUs based on 25% hop utilization for a one-hour boil of hop pellets at specific gravities less than 1.050. For post-boil hop stands, we calculate IBUs based on 10% hop utilization for 30-minute hop stands at specific gravities less than 1.050. Increase hop dosage 10% if using whole leaf hops.

Gallons:
We use US gallons whenever gallons are mentioned.

Brew Your Own — THE HOW-TO HOMEBREW BEER MAGAZINE

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If you could share a bottle of your homebrew with anyone in the world, who would it be?

I've been a Howard Stern fan since the late '80s. Howard is brash, audacious, and at times a bit crude. He's also compassionate, articulate, honest, virtuous, intelligent, appreciative, and surrounds himself with good people. And more than anything, his show makes me laugh hysterically every time I listen. I would love to sit and have a beer with Howard, even if it was just to hear him belch a "thank you."

I would like to share a homebrew with Mark Hamill. Growing up a HUGE Star Wars nerd it's kind of a dream to have a beer with Luke Skywalker, and to have one with The Joker at the same time would be mind blowing. Mark Hamill is also from my hometown and is well known for his charity work, so it would be fun to sit back and hear some of his life stories . . . with "Mad About Me" by Figrin D'an and the Modal Nodes, playing in the background of course.

Michael Jackson was the pioneer of beer styles and craft beer decades before the craft beer movement. He championed amazing beers that no one would have tasted if it wasn't for him. Michael had a great palate and I wish he was still with us today.

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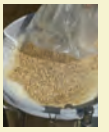
suggested pairings at BYO.COM



Brew-in-a-Bag All-Grain Techniques

If you are ready to dive into your first brew-in-a-bag, this article is the perfect guide to get you started. Learn some basic calculations, concepts, recipes, and suggested tips to make the first brew day a breeze. Includes step-by-step instructions to get you through. https://byo.com/article/brew-in-a-bag-techniques/

Brown Malt

Found in many historical recipes, brown malt is often one that is not well-understood by homebrewers and also not easy to find at many homebrew shops. Dive into the history of this malt and some of the key characteristics that make this malt so unique. https://byo.com/article/brown-malt/

MEMBERS ONLY

Blending Sour Beers with the Solera Method

Lambics are the perfect candidate to dive into the Solera method. This is a method of blending beers but using less fermenter space. With just one or two barrels, the Solera method can provide years of sour bliss for brewers. Learn more from our Advanced Brewing columnist Michael Tonsmeire. https://byo.com/article/solera-blending-techniques/

MEMBERS ONLY

New Pumpkin Beer Styles

Fall is approaching and brewers are starting to head to local pumpkin patches for the most trendy of fall bewing ingredients. But brewing with pumpkins doesn't mean you have to make a traditional pumpkin ale. How about adding pumpkin to a different beer style this fall? https://byo.com/article/new-pumpkin-beer-styles

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Pinthouse Pizza at Hop Selection
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Joe Mohrfeld (r), Director of Brewing
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MAIL

"SENSORY METHODS" HIT THE SPOT

Awesome article in *BYO* on ingredient sensory methods (the "Techniques" column in July-August 2018)! I've wanted to pursue this area and you've just written a guide for me! Thanks for the excellent writing and research!

Doug Pipen • *via email*

"Techniques" author Aaron Hyde responds, "Thanks, Doug! I'm glad you enjoyed the article. It's a bit of uncharted territory for many homebrewers, but I believe you'll find it quite valuable to better understand the ingredients you brew with."

METRIC CONVERSIONS

I've been reading some of your recipes and the thing that surprises me is that you convert everything to metric except for the priming sugar! Is there a reason for doing this?

Christiaan Klein Zessink • *via email*

BYO *Recipe Editor Dave Green responds, "Good question, Christiaan. Dry volumetric measurements are the one measurement that we don't convert — so dry portions measured as cups, tablespoons, and teaspoons do not get a metric volumetric equivalent. It's been that way since I started doing recipes for the magazine. But for corn sugar (priming sugar), I always use:*

¼ cup = 50 g, so 1 cup = 200 g

It's a pretty good rule of thumb but obviously different density dry goods will not be the equivalent. PS — I do always recommend finding an online carbonation priming chart (like the one on our website at https://byo.com/resource/carbonation-priming-chart/) or priming calculator for fine-tuning bottle priming."

LACTOSE ADDITIONS

I am going over a recipe I found on your website for a milk chocolate Märzen. I'd really like to brew it but it doesn't say when to add the lactose. I only have about four brews under my belt and don't want to mess it up terribly. Any help would be greatly appreciated with this.

Ben Lynch • *via email*

contributors


Hannah Crum is The Kombucha Mamma and the originator of the Kombucha Kamp workshop in 2004. Soon after, she and husband **Alex LaGory**, aka Alex Kombucha, partnered to create Kombucha Kamp (www.KombuchaKamp.com), to provide clear, quality information about the brewing process and kombucha lifestyle. Hannah tours as a popular speaker about kombucha, fermentation, and bacteriosapiens at corporate and health conferences, fermentation festivals, and events around the world. As an outgrowth of their corporate consulting, industry reporting, and class marketing efforts, Hannah & Alex co-founded Kombucha Brewers International in 2014 to unite and advocate for the commercial Kombucha bottling industry around the world. They are also the authors of *The Big Book of Kombucha* (Storey Publishing, 2016).

Hannah and Alex make their *BYO* writing debut with an overview of the history and brewing techniques to make kombucha at home, beginning on page 46.

Jason Simmons has served the public since graduating from high school in New Jersey more than a decade ago as an EMT and volunteer firefighter. After discovering the hobby of homebrewing, Jason dedicated his free time to learn every aspect of brewing that he could. In a short amount of time he found himself working two full-time careers as a professional brewer by day and EMT at night. He now focuses his professional time as a brewer (while continuing his efforts as a volunteer firefighter). With about 15 years of homebrewing and professional brewing experience, he has worked at several production breweries, brewpubs, as a brewery consultant, and is currently the Head Brewer at Lindgren Craft Brewery in Duncannon, Pennsylvania.

In this issue, Jason makes his *BYO* writing debut with a story about homebrew safety, starting on page 38.

Kevin Kawa is a Technical Sales Manager for Brewers Supply Group. Kevin has been with BSG for two years where his region is the Northeast states of the US. He grew up in Nebraska where he received his bachelors in Chemistry from the University of Nebraska. He then continued his education by getting his Masters in Brewing and Distilling from Heriott-Watt University in Edinburgh, Scotland, where he gained a love for whisky as well as beer. Kevin has experience in the alcohol beverage industry as both a former brewer and distiller.

Beginning on page 60, Kevin makes his *BYO* writing debute explaining the importance of, and differences between, base malts.

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BYO *Recipe Editor Dave Green responds, "That is an ingredient that can be added at just about any point in the brewing process since it doesn't have any aromatic qualities (such as honey) that could be driven off in the boil, nor is it a very high gravity beer where additional sugar may hamper the yeast at the outset of fermentation. So for those reasons, I would add the lactose with the dried malt extract and the cocoa powder. Best of luck brewing it!"*

NANOBREWING

Will the spring of 2019 Asheville event be tied to nanobrewing in any way?

Shawn Stafford • *via Facebook*

BYO *Publisher Brad Ring responds, "The Asheville, North Carolina Boot Camp in March 2019 is geared towards homebrewing and not nanobrewing. The one exception will be a 2-day brewery start-up workshop in Asheville, but all other classes are targeted for homebrewers. At NanoCon — being held this November 2 & 3 in Burlington, Vermont — every single seminar, workshop, and exhibitor is focused just on nanobrewing. I hope you can make it!"*

IMAGES ON THE *BYO* WEBSITE

I've noticed when reading articles online they sometimes refer to pictures and figures that are missing. It would be nice to have the pictures too. In the article https://byo.com/article/crystal-caramel-malt/ it says, "Some of the main compounds and their flavors are shown in the figure on page 37."

Scott MacDonald • *via email*

BYO *Editor Dawson Raspuzzi responds, "Thanks for pointing this out, Scott. The figure you mentioned has now been added to the online story. These types of page references and missing images result from our past* BYO *articles we've made available digitally for the first time as part of our new website. It is something we are cleaning up.*

I'd like to encourage anyone reading our content online who has questions about an article to please let us know. I can be emailed directly at dawson@byo.com and we will work to get any missing content or questions taken care of immediately.

WRITE TO *BYO*

Have a question about something you've seen in *BYO*? Want to show off your latest DIY homebrewing gear or recipe? Write to us at: edit@byo.com, find us on Facebook: www.facebook.com/BrewYourOwn, Instagram: @brewyourownmag, or reach out to us on Twitter: @BrewYourOwn. BYO

BEGINNER'S BLOCK

BY DAVE GREEN

UNDERSTANDING MALT LINGO

There are plenty of technical terms that surround the cereal grains that we brewers use as a source of sugar to make beer. Understanding the brewing jargon used when talking about malt can be very helpful. This column assumes you have a basic understanding of mashing already. If you would like to learn more on the basics of mashing, visit https://byo.com/article/your-first-all-grain-beer/

MALTING TALK

Most of the grains that brewers use are of the malted variety. The malting process takes the raw, whole-grain *berries*, another term for the raw seeds of the grain, and begins the germination process of the berry. Malting is most often done on barley, but wheat, rye, and oats, are a few other popular grains. As the grain begins to become metabolically active, it sprouts or chits in malting lingo; some grains that are just barely modified before kilning are called *chit malz*. The germination process lasts about 3-4 days before it is halted at a certain point when the germination has progressed as far as the maltster requires. At this point the grains are kilned, or dried. Some specialty malts are roasted to varying degrees in a drum roaster, and others are changed by *stewing* before roasting. Stewing involves taking the newly germinated grains and raising the temperature into the same range that brewers mash their grains. This effectively converts almost all the starch in the grain to sugar prior to the drying/roasting process.

GET A REACTION

There is a class of chemical reactions that occurs in the malting process that every homebrewer should understand, a process known as the *Maillard reactions*. Maillard reactions create the lion's share of the characteristic malty flavor and aroma compounds found in beer. Maillard reactions combine a sugar molecule with an amino acid to produce hundreds of flavor-active compounds. The aromas generated from the Maillard reaction intensify as the reaction progresses as temperature and/or roasting time increase. The progression of Maillard reaction products begin with cracker and light toast aromas, then into the caramel, toffee, honey, nutty realm, and finally into roasted aromas like chocolate, coffee, and burnt bread. Maltsters can adjust their process to guide their roast towards different sets of these Maillard reaction products.

Maltsters provide the color contribution of the malt in degrees Standard Reference Method (*SRM*) (which is based on the Lovibond (°*L*) scale), or in European Brewery Convention (*EBC*) units. Utilizing a good calculator, homebrewers can take the color contribution from each malt in the mash and combine them to come up with a general idea of the final beer color via the *Morey equation*. While this can give brewers a rough idea of the final color of a beer, it has its limitations such as not being able to distinguish brown hues versus red hues.

FEEL THE POWER

One of the most important concepts to understand is *diastatic power* of a malted grain. So what is diastatic power? It's basically the grains' ability to convert the starch into sugar via enzymes, particularly alpha amylase and beta amylase. The more amylase enzymes found in the malt, the more diastatic power. The highest level of diastatic power is found in green malt, in other words malt that has just finished with the germination process. Once the malt enters the kilning process, this level begins to drop as the heat from the kilning process tears apart these enzymes. In general, base malts will have enough diastatic power to convert the starch found in the mash in addition to starch from adjuncts, so long as the brewer does not dilute the base malt enzymes too much. If brewers are using lots of grains with little or no diastatic power, they may want to extend the mash time.

MEET THE FAMILIES

Steeping grains and *mashing grains* are two distinct classes of grains that homebrewers should familiarize themselves with. Steeping grains are generally limited to two families of grains, dark roasted grains (such as chocolate malts, black malts, and roasted barleys), and caramel malts (such crystal, cara-types, and Special B/Special W). Basically all other grain families fall into the mashing class, including base malts (such as Pilsen, pale, Vienna, and Munich), roasted malts (such as Biscuit, Victory®, and brown), specialty malts (such as acidulated and rauch), unmalted grains, and miscellaneous malts (like wheat, rye, and oat).

Here's a truism for you: Mashing grains should be mashed. That's not to say they have to be. Extract brewers can use them to add some flavor from their Maillard products; just don't expect much sugar contribution from them if they are simply steeped. Mashing grains contain high levels of starch that brewer's yeast cannot eat, but other microbes can, which creates an instable beer. Starch can also create a haze in the beer. Partial mashes are a great method for extract brewers who would like to try a mash, without the need for specialized equipment. For more on mashing versus steeping, visit https://byo.com/mr-wizard/101/.

HOMEBREW DROOL SYSTEMS

JOEL SIMARD • GATINEAU, QUÉBEC

My brewing system is a fully electric bottom-drained, single-tier HERMS system. Both the hot liquor tank and the kettle are each fitted with a 5500 watt water heater element powered with a 30 amp dryer outlet. The mash is steadily held within 0.1 ºC (sorry, I'm from Canada!) of the targeted temperature using a PID made from an Arduino microcontroller, which monitors the wort temperature at the exit of the hot liquor tank. My control panel has two more controllers monitoring the water temperature in the hot liquor tank and in the kettle. Using another Arduino microcontroller, I also programmed a countdown timer to help keep an eye on the time of the various brewing steps. All of the components of the control panel are powered on 12V DC to limit the usage of high voltage to a bare minimum in the panel.

While designing my system, I went with an unconventional approach and decided to reverse the kegs and connect a 2" tri-clamp on the spear connection of the kegs. This eliminates dead space, maximizing every drop of water used during the brewing process. This also makes it easy to clean the vessels without any heavy lifting. After about a year of use and fine tuning, the system has been able to achieve an extraction efficiency of up to 90-95%. The same tri-clamp fittings are used for the elements and the sight glass mountings, making it easy to take apart the system for maintenance.

The biggest challenge after choosing to go with the reversed keg route was to find all of the hardware enabling me to do so. Back in 2016 when I was designing and assembling the parts to complete my project, my local homebrew shop did not carry tri-clamp fittings (to this day, they still don't carry the 2" version) and very few Canadian online brew shops carried them, making access to parts very difficult since they were often out of stock.

Single-tier, bottom-drained, electric HERMS system designed and engineered by a gearhead, for a gearhead.

During the design process for the stand, I quickly decided to work with pressure-treated wood instead of steel since I do not have access to an arc welder. Another restraint of the bottom drain design was to build a stand that grants easy access to all of the valves and other hardware under the vessels, while still being able to steadily hold near 16 gallons (61 L) of hot water. The usage of 4"x4" lumber might have been a little bit of an overkill, but at least I can be sure that my stand can withstand whatever load I throw at it.

As an engineer, my favorite part of the brewing hobby is definitely designing my custom equipment and tools. One of my most recent additions is a water flow meter that precisely calculates the amount of water used. It's a simple tool designed with, you've guessed it, another Arduino microcontroller. This small addition makes my brew day much easier, since I previously had to haul buckets of water over to fill my hot liquor tank and my mash tun.

I could have decided to take the easy route and bought myself an already designed system from one of the amazing manufacturers available nowadays, but I really love figuring things out on my own and building my own approach to a problem. I even fashioned my own recipe-designing software. Designing your own equipment really helps you during future troubleshooting, and it gives you an incredible added amount of pride with every pint you pour.

A water flow meter allows precise and accurate measurements of the water coming into the hot liquor tank.

Draining the wort from the bottom of the keggles allows every drop to be collected from the mash, allowing for a highly efficient system.

CALENDAR

SEPTEMBER 8
CFA ROCKTOBER FEST HOMEBREW COMPETITION
Redmond, Oregon

The third annual Rocktoberfest held by The Cascade Fermentation Association will take place September 22–23. Top beers in every category will receive awards, ribbons, or prizes, and the Best of Show brewer will get a 10-gallon (38-L) brew kettle, and the runner up wins a 50-lb. (23-kg) bag of Mecca Grade Estate Malt. Winners will be announced September 29 at Wild Ride Brewing during the Kiwanis Club Of Redmonds Oktoberfest Festival. Registration deadline is September 8 with multiple drop-off points found throughout the region. Visit http://www.cfahomebrew.org for more information.

SEPTEMBER 15
BIG MUDDY MONSTER HOME BREW CONTEST
Murphysboro, Illinois

Hosted by the Friends of Murphysboro, the ninth annual Big Muddy Monster Home Brew Contest is open to all amateur adult homebrewers and accepts all beer styles and substyles in BJCP categories 1–34 of the 2015 BJCP Guidelines. Each entrant needs to fill out one form, no matter how many entries they are submitting, but each submission requires two bottles. Entries can be submitted between September 8 and September 15. Judging will be held September 29 and entries can be mailed in or dropped off at several locations. There is a $250 cash prize or the equivalent in credit at a homebrew supply store of their choice, and the winning beer will be brewed by a local brewery. Visit http://www.bigmuddymonsterbrewfest.com for more information.

SEPTEMBER 18
AUSTRALIAN NATIONAL AMATEUR WINE AND BEER SHOW
Adelaide, South Australia

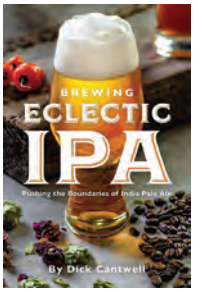
Since 1979, the ANAWBS has offered hobby brewers and winemakers an opportunity to have their beers and wines assessed by qualified judges and compared to other homebrewers and winemakers. This is a BJCP-sanctioned competition and is hosted by the Amateur Winemakers and Brewers Club of Adelaide Inc. and The Blackwood Winemakers and Brewers Club Inc. All entries must be registered by September 18 and winners will be presented on September 30 at the Charles Hawker Lecture Theatre on the University of Adelaide — Waite Campus. For more information, visit http://anawbs.org.au/

BYO WHAT'S NEW?

SS BREWTECH GRAIN MILL

Ss Brewtech is entering the grain mill arena, releasing a grain mill this fall with an innovative design. This unit has an integrated high torque motor, encased in a sealed section, which drives the two rollers. One roller turns at 250 rpms while the other roller is driven at a slower speed. This helps to increase shear to split instead of pulverize the grains like standard homebrew grain mills. At 3.9" (100 mm), the larger roller diameter creates a steep approach angle for the grain, allowing the rollers to be fluted instead of knurled. Hopper attachment and arms come with the mill to allow crushing directly over the mash tun. The gap spacing can be adjusted easily without the use of any tools. Find more information or to purchase once they are released, at www.ssbrewtech.com.

BREWING ECLECTIC IPAS: PUSHING THE BOUNDARIES OF INDIA PALE ALE



The IPA is the crowned head of the craft brewing world, but many of the current takes on this style bear little resemblance to the IPAs of old. Author Dick Cantwell takes readers on a journey to explore the new frontiers of this style. From coffee, to vegetables, to fruit, to spices, and wood aging; Cantwell provides 24 recipes for contemporary IPAs. Dick Cantwell was the co-founder of Elysian Brewing Co. where he was Head Brewer until its sale to Anheuser-Busch in 2015. He has written for many publications, is co-author of *Barley Wine* with Fal Allen, author of *The Brewers Association's Guide to Starting Your Own Brewery*, and co-author of *Wood & Beer* with New Belgium's Peter Bouckaert. The cover price is $19.95 in the US and the book can be found at better homebrew shops and bookstores, or online at www.brewerspublications.com.

SPIKE+ BREW KETTLES

Spike Brewing Equipment has introduced a new line of brew kettles featuring welded ports with 1.5-inch tri-clamp (TC) fittings. The ports are welded in Milwaukee, Wisconsin using high-quality TIG welding. This means no threading required, and they use a standard 1.5-inch gasket and clamp to secure accessories and hosing. This is inspired by the use of TC fittings in the professional brewing world. The ports are offset from center allowing enough room for butterfly valve ports to be secured and easily opened and closed without interference from other ports. Custom designs are available with their entire line for electric setups, custom recirculation ports, and HERMS coils, to name a few options. Several accessories for the Spike+ are also available for purchase to convert to a mash tun or hot liquor tank with HERMS coil. Visit www.spikebrewing.com/collections/spike-plus-kettles for more information or to purchase.

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REPLICATOR

BY MICHAEL BURY

DEAR REPLICATOR, My son, Tanner, took me to Junkyard Brewing Co. in Moorhead, Minnesota where I sampled several of their very good and very interesting brews. The Peanut Butter Bandit stout was particularly good with a nice balance of peanut butter and roast barley flavors. Any chance you could come up with a homebrew recipe for this dark chocolate peanut butter cup in a glass? Cheers!

Jon Stika
Dickinson, North Dakota

Necessity is the mother of invention. This English proverb couldn't be more applicable to homebrewers in general and especially so, for two recent college graduates. Operating on a limited budget due to the constraints of collegiate life, brothers Aaron and Dan Juhnke had to forge their own way. Using their own hands, their ingenuity, and whatever free time they had, the two created Junkyard Brewing: A humble 1.5-barrel (BBL) nanobrewery back in 2013.

Since those modest beginnings, Junkyard has expanded twice. One expansion was to a 3-BBL system, which coincided with a move into their current space, while the second expansion brought them up to a 10-BBL system. Despite the upgrade in capacity they continue to have difficulty keeping their taps full. One might say it's the colder weather in Minnesota that produces a thirstier beer drinker. But I'd prefer to think it's due to the quality and inventiveness of their brews that keeps bringing back patrons (that's coming from a former Michigander who's used to the cold).

During Junkyard's existence, there have been a few themes that have woven themselves throughout the company. First is the desire for creativity and experimentation. Dan mentioned to me that Junkyard has "become known as a very experimental brewery with something new on tap every visit." Perfect for anyone seeking out another new combination that stems from the synergy of malt, hops, yeast, and water.

Just like any R&D operation, with some of that experimentation comes proprietary information and ownership. Peanut Butter Bandit is such an example. Although the first batch of the Bandit hit the taps at Junkyard mere months after opening, Dan and Aaron had already spent a considerable amount of time and money figuring out what product gave them the dry peanut flavor and finish they were looking for. What they ended up proceeding with would be fiscally unreasonable even for a homebrewer. Darn, a dead end. But what was that about necessity again?

One of the largest concerns with adding peanuts to a beer centers on the slick and unpleasant mouthfeel contributions and impedance of head formation/retention due to peanuts' significant oil content. When compared to other eating nuts (almonds, walnuts, cashews, pine nuts, etc.), peanuts share a similar profile to another nut used commonly in brewing, the hazelnut. And as luck would have it, the "Tips From the Pros" section in the March-April 2017 edition of *BYO* focused on the use of nuts in brewing with Jamil Zainasheff focusing on hazelnuts that he uses for his chocolate hazelnut porter. The take-home message is that 100% nut extracts don't cut it; by the time you'd used enough to impart the necessary flavor in your beer, you've also added other undesirable flavors such as medicinal or alcoholic attributes. Dan also agreed that using peanut powders leaves such an impression on the drinker.

So where does that leave us? . . . Using the real thing. There are many partial extract peanut options out there depending on where you live and your accessibility to them. Look for fresh options with best buy dates and a maximum oil removal of 80%. This will ensure there's still enough oil and consequently flavor in the product. You could also attempt to de-oil peanut butter. It's a multi-week process that I honestly can't recommend. But if you're a brave soul, who's up for the challenge, perform an internet search and you'll have multiple references on the procedure. The third and final option is to use fresh peanuts. I'd start with ones already shelled to simplify your life. If they're unroasted, pop them in the oven at 350 °F (177 °C) for 15–20 min. on parchment paper. This will not only intensify the flavors but also give you the opportunity to rest the nuts on paper towels, which will absorb the excess oil that leached out.

Whichever method you choose, aim to add the nut component near the end of primary fermentation. This will prevent CO_2 from scrubbing away the delicate, complex flavors of the peanut, which will be extracted even further with the bit of alcohol that's already been produced. Also, it will give the yeast a chance to use and/or sequester some of the residual oil present in your nut addition. Pull a sample of your nearly complete beer and doctor this smaller portion to determine how much you need to add to the main batch. Sometimes less is more while at other times more truly is more; it'll all depend on your peanut source.

At the end of your experimental, resilient brewing, you should be rewarded with a sweet stout with a biscuit malt backbone, rich, dark chocolate flvors, subtle sweetness that stops short of being cloying, all with an undercurrent of peanuts that ties everything together. Cheers!

JUNKYARD BREWING CO.'S PEANUT BUTTER BANDIT CLONE

(5 gallons/19 L, all-grain)
OG = 1.070 FG = 1.017
IBU = 23 SRM = 42 ABV = 6.9%

INGREDIENTS

10 lbs. (4.54 kg) Maris Otter pale ale malt
2 lbs. (0.91 kg) dark Munich malt (20 °L)
1.5 lbs. (0.68 kg) crystal malt (120 °L)
0.75 lb. (0.34 kg) pale chocolate malt
0.50 lb. (0.23 kg) chocolate malt
0.25 lb. (0.11 kg) roasted barley malt (300 °L)
0.25 lb. (0.11 kg) to 0.75 lb. (0.34 kg) peanut component
6.5 AAU Magnum hops (60 min.) (0.5 oz./14 g at 13% alpha acids)
Wyeast 1056 (American Ale) yeast or White Labs WLP001 (California Ale) or Safale US-05 yeast
¾ cup corn sugar (if priming)

STEP BY STEP

Mill the grains, then mix with 4.7 gallons (17.7 L) of 169 °F (76 °C) strike water to reach a mash temperature of 154 °F (68 °C). Hold this temperature for 60 minutes.

Vorlauf until your runnings are clear then sparge the grains with 4.5 gallons (17 L) of water and top up as necessary to obtain 6.5 gallons (25 L) of wort. Boil for 60 minutes, adding hops at the beginning of the boil. Add kettle fining if needed at 10 minutes left.

After the boil and whirlpool, rapidly chill the wort to slightly below fermentation temperature, which is 66 °F (19 °C) for this beer. Pitch yeast.

Maintain fermentation temperature of 66 °F (19 °C), for ten days or until the completion of primary fermentation, whichever is later. Now, add your peanut butter source, utilizing one (or more) of the three options outlined in the column. Then, reduce temperature to 32 °F (0 °C), and bottle or keg the beer and carbonate to approximately 2.5 volumes.

JUNKYARD BREWING CO.'S PEANUT BUTTER BANDIT CLONE

(5 gallons/19 L,
extract with grains)
OG = 1.070 FG = 1.018
IBU = 23 SRM = 41 ABV = 7.0%

INGREDIENTS

6 lbs (2.72 kg) light dried malt extract
0.5 lbs (0.23 kg) Munich liquid malt extract
1.5 lbs. (0.68 kg) crystal malt (120 °L)
0.75 lb. (0.34 kg) pale chocolate malt
0.50 lb. (0.23 kg) chocolate malt
0.25 lb. (0.11 kg) roasted barley malt (300 °L)
0.25 lb (0.11 kg) to 0.75 lb. (0.34 kg) peanut component
6.5 AAU Magnum hops (60 min.) (0.5 oz./14 g at 13% alpha acids)
Wyeast 1056 (American Ale) yeast or White Labs WLP001 (California Ale) or Safale US-05 yeast
¾ cup corn sugar (if priming)

STEP BY STEP

Mill the specialty grains and then steep them for 30 minutes in ~154 °F (68 °C) of 5.0 gallons (18.9 L) of water. Remove the grains and drain. Add the malt extract, while stirring, to ensure complete dissolution. Bring the mixture to a boil. Add the hops and boil for 60 minutes. Add kettle fining if needed at 10 minutes left in the boil.

After the boil and a 5 minute whirlpool, rapidly chill the wort to slightly below fermentation temperature, which is 66 °F (19 °C) for this beer. Pitch yeast.

Maintain fermentation temperature of 66 °F (19 °C), for ten days or until the completion of primary fermentation, whichever is later. Now, add your peanut butter source. Then, reduce temperature to 32 °F (0 °C), and bottle or keg the beer and carbonate to approximately 2.5 volumes.

TIPS FOR SUCCESS:

In order to make the closest beer to Junkyard's Peanut Butter Bandit, Dan Juhnke recommends focusing on three aspects. The first is for the all-grain brewers. Junkyard tries to hit a mash pH of 5.3, which leads to a kettle pH of 5.0 and a final beer pH of 4.3–4.5. Anything lower than those numbers results in a thin, acrid beer. Your water profile will more than likely vary from theirs but look to add baking soda ($NaHCO_3$) in the mash to counteract the acidity from the roasted grains. The second tip is oxygenation. Use pure oxygen and a sanitized diffuser stone on a low flow rate for up to 1 minute prior to pitching your yeast. Finally, here comes the peanut butter. Dan recommends to "try out as many different products as you can, even try combining things. Always mix things in a test sample before adding them to your batch. 70% of products out there will ruin your beer." BYO

BY DAVE GREEN

BREW-IN-A-BAG (BIAB)

Make the most of your bagged mash

The BIAB system has grown from its roots in Australian homebrewing culture to become popular worldwide. We got advice from two brewers well steeped in the system of mashing in a bag to describe pitfalls, dispel myths, and provide guidance for those who utilize or plan to utilize a BIAB system.

The weight of the grain pressing on the bag naturally drains more wort than a standard lauter tun, and you therefore get more wort from the same size mash . . .

John Palmer is the author of How to Brew *and co-author of* Water – A Comprehensive Guide for Brewers *and serves as the Publications Director for the Master Brewers Association of the Americas. He is also a member of the American Society of Brewing Chemists and the Brewers Association. As an engineer, John is keenly interested in the nuts and bolts of the brewing process and he frequently travels to conferences all over the world to share what he has learned. He lives near Pasadena, California.*

Brew-in-a-bag (or basket) might actually be the original homebrewing method from thousands of years ago, and traditional mash and lauter tuns may actually be new-fangled contraptions to enable large-scale brewing in the relatively recent past centuries.

Generally speaking, the efficiency of BIAB should be between 74–84% for beer OGs between 1.040–1.075, lower OG having higher efficiency than high OG. Crushing the grist finer/smaller will increase efficiency by a few percent, but I really don't recommend doing that as it will increase the fines in your wort and slow the draining from the bag. If you plan your grain bills conservatively, you should easily hit your OG target. The BIAB water retention factor, 0.25 quart per pound of grain, is typically half that of a standard mash 0.5 quart per pound. In liters and kilograms, these numbers are roughly 0.5 liter per kilogram and 1 liter per kilogram. The weight of the grain pressing on the bag naturally drains more wort than a standard lauter tun, and you therefore get more wort from the same size mash, all else being equal.

The high water-to-grist ratio can cause problems with the mash pH if you have high alkalinity water – and many people do. What is high alkalinity water? Look at your water report for Total Alkalinity as Calcium Carbonate. If this number is 100 ppm or greater, your alkalinity is high. If it is more than 150, then it is very high.

Dark beers can often be brewed with high alkalinity water without having pH/flavor problems, but very high alkalinity often results in high mash and wort pH and harsh flavors. Those with high alkalinity water, I recommend you dilute that water 50/50 with distilled water, and/or use some acidulated malt or brewing acid (ex. lactic acid) to help neutralize the alkalinity and bring the mash pH down into the recommended range, 5.2–5.6 (on a cooled sample about 5–15 minutes after mashing-in).

There are two reasons to squeeze the bag: 1. Squeeze it a little bit to prevent it from dripping on the floor, and 2. Squeeze it quite a bit to wring out every milliliter of wort. Option 1 — A little bit, is never a bad idea. Option 2 — A lot, depends on the kind of grain you are mashing. The base malts and low-color and caramel malts give up their extract easily, so squeezing the bag gives you retained wort instead of retained extract. Roast malts and high-color caramel malts, like Special B, don't give up their extract easily, and aggressively squeezing the grain bag will release more of the roast compounds into the wort. These compounds can taste quite harsh.

Too high a wort pH can commonly lead to tannin and silicate extraction from the grain, but excess pressure can excrete these compounds into your wort as well. So in general, I don't recommend squeezing the bag to wring every last drop, and in particular, I certainly don't recommend it when you are brewing dark beers. See my article, "Mechanics and Chemistry of Steeping" in the March-April 2016 issue of BYO.

This is just a partial transcript; to read more tips from John Palmer on this topic, find his complete transcript at byo.com/article/biab-tips-from-the-pros

Rex Slagel is the founder of The Brew Bag® - a manufacturer of fabric filters for beer, juice, coffee, tea, and many things he's not aware of. He's brewed over 100 batches using The Brew Bag® and although he's witnessed sparging a few times, he's never done it. He lives outside Chicago with his wife of 36 years.

The biggest question is whether to squeeze the bag or not. My advice: Squeeze — leave no wort behind. Excess tannins taste astringent and generally result from over-sparging when the pH rises above 5.8 at mash temps. When full volume mashing (as occurs in BIAB) followed by no sparge, the pH doesn't change.

The other misconception is beer clarity, I don't think there are clarity concerns when using a fabric filter — it's just a filter. I believe there's not enough information to support the controversy about this issue. Brewers have always had clarity issues, but when they switch to using a fabric filter and have a cloudy beer they point to the obvious variable — without true controls to rationalize the outcome. I've never sparged and always squeezed and I'll refer to the many awards using this process.

One special consideration that I feel brewers should address when attempting their first BIAB is their kettle size. A good rule of thumb is 2.5 times batch size = kettle volume. A 10-gallon (38-L) kettle will allow a 5-gallon (19-L) batch, but when pushing the volume up to retain that water-to-grain ratio for high gravity beers, the extra space is beneficial.

A fellow brewer and I tracked 150 or so batches and we both averaged 78.5% extract efficiency for our mashes. That means reduced grain bills off of the 72% to 74% efficiency typical of sparge results. A hidden factor is the amount of wort tossed away into the compost or garbage when sparging. Using a fabric filter and no sparge, all of that wort is transferred to the boil kettle so the efficiency is 100% of the available wort — leave no wort behind.

One technique I've utilized with success is a modified parti-gyle. You can lift the grain out of the kettle and drop it into a cooler. With a few additional pounds of grain you can double your volume by only adding the boil time of the second batch. The first is boiling while the second is mashing. And by changing the grain addition you can create a porter from a Kölsch, or whatever you choose. BYO

BY ASHTON LEWIS

BREWING A HOP BOMB

Also: Yeast dosing specifics and carbonating in a unitank

Q I AM A TOTAL AND COMPLETE HOP HEAD, AND HERE IS MY QUESTION FOR YOU: HOW ARE SO MANY BREWERS GETTING SO MUCH AROMA AND FLAVOR IN THEIR BEERS (MAINLY IPAS AND PALE ALES)? I'VE USED MANY HOPPING TECHNIQUES OVER MANY YEARS, AND STILL HAVEN'T BEEN ABLE TO ACHIEVE WHAT THEY'RE GETTING. MOST RECENTLY I'VE USED MORE LATE HOPS, HOP STANDS, DRY HOPS, AND EVEN CRYO HOPS.

RICK PFARR
MARYSVILLE, OHIO

A As simple as it sounds, many brewers who are brewing super hoppy beers are using lots and lots of hops! And I do mean lots of hops. Back in the 1980s, few beers in the world contained more than 1 pound of hops per US beer barrel (this is equivalent to 2.6 ounces/5 gallon batch, 3.9 grams/liter, or 0.4 kg /hl). This metric refers to the total weight of hops added to beer during the process. A respectively hopped Pilsner has about ½ pound/BBL (2 g/L) when low-alpha, noble hops are exclusively used in the brewhouse. Today, it is possible to buy beers that are hopped in the 3–5 pound/BBL (12–20 g/L) range. Looking for obscenely hoppy beer? Check out brewers boasting hopping rates in the 10 lbs./BBL (40 g/L) range.

Personally, I think this gratuitous use of hops is like driving a gas guzzler from the '60s that uses gas like water, but to each their own. If you want tons of hop aroma and flavor in your beer, sometimes you need to use a ton of hops! But why is it that some brewers are better at this game than others?

One of the real tricks to brewing terrific hop bombs is by starting off with the best hops. Seriously, if you want to grill the best steak at home you need to start with a terrific piece of meat. Brewing the best hoppy beer is not different, except the market is different. The fact is that most homebrewers and small-scale commercial brewers don't go to the hop market to pick out the hops that will be used in their beer. You may go to a homebrew store or order hops from a supplier known for great products, but this is not the same as picking out your hops at the hop market. Commercial brewers who have hop contracts with hop growers and/or hop merchants can, in fact, go to the hop market during harvest to select lots of hops for their contracts. And homebrewers who live near hopyards, whether the hopyard is in your backyard or within a reasonable road trip from home, can also travel to the hop market.

Going to the hop market is not like going to the local gourmet grocery store because you typically don't leave with a bag of hops. The purpose of hop selection, which is really what happens at the hop market, is choosing lots of harvested hops (a lot refers to bales of hops harvested from an area, so a sample from one bale is used to represent the lot) before they are processed. In the days when all breweries used cone hops, a trip to the market could end with a bale of hops in the back of the pick-up. But today most brewers use pellet hops, and the selected hops are pelletized by hop processors following selection. The real take-home here is

One of the real tricks to brewing terrific hop bombs is by starting off with the best hops.

Photo by Michael Tonsmeire

that brewers who select hops have a leg up on brewing hoppy beers because not all hops are created equally. I will get back to hop oils and products like Cryo hops in a moment, but let's move onto brewing process.

The trend with these hop bombs has been adding hops at multiple points in the brewing process, with a real focus on adding hops later in the game. Rewind the clock 20 years and you land in a world where few craft brewers were dry hopping or whirlpool hopping. And the brewers who did use these methods were looking for a bump in aroma to let folks smell hops in beer. No one was really thinking of brewing beers that smelled like hop juice. Words like Torpedo, hop bursting, biotransformation, and Randall had no hopcentric meaning to brewers. Today, there are few hop heads who don't know what these terms mean.

OK, so how does this help you? For starters, seek out the best hops you can find. This may involve posing all sorts of questions to your local homebrew supplier, seeking hops from local breweries who have the inside track on certain varieties, or getting to know some hop farmers. The next thing you need to do is add hops early and often. Mash down that hop pedal and start adding!

Hop character can be layered into beer by adding hops to the kettle, whirlpool, late in fermentation, at the end of fermentation, and to the serving vessel. But there are two major problems with this strategy. The first is crazy beer losses associated with the beer sponges that brewers call hops. Add enough hops to beer, and there is no beer left to drink. While this is a slight exaggeration, some commercial breweries have staggeringly expensive, hop-associated, beer losses that approach 30%. The other commercial problem is that hops are expensive, and if hopping rates are pushed into the 5–10 pound/BBL (20–40 g/L) range the selling price of the beer must reflect this massive increase to the cost of raw materials. These are very real challenges to the business of brewing, so creative solutions continue to follow the trend in hoppy beers.

This is where ingredient and process technology enters into the conversation. Hopping method can reduce the hopping rate required to achieve a given level of hoppiness. Commercial breweries have a major leg up on homebrewers because large kettles, whirlpools, and fermenters have a smaller surface-to-volume ratio, thereby minimizing aroma loss at surfaces. Aside from that difference, specialized hop backs, dry hopping vessels, and new hopping methods like late fermentation hopping have all improved hop aroma yield in beers. The ingredient improvements are also quite real. New hop oils, Cryo hops, greater availability of Type 45 (and other) pellets, and enzyme treatments aimed at biochemically changing the volatility of hop oils are some examples of advancements in the ingredient world.

I want to end this answer with a few tips suggested by craft brewer extraordinaire and *BYO* reviewer, Mitch Steele, whose reviews of my columns are always much appreciated. So here are some great concluding points from Mitch:

- Do consider multiple dry hop additions, but remove the first addition before adding the second. Independent of the number of additions, remove hop material after two days contact time. This will maximize extraction of the good oils you want and minimize the addition of vegetative and/or stem flavors.
- Minimize oxygen pickup when dry hopping. Nothing pulls out hop aromatics faster from your beer than exposure to oxygen. Admittedly, this is very hard in a homebrew set up, and if trying to do multiple dry hops, but it is something to work hard to accomplish.
- Hop oils are a nice way to augment hop flavor and aromatic intensity. I don't like using them in place of pellet hops, but adding a small amount along with the pellets can help increase flavor intensity and how long the hop flavors last in the beer.

Q AS PART OF YOUR "TOP HOMEBREWER TIPS" ON PAGE 25 OF THE MAY-JUNE 2018 ISSUE OF *BYO*, YOU ADVISE TO "CLARIFY, RACK AND DOSE WHEN BOTTLE CONDITIONING" WITH SUGAR AND "DRIED YEAST ADDED AT THE RATE OF 0.2 G/L."

I AM WONDERING WHAT GENERAL METHOD YOU SUGGEST TO ACCOMPLISH THIS. SPRINKLING SOME US-05 INTO MY BOTTLING BUCKET WITH THE USUAL DOSE OF PRIMING SUGAR DOES NOT SEEM LIKE THE RIGHT IDEA. DO I COLD CRASH ALONG THE WAY?

ALEX WASOWICZ
DAVIDSON, NORTH CAROLINA

A The basic method for this process uses a carboy and plastic bottling bucket, and begins with relatively clear beer. If you want maximal clarity, cold crashing definitely makes a big difference; this is true of gravity clarified, fined, and filtered beers. Independent of clarifying methods you may use, ale fermented at 68 °F (20 °C) contains about 0.8 volumes of carbon dioxide (1.6 g/L) after non-pressurized fermentation, and lager fermented at 50 °F (10 °C) contains about 1.1 volumes of carbon dioxide (2.2 g/L) after non-pressurized fermentation. You need to know the base-line carbonation level so you can calculate how much sugar to add to achieve the desired level in your beer, and you must know your beer volume. The volume is also needed to determine how much yeast to add. I will come back to some basic calculations, but want to stick to process for the moment.

Using this basic set up of carboy and bottling bucket, you start by determining the beer volume in the bottling bucket because the dosing rate of yeast and sugar ties directly to beer volume (I will get to these details in moment). Next, hydrate your dried yeast in about 100 mL (3.4 fl. oz.) of boiled and cooled water, make up your priming sugar as usual, and very gently stir these into your beer to mix. At this stage of the process, your beer may be warm or cold depending on the use of a cold-crash step; it really makes no difference at this point. If you bottle the beer within an hour, you should have no major issues with yeast settling in the bucket, but if this concerns you, gently stir the bucket a couple of times during the bottle run. The basic set up has two main limitations: The first is that the beer is flat going into the bottle, and the second is the very real risk of oxygen pick-up and subsequent oxidation when using an open bottling bucket.

Yes, I did just write that flat beer going into the bottle is a limitation to this method of bottle conditioning. While bottle conditioning does add carbonation to the beer in the bottle, hence the term bottle conditioned, it is not the only source of carbon dioxide. In fact, most commercial brewers who bottle condition their beers use the method to improve shelf life and/or achieve higher carbon dioxide levels than are possible by bottling carbonated beer (anything over about 3.0 volumes or 6 g/L is not practical due to excessive foaming).

A more advanced bottle conditioning technique is to add priming sugar and yeast to a keg of beer that is carbonated to about 2.2 volumes (4.4 g/L) of CO_2. This method presents the challenge of knowing how much beer is in the keg, but also makes the mixing process less risky from an oxygen pick-up perspective. The easiest way to know how many liters of beer are in the keg is by weight. Simply weigh the keg before and after filling (kilograms are used for simplicity), and dividing the difference in weight by the specific gravity of the beer. For example, if the empty keg weighs 1.5 kg (3.3 lbs.) and the full keg weighs 19 kg (42 lbs.), the beer weight is 17.5 kg (38.6 lbs.). Divide

this by the beer specific gravity and you now know beer volume. For example, if the final gravity after fermentation is 1.008, 17.5 kg (38.6 lbs.) ÷ 1.008 kg/l (38.4 lbs.) = 17.4 liters (18.4 qts.). As long as the keg was purged with carbon dioxide before filling, you can gently rock the keg to mix your yeast and sugar solutions with your beer. After allowing the beer to rest for a few minutes, you can bottle using a counter-pressure filler and cap on foam for the best shelf life. Again, the reason for bottle conditioning is not just beer carbonation. This method gives you better beer stability in the bottle and it also allows you to produce highly carbonated beers without struggling during filling.

Both of the methods described above discuss bottling cold beer. It is important to store the filled bottles at room temperature for conditioning. Since fresh yeast is being used, the process is typically complete within 2 weeks of bottling.

Now that the process has been discussed, what about the math? I like to use grams of CO_2/liter of beer because the math is easiest (2.00 grams of carbon dioxide per liter of beer equals 1.02 volumes of carbon dioxide). Chemistry shows that 2.05 grams of glucose produces 1 gram of carbon dioxide when fermented (dextrose, corn sugar, and invert sugar are common names for glucose). So here are two examples for a "flat ale" and a lightly carbonated lager:

Flat Hefe Weizen (ale) Example

- 17.4 L of beer
- Estimated carbonation level is 1.6 g/L (20 °C at 0 psig)
- Target carbonation level of 7.0 g/L using corn sugar (sorry speise lovers!)
- Need to increase carbonation by 5.4 g/L (7.0 g/L – 1.6g/L)
- 17.4 liters beer x 5.4 g CO_2/liters beer x 2.05 g glucose/g CO_2 = 192.6 grams glucose
- 193 grams ÷ 28.4 grams/ounce = 6.8 ounces glucose
- Target 0.5 to 1.0 million yeast cells per mL of beer using dried yeast with density >6 billion cells per mL; add 0.1-0.2 grams of yeast per liter of beer
- 17.4 liters beer x 0.1-0.2 grams yeast/liter = 1.8 to 3.5 grams of yeast

Carbonated Lager Example

- 17.4 L of beer
- Estimated carbonation level of 4.4 g/L
- Target carbonation level of 5.2 g/L using corn sugar
- Need to increase carbonation by 0.8 g/L (5.2 g/L - 4.4 g/L)
- 17.4 liters beer x 0.8 g CO_2/liters beer x 2.05 g glucose/g CO_2 = 28.5 grams glucose
- 28.5 grams ÷ 28.4 grams/ounce = 1.0 ounces glucose
- Target 0.5 to 1.0 million yeast cells per ml of beer using dried yeast with density >6 billion cells per ml; add 0.1-0.2 grams of yeast per liter of beer
- 17.4 liters beer x 0.1-0.2 grams yeast/liter = 1.8 to 3.5 grams of yeast

Q I'VE BEEN BREWING NOW FOR AROUND 2 YEARS AND ALWAYS BOTTLED THE BEER OUT OF MY PLASTIC BUCKETS. RECENTLY, I STEPPED MY GAME UP A BIT AND PLUNGED INTO THE REALMS OF Ss BREWTECH'S 7 GALLON (26.5 L) CHRONICAL. GREAT BITS OF KIT, REALLY IMPRESSED. SO, I NOW HAVE A UNITANK AND A GLYCOL CHILLER. MY QUESTION IS HOW DO I GO ABOUT CARBONATION USING THE UNITANK AND CARBONATION STONE?

CAN'T SEEM TO FIND AN AWFUL LOT ONLINE REGARDING THE ACTUAL METHOD AND HOW LONG TO CARBONATE. I'VE JUST DONE A TRIAL ON A LAGER THAT I RUINED DUE TO LEAVING IT ON THE YEAST FOR TOO LONG SO DIDN'T MIND OVER-CARBONATING OR WASTING IT. MY STEPS WERE AS FOLLOWS:

- TEMPERATURE SET TO 3 °C (37 °F)
- CRANK THE CO_2 PRESSURE UP TO 20 PSI (138 KPA) AND LEFT IT FOR APPROXIMATELY 1 HOUR
- BEING SCARED OF OVER-CARBONATING, REDUCED THE PRESSURE DOWN TO DESIRED 10 PSI (69 KPA) TO GIVE AROUND THE 2.4 MARK, AND LEFT IT FOR A FEW DAYS IN THE UNITANK AT THIS PRESSURE.

CAME BACK TO IT AT THE WEEKEND AND IT FELT UNDER-CARBONATED. ANY ADVICE ON THIS? I LIKE DOING MY RESEARCH AND WOULD LIKE A TRIED AND TESTED METHOD USING A CARBONATION STONE.

JAMES BROADBENT
WAKEFIELD, ENGLAND

A There a few ways to go about carbonating beer using a stone, and I think your approach is sound, but needs a few changes. I will review the method that has worked for us at the Springfield Brewing Company in Springfield, Missouri for the last 20 years because what we have is not too different from the set up you describe. Our nominal batch size is 20 hL (2,000 liters or 528 gallons), so our tanks are not so large to be totally different beasts. The beers that we carbonate or nitrogenate with a stone are adjusted in the bright beer tank, and then dispensed directly to our taps. Just giving a bit of background to establish that I will be describing something that

Photo courtesy of MoreBeer Pro!

is routinely used for this process.

There are really two key pieces of data that you need to know about your system. One is the pressure required to push gas through your carbonation stone; in engineering lingo this is called the pressure drop, or ΔP, across the stone. Pressure drop is important because it lets you know the pressure after the gas flows through the stone. The easiest way to determine the ΔP is to connect your stone to a carbon dioxide line with a gas regulator controlling the pressure to the stone, submerge the stone in a bucket of water, and slowly increase the pressure while watching the stone for bubbles. When you see gas bubbles flowing from the stone, you have determined the ΔP across the stone. It may be a good idea to check this a few times to verify your findings. A typical value is about 2 psi (14 kPa). Beer deposits, like beer stone or calcium oxalate, will increase the ΔP across the stone, so this is a good reason to soak stones in acid after use. I will come back to ΔP in a moment.

The second value you need to determine is the hydrostatic pressure exerted by the beer when your tank is full. In small tanks this value is negligible, but it exists, so let's not ignore it. A medium-sized tank in a pub may be 10 feet tall (3 m) and the beer level at 8 feet (2.4 m) above the tank bottom when the tank is full. A one foot (30.5 cm) column of beer exerts approxi-

mately 0.43 psi (3 kPa) of pressure, so 8 feet (2.4 m) of beer is equal to 3.4 psi (24 kPa). This value is often called liquid head by engineers. This is where things get a little fuzzy; serving tanks and kegs change level when used, so the liquid head changes over time. I figure the average height between full and empty is about as exacting as one can be, so I would use 1.7 psi (12 kPa) for the liquid head value in this example. This beer height in your 7 gallon (26.5 L) tank is about 3 feet (0.9 m), so your average liquid head is about 0.7 psi (5 kPa).

Now that we have the ΔP across your stone and the average liquid head of your beer, we need to know the carbon dioxide pressure required to hit the desired carbonation level. Your target of 2.4 volumes is actually a bit low, so your test beer may have seemed a bit low in CO_2 because of your target value. For the purpose of this example, I am going to bump this value to 2.5 volumes. Referring to a gas chart, for example http://www.zahmnagel.com/wp-content/uploads/2017/04/Zahm-Nagel-CO2-in-Beer-Chart.pdf, the pressure at 3 °C (37 °F) required for 2.5 volumes can be determined, and that pressure is about 11.5 psi (79 kPa).

Now it's time to use the pressure drop and static head information. The pressure drop must be overcome by adding more pressure, so the 11.5 psi (79 kPa) required for carbonation needs to be increased, and the liquid head increases gas solubility by adding pressure to the system, so this value is subtracted. The resulting math looks like this:

Target pressure delivered to the inlet of the stone = 11.5 psi (79 kPa) + 2 psi (14 kPa) – 0.7 psi (5 kPa) = 12.8 psi (88 kPa).

The easiest and most robust method is to adjust your gas pressure to 12.8 psi (88 kPa), open the valve to the stone, and leave things be for 24-36 hours. This should be plenty of time for the system come to equilibrium. The stone size does factor into this because the size is related to area, and insufficient area will slow down the gas transfer rate (as will a dirty stone), but this is unlikely with a 7-gallon (26.5-L) tank.

A variation on this theme that can really speed things up is to use an adjustable pressure relief valve on the top of your tank, and adjust this pressure to the pressure fetched from the chart minus your liquid head; 11.5 psi (79 kPa) – 0.7 psi (5 kPa) = 10.8 psi (74 kPa). Then bump the 12.8 psi (88 kPa) in the example above by about 0.2 (1.4 kPa) to 13 psi (90 kPa). What will happen is that a slow flow of carbon dioxide will escape from the relief valve as an excess of gas constantly flows into the system because we have set the conditions up to force a flow of gas through the beer. Depending on the size of your stone, this method will carbonate your beer in about an hour. It is important not to get too carried away with the inlet pressure because this method will cause foaming if too much gas flows through the beer. It also may result in aroma loss, beer loss, and reduced foam stability, not to mention a potential mess if foam spits out of the pressure relief valve. BYO

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AMERICAN IPA

The flagship American craft beer

The modern American IPA has many different control points that brewers can experiment with in order to make their own signature beer.

AMERICAN IPA BY THE NUMBERS

OG:	1.056–1.070
FG:	1.008–1.014
SRM:	6–14
IBU:	40–70
ABV:	5.5–7.5%

What more can be said about American IPA? Everyone knows what it is, and everyone has tried it. It continues to be the most popular style of craft beer by sales, and it tends to dominate beer competitions (both homebrew and commercial). Yet, if you haven't been drinking and brewing these beers for years, you may not realize how much change it has undergone and how many different ways you can make it.

The modern American IPA has many different control points that brewers can experiment with in order to make their own signature beer. Grist composition, water profile, hop varieties, and hopping techniques are but a few that we will explore in this article. There is no one right answer; IPA is a very broad style family, and it continues to evolve and be the subject of new experimentation. It all really comes down to the vision of the brewer – what kind of beer do you want to make?

HISTORY

IPA as a style of beer originated in England in the late 1700s as a pale ale that was prepared for shipment to India. Although not called India pale ale at the time, it gained this name as its popularity grew. Many fanciful stories and wild speculation have surrounded this type of beer ever since. The one thing known for certain is that it was a heavily hopped and well-attenuated beer so as to survive the sea journey and temperature changes and arrive in good condition.

IPAs were brewed in America, as were many styles originating in Europe. One of the most long-lived and well-regarded examples was Ballantine IPA, which was oak-aged and made using an old English recipe. Although it is now owned by Pabst and can be occasionally seen as a relaunched craft beer, it's not the same beer from Newark, New Jersey that is often described as an influence for modern American craft beer. Although not confirmed, it is widely believed that the yeast from Ballantine is what became the "Chico" yeast used at Sierra Nevada.

The style known as American IPA in the modern craft era traces its roots to Anchor Liberty Ale, first brewed in San Francisco in 1975. While the style has moved beyond this original example, it certainly set the standard for years. Featuring whole Cascade hops (the signature hop for many original craft beers), the beer was pale, dry, bitter, crisp, and hoppy. It wasn't excessively strong — at 5.9% it seems more like a pale ale today — but it was dry-hopped and used a base of pale 2-row malt.

Other early influential examples included Sierra Nevada Celebration Ale, which was darker and used more crystal malts, and Bert Grant's IPA – the first of the new craft beers to actually be called an IPA on the label, according to Michael Jackson. More experimentation ensued, and the style continued to change and evolve over time. What began as an English style took on an American character when the base malts and yeast became more neutral, and the hops became more citrusy.

Regional variations became more popular, as those brewed in the Eastern US tended to have more of a malty backbone, as exemplified by Harpoon IPA, and those in the Western US tended to be paler, drier, stronger, and more hop-forward. Double IPAs split off, and showed that a stronger hoppy beer didn't have to be a barleywine. More recent variants have played with the water profile to emphasize a drier or wetter finish, and the huge influx of new hop varieties have given brewers even more toys for their playground.

My how times have changed . . .

Now it seems like every other beer on the shelf is labeled "IPA," and it has spawned countless variants in a rainbow of colors, variety of strengths, and (more dubiously) a plethora of clarities. The beer-consuming public certainly identifies "IPA" with "craft beer," and anything called an IPA seems to sell. I sometimes wonder how many people today know what IPA actually means, since none of these beers ever went to India, many aren't pale, and some aren't even ales. IPA has moved beyond an acronym for India pale ale, and has become its own word.

In all this change, however, let us not forget what an IPA is, and has always been: A pale, clear, dry, bitter, hoppy beer. If you build variants upon IPA, so be it; but the basic understanding is that the core beer should have these attributes, especially hoppiness.

SENSORY PROFILE

Nowadays there are many variants of IPA, let's just talk about the original craft beer – the American IPA, BJCP Style 21A. The BJCP Style Guidelines describe this style as, "a decidedly hoppy and bitter, moderately strong American pale ale, showcasing modern American or New World hop varieties. The balance is hop-forward, with a clean fermentation profile, dry-ish finish, and clean, supporting malt allowing a creative range of hop character to shine through."

In the 2008 BJCP Style Guidelines, the American IPA style assumed American hops were used, and that American hops had a fairly restricted range (citrus, pine, resin, floral, fruit). But then the style had problems when newer hops were introduced with different characteristics. The 2015 guidelines solves this problem by defining the hops by modern American or New World hops, which allows new characteristics to be included as hop varieties continue to be introduced.

The newer guidelines explicitly adds "spicy, tropical fruit, stone fruit, berry, melon, etc." to that list of IPA characteristics, and the New World hops mention Australian and New Zealand hops that can add tropical fruit, white grape, and other interesting

AMERICAN IPA

(5 gallons/19 L, all-grain)
OG = 1.061 FG = 1.011
IBU = 56 SRM = 6
ABV = 6.5%

INGREDIENTS

10 lbs. (4.5 kg) North American 2-row malt
2 lbs. (907 g) Vienna malt
8 oz. (227 g) Caravienne or caramel malt (20 °L)
4 oz. (113 g) Carahell® malt or crystal malt (10 °L)
7.7 AAU Centennial hops (first wort hop) (0.75 oz./21 g at 10.3% alpha acid)
10.3 AAU Centennial hops (15 min.) (1 oz./28 g at 10.3% alpha acid)
10.3 AAU Centennial hops (5 min.) (1 oz./28 g at 10.3% alpha acid)
1 oz. (28 g) Centennial hops (1 min.)
2 oz. (57 g) Centennial hops (hop stand or dry hops)
Wyeast 1272 (American Ale II) or White Labs WLP051 (California Ale V) or Mangrove Jack's M36 (Liberty Bell Ale) yeast
¾ cup corn sugar (if priming)

STEP BY STEP

This recipe uses reverse osmosis (RO) water. Adjust all brewing water to a pH of 5.5 using phosphoric acid. Add 0.5 tsp. calcium chloride and 0.5 tsp. calcium sulfate to the mash.

Mash in base malts (2-row and Vienna) at 147 °F (64 °C) and rest for 60 minutes. Add crystal malts and raise to 168 °F (76 °C) for 15 minutes, recirculating the wort. Fly sparge with 170 °F (77 °C) water, collecting 6.5 gallons (25 L) of wort.

Boil the wort for 90 minutes, adding hops at the times indicated in the recipe. First wort hops are added directly to the boil kettle before lautering and sparging. The whirlpool hops are added after heat has been turned off and the wort has rested 15 minutes. Stir the hops in and rest an additional 15 minutes.

Chill the wort to 65 °F (18 °C), pitch the yeast, and ferment until complete. Rack the beer. If desired, add the dry hops for 3 days at room temperature. Rack and package the beer, or rack and clarify the beer if desired with finings before packaging (prime and bottle condition, or keg and force carbonate).

AMERICAN IPA

(5 gallons/19 L, extract with grains)
OG = 1.061 FG = 1.011
IBU = 56 SRM = 6 ABV = 6.5%

INGREDIENTS

7.8 lbs. (3.5 kg) pale liquid malt extract
8 oz. (227 g) Caravienne or caramel malt (20 °L)
4 oz. (113 g) Carahell® malt or crystal malt (10 °L)
7.7 AAU Centennial hops (first wort hop) (0.75 oz./21 g at 10.3% alpha acid)
10.3 AAU Centennial hops (15 min.) (1 oz./28 g at 10.3% alpha acid)
10.3 AAU Centennial hops (5 min.) (1 oz./28 g at 10.3% alpha acid)
1 oz. (28 g) Centennial hops (1 min.)
2 oz. (57 g) Centennial hops (hop stand or dry hop)
Wyeast 1272 (American Ale II) or White Labs WLP051 (California Ale V) or Mangrove Jack's M36 (Liberty Bell Ale) yeast
¾ cup corn sugar (if priming)

STEP BY STEP

Use 6 gallons (23 L) of water in the brew kettle; heat to 158 °F (70 °C). Steep the crystal malts for 30 minutes, then remove.

Turn off the heat. Add the malt extract and stir thoroughly to dissolve completely. You do not want to feel liquid extract at the bottom of the kettle when stirring with your spoon. Turn the heat back on, add the first wort hops, and bring to a boil.

Boil the wort for 60 minutes, adding remaining hops at the times indicated. Follow the all-grain step by step for remaining post-boil and fermentation directions.

aromatics. So the style can evolve as the hops available to brewers changes. Basically anything modern that isn't the classic Saazer or noble-type hops, or traditional English or other continental hops is likely in play.

So while the hop aromatics and flavors are widely variable (especially when combinations of hops are considered), the intensity is moderate to very high, but always prominent in the balance. The hops can also have a fresh character if dry hopping is used, but that technique shouldn't make the beer excessively grassy.

The malt aroma and flavor tends to be neutral and clean, with a low to medium-low intensity. There can be a little graininess, very light bready notes, or a little caramel sweetness present, but the malt needs to support the hops not compete with it. Any caramel character is light and lower in color as more intense and dark versions tend to clash with the hops.

The bitterness level tends to be medium-high to very high, but it should finish clean and dry without a harsh bitterness. The hops should be noticeable in the aftertaste, but a light maltiness can be present as well. The fermentation character is typically neutral, although a very light fruitiness is acceptable, particularly if it complements the hop varieties used.

The body is medium-light to medium; a heavy beer is harder to drink. Medium to medium-high carbonation helps keep it lively, and any alcohol character should be restrained. Stronger versions may have noticeable alcohol, but the beer should not burn. The beer is typically well-attenuated, although the impression of dryness may be affected by the water profile (higher sulfates increase dryness, while chlorides add more of a rounded mouthfeel).

Modern American IPAs tend to be fairly pale, gold or lighter in color. Some can be a bit darker, adding a light reddish-amber color, but care should be taken not to veer into the Red IPA style. With color comes flavor, and the darker colors tend to add flavors that are undesirable in American IPA. Most IPAs are clear, although a light hop haze is acceptable in unfiltered versions. A well-formed white head that persists is typical.

The IPA should be hoppy and bitter, clean and fresh, with malt in support. A wide range of hop character is allowable, and lets the brewer express their own creativity. Since there is a stronger Double IPA available as a style, the American IPA shouldn't be overly strong. Between the 6% and 7% range is fairly common. It should be hoppier in balance than an American Pale Ale and a bit stronger, but otherwise fairly similar.

BREWING INGREDIENTS AND METHODS

Hops, and lots of them. Next question? OK, there's more to it than that. Let's save the hops for last since that will be most of the discussion.

The grist can be as simple as all North American two-row pale malt, but I often like to mix it up a bit. You can use some more flavorful base malts such as Pilsner, Vienna, and Munich, but don't go overboard. If the maltiness is too rich, the beer won't taste right. Similarly, if English type malts (such as Maris Otter) are used, the beer can be too bready and biscuity, which can clash with the hops as well. So I like to keep it simple, often a mix of two-row and German Pilsner malt.

A little bit of crystal malt can be used, as long as it isn't too dark and too high a percentage. Something 40 °L or lower would be fine (I like to use crystal-type malts in the 20 °L range), and I'd limit it to less than 10% of the grist (something around 5% is fine). Often I will use Munich malt instead of crystal malt ("Munich is the new Crystal", as I like to say). This will give an extra maltiness to the beer without adding sweetness.

"The IPA should be hoppy and bitter, clean and fresh, with malt in support. A wide range of hop character is allowable, and lets the brewer express their own creativity."

Depending on the mash program, some brewers like to add some dextrin-type malts for body, but I think crystal and Munich malts can give some of that body too. On the other hand, some brewers will add white sugar or corn sugar to lighten the body (again, less than 10%) but I think of this as more appropriate for the higher strength Double IPAs.

Mash for attenuation, so aim for a conversion temperature between 146 °F and 151 °F (63-66 °C). Step mashes aren't typically used, but I don't have a problem with mashing this beer like a German altbier or Kölsch — 131 °F, 144 °F, 158 °F (55, 62, 70 °C). In general, I like to mash on the low side for proper attenuation and control the body through grist additions.

I mentioned how the water profile can affect the finished beer. I tend to dislike sulfur flavors in beer, so I usually avoid excessive use of gypsum (calcium sulfate). If I know I'm using a very attenuative mash program, I'll often use calcium chloride as my calcium source. Otherwise I'll use a balanced calcium sulfate and calcium chloride addition to the mash. I tend to save all calcium sulfate for English IPAs (this is often called "Burtonizing" the water).

The yeast for this style is American and neutral in character. The classic yeast is Chico yeast (Wyeast 1056, White

Labs WLP001, Safale US-05), but I also like using Wyeast 1272 American II (the yeast from Anchor Liberty), which can give a touch of fruitiness. Whatever yeast used should be attenuative and relatively neutral, and should drop bright. I've even used some English yeasts, such as the Fuller's yeast (White Labs WLP002, Wyeast 1968) fermented cool. German alt or Kölsch yeast could also do the trick.

Hop varieties can be anything American or New World, but don't muddy it by using too many varieties. I think some of the best IPAs I've tried have between one and four hop varieties. Amarillo® and Simcoe® are a nice pairing (Alpine Duet, one of my favorite IPAs, uses that mix), and Cascade and Centennial are wonderful together. Some newer varieties can add a great deal of interest but can often be quite pungent if used alone (I'm looking at you, Nelson Sauvin . . .). Newer varieties can give tropical fruit flavors, showing that you can make a "juicy" IPA without making a murky mess.

My recommendation for hops is to choose a theme for the flavor and aroma, and look for either a single hop that you know or pairings of hops that have complementary flavors. If you have a bittering addition, look for a variety with a clean bitterness like Magnum or Warrior. But you can often omit a bittering addition entirely by getting your IBUs from other hop techniques.

First wort hopping can give a smoother bitterness than a traditional 60- to 90-minute addition, and also gives quite a bit of hop flavor. This is my preferred method for adding a large amount of IBUs. Late hop additions (in the last 10 minutes) give more aroma, and also can provide IBUs. Even hops added at knockout will provide IBUs, provided the wort is hotter than around 180 °F (82 °C).

When I'm formulating a recipe for a hop-forward beer, I usually start with the late additions. I think about the quantity of hops to give me the aroma and flavor that I want, then I calculate how many IBUs those provide. Then I make up the remainder of the bitterness with first wort hops. You can, of course, do the classic bitterness, flavor, and aroma additions, but I like how the

late additions and first wort additions reduce the harshness in the beer.

Dry hopping is always an option, and can greatly enhance the fresh hop character of the beer. There are two warnings, however, with dry hopping. The first is to be careful in how the hops are added since you don't want to oxidize the beer, which will kill the wonderful fresh character. The second is to avoid grassiness from dry hopping, which is often a function of time, temperature, and quantity. Limit the contact time of dry hops to three to five days and the chances of grassiness is reduced. If more hop aroma is still needed, perform a second dry hopping after the first one is done.

HOMEBREW EXAMPLE

My recipe is a bit old school since I'm not using the latest sexy hop varieties. I'm just using good old Centennial, which was first called a "Super Cascade" when introduced. It has many of the same characteristics, like citrus, grapefruit, and pine. It's like talking to an old friend.

I'm using first wort hopping, hop bursting, and late whirlpool hops to get the hop character in my beer; no bittering additions and no dry hopping. After the boil is over, I let the beer stand for around 15 minutes to cool off and to improve clarity, then I add the last hop addition. Dry hopping is always an option, but I like this method to improve clarity and to reduce the risk of oxidation. I taste the beer a week before I intend to serve it and decide then if it needs some additional dry hopping.

The grist is mostly North American two-row, with some Vienna malt to provide a richer backbone and some 10-20 °L crystal type malts for a touch of sweetness and flavor. This is just to show that not all crystal malt is evil, and it can be used judiciously in an IPA.

I'm using the balanced water profile I described, with equal parts of calcium chloride and calcium sulfate to give around 50 ppm of calcium in the mash. As always, I'm using reverse osmosis water because my water is full of chalk and produces horrible hoppy beers.

The yeast I'm using is Wyeast 1272 (American Ale II), which always seems to make great IPAs for me. It's a personal favorite, and an homage to the original Anchor Liberty Ale. I keep fermentation temperatures restrained to help control ester production.

I'm targeting a beer of about 6.8% ABV and a final gravity of 1.011, which should be dry but not bone dry. The IBU estimate is 56, which is in my preferred range of 50-60. The interaction between FG, IBUs, and sulfate content of the water profile is how these beers are best fine-tuned in my opinion. Subtle changes can affect the balance quite a bit.

If some of these choices sound familiar to you, I'm also trying to make a beer in the general style of Bell's Two-Hearted Ale, one of my favorite IPAs from when I just started to brew. It's not meant to be a clone; I prefer the term "tribute." BYO

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THURSDAY, MARCH 21, 2019

INSIDER TOURS OF ASHEVILLE CRAFT BREWERIES - You'll tour – and taste – at four different craft breweries around Asheville during this pre-Boot Camp offering. You'll have the opportunity to meet brewers and ask questions in addition to sampling beers. Includes a meal. A great way to kickoff your Boot Camp experience and check out some of Asheville's booming craft beer scene.

FRIDAY, MARCH 22, 2019 ASHEVILLE BOOT CAMPS

Each Boot Camp will run from 10 a.m. to 5 p.m. and is limited to just 35 people. Your boot camp will include lunch, a lunch keynote with program, plus a post-Boot Camp Asheville Craft Beer Reception with local craft breweries pouring samples to wrap up your full day.

ADVANCED HOPPING TECHNIQUES – ***Josh Weikert*** – Join *BYO* Contributing Writer Josh Weikert as he explores when and how to add hops to create awesome hop-forward beers. You'll cover timing and techniques of hop usage including mash hopping, boil hopping, whirlpool/knockout hop stand additions, and dry hopping. You'll cover hop varietal choices, hop pairing/blending, evaluating hops including hop rubbing and sensory training, water adjustments and much more to get the most out of your hops and into your glass. *Please note this workshop will also be offered on Saturday as well.*

TROUBLESHOOTING HOMEBREW FAULTS & FIXES – ***Ashton Lewis*** – Join *Brew Your Own*'s Mr. Wizard and Technical Editor Ashton Lewis as he walks you through the potential minefield of beer flaws and faults homebrewers can face. You'll learn how to troubleshoot – and fix! – your own homebrews with Ashton who has helped thousands of homebrewers over the last 20 years as *BYO*'s Mr. Wizard. You'll have the chance to experience many faults first-hand to better recognize them later.

ALL-GRAIN BREWING ESSENTIALS – ***John Palmer & John Blichmann*** – Designed for intermediate to beginner homebrewers getting into all-grain brewing, this full-day workshop will cover all you need to know to successfully make great homebrews using all-grain brewing both with traditional and newer techniques. *How To Brew* best-selling author John Palmer and equipment guru John Blichmann will take you hands-on through the full all-grain process from milling, mashing, and sparging before going into the boil. You'll get to know the equipment, techniques, and ingredients first-hand and learn all-grain brewing by doing in a small-class environment. They'll also cover newer homebrew all-grain techniques such as Brew-in-a-Bag and No Sparge in addition to traditional mashing and some advanced tips as well.

ADVANCED ALL-GRAIN TECHNIQUES – ***Gordon Strong*** – Pull out the mash tun and get ready to learn advanced all-grain techniques hands-on with *Brew Your Own* Columnist, book author, and President of the Beer Judge Certification Program, Gordon Strong. Gordon will walk you through a world beyond straight infusion mashing with keys to mastering step mashing, sour mashing, and decoction mashing. Plus you'll learn about playing with mash thickness and other ways to control your all-grain wort production. *Please note this workshop will also be offered on Saturday as well.*

BARRELS & WOOD-AGING – ***Michael Tonsmeire*** – Learn how to choose, use, and maintain oak barrels – and oak alternatives – for your brewing. Barrels are a significant investment in money, time, and beer so understanding how to properly select and use them is essential. Learn hands-on from *Brew Your Own* Columnist and *American Sour Beers* book author Michael Tonsmeire. Michael will also cover options for barrel alternatives and how to best use the broad variety of available products such as chips, staves, and spirals including both oak and non-oak alternatives. This full-day workshop will also cover special brewing and recipe considerations to making beers to complement the flavors of woods, spirits, and wines to take your wood-aged beers to a new level.

HOMEBREW EXPERIMENTS – ***Denny Conn and Marshall Schott*** – Developing your own recipes, refining your own brewing techniques, and tweaking your equipment set-up all require the know-how to conduct your own homebrew experiments. Without reliable results you rely on guesswork instead of facts to improve your brewing. Join two of the true leaders in experimenting with homebrews – podcaster/book author Denny Conn from Experimental Brewing and blogger/podcaster Marshall Schott from Brülosophy – as they first walk you through how to properly conduct your own experiments at home including structured blind evaluation techniques, and then walk you through some real life homebrew case studies to show how these experiments can play out. Get ready to roll up your sleeves and get your science on! *Please note this workshop will also be offered on Saturday as well.*

ADVANCED RECIPE FORMULATION – ***Brad Smith*** – Create your own signature recipes and learn the keys to developing the specific grain bill, hop schedule, and ingredient proportions to meet your homebrewing goals. Brad Smith, *BYO* Contributor and BeerSmith software owner, has helped thousands of homebrewers design their own beer recipes and now you'll learn first-hand from this recipe building expert how to use both artistic and scientific approaches to beer design to end up with the beer you envisioned in your glass. You'll also explore ingredients, techniques, and understanding your own brewing system. *Please note this workshop will also be offered on Saturday as well.*

ADVANCED YEAST TECHNIQUES – ***Dr. Chris White*** – Join Dr. Chris White of White Labs as he discusses how to master different yeast-related techniques including harvesting yeast, figuring cell counts and viability, the do's and don'ts of repitching including steps such as yeast washing, building up a proper yeast starter, storing your yeast samples, and much more! Here's your unique chance to learn in a full-day seminar format about getting the most from your yeast from one of the true leaders in the beer yeast field.

TWO-DAY BOOTCAMP: COMMERCIAL BREWERY START-UP – ***Steve Parkes*** – When you register for this Boot Camp you will attend it for both Friday and Saturday unlike our other offerings to better cover more material in greater depth. Opening a commercial craft brewery is a far cry from just ramping up the amount of beer you brew. Over Friday and Saturday you'll walk through the steps, planning decisions, and keys you need to know on both the brewing and management side to successfully open a commercial craft brewery with the Lead Instructor and Owner of the American Brewers Guild Steve Parkes, who has trained hundreds of professional brewers. Learn from Steve's decades of expertise and wide range of experience to help you better achieve your goals. Over two full days you'll be guided through all the various elements you'll have to know for the next big step toward starting a craft brewery.

SATURDAY, MARCH 23, 2019 ASHEVILLE BOOT CAMPS

Each Boot Camp will run from 10 a.m. to 5 p.m. and is limited to 35 people. Your Boot Camp will include lunch, a lunch keynote with a program, plus a post-Boot Camp Asheville Craft Beer Reception with local craft breweries pouring samples to wrap up your full day.

SOUR BEER TECHNIQUES – ***Michael Tonsmeire*** – Learn hands-on traditional European as well as newer American methods to produce sour and funky beers from Michael Tonsmeire, the *Brew Your Own* Columnist who literally wrote the book on the subject with *American Sour Beers*. Michael will demonstrate the unique skills needed to create your own delicious sour beers including wort production (extract and all-grain), growing alternative microbes, blending, aging on fruit, and sanitation. The focus will be on practical topics difficult to convey by words alone, so no biology or chemistry degree required. You'll leave with a clear understanding of the processes to reliably produce sour beers suited to your palate and desired time frame.

HANDS-ON HOMEBREW SCIENCE – ***Ashton Lewis*** – Get hands-on with pH meters, refractometers, slants and loops, stir plates, centrifuges, and other brewing science gear with *BYO* Technical Editor and Mr. Wizard Columnist Ashton Lewis. Ashton will walk you through how to best use scientific gear at home to help you improve the quality of the beer. You'll have the chance to understand how to not only use and care for the equipment properly, but also how to take the results and put that data into action to produce better beer in your glass. This workshop will focus only on those pieces of equipment suitable – and affordable – for your homebrewery.

ADVANCED YEAST LAB – ***Kara Taylor*** – Join White Labs' Laboratory Operations Manager Kara Taylor for some hands-on yeast lab work to develop skills you can bring back home to help you make better beer. Learn how to accurately count yeast using a microscope, culturing yeast, using slants, harvesting yeast, washing and reusing yeast, propagation and determining growth rates, and more. Here's your chance to learn up close and personal what you may have read in books or magazines, or listened to in seminars, and Kara is the perfect teacher to lead you personally through the world of yeast using lab equipment you can source for your own home use.

BREWING WATER ADJUSTMENTS – ***John Palmer*** – Water is the least understood ingredient when making great beer. John Palmer, who literally wrote the definitive book on the subject, *Water: A Comprehensive Guide for Brewers*, will help take the mystery out of water's role in brewing and how to make better beer as a result. You'll learn how to read water reports, understand flavor contributions, and how to adjust your brewing water to brew different styles of beer. You'll leave with not only an understanding of the chemistry concepts of brewing water, but also the practical how-to aspects of getting the most from this critical ingredient.

Due to many requests we are repeating four of our most popular Boot Camp topics from Friday again on Saturday to give more people the opportunity to register for the following workshops that have all sold out at prior locations.

ADVANCED HOPPING TECHNIQUES – ***Josh Weikert*** – Join *BYO* Contributor Writer Josh Weikert as he explores when and how to add hops to create awesome hop-forward beers. You'll cover timing and techniques of hop usage including mash hopping, boil hopping, whirlpool/knockout hop stand additions, and dry hopping. You'll cover hop varietal choices, hop pairing/blending, evaluating hops including hop rubbing and sensory training, water adjustments and much more to get the most out of your hops and into your glass. *Please note this workshop will also be offered on Friday as well.*

HOMEBREW EXPERIMENTS – ***Denny Conn and Marshall Schott*** – Developing your own recipes, refining your own brewing techniques, and tweaking your equipment set-up all require the know-how to conduct your own homebrew experiments. Without reliable results you rely on guesswork instead of facts to improve your brewing. Join two of the true leaders in experimenting with homebrews – podcaster/book author Denny Conn from Experimental Brewing and blogger/podcaster Marshall Schott from Brülosophy – as they first walk you through how to properly conduct your own experiments at home including structured blind evaluation techniques, and then walk you through some real life homebrew case studies to show how these experiments can play out. Get ready to roll up your sleeves and get your science on! *Please note this workshop will also be offered on Friday as well.*

ADVANCED ALL-GRAIN TECHNIQUES – ***Gordon Strong*** – Pull out the mash tun and get ready to learn advanced all-grain techniques hands-on with *Brew Your Own* Columnist, book author, and President of the Beer Judge Certification Program, Gordon Strong. Gordon will walk you through a world beyond straight infusion mashing with keys to mastering step mashing, sour mashing, and decoction mashing. Plus you'll learn about playing with mash thickness and other ways to control your all-grain wort production. *Please note this workshop will also be offered on Friday as well.*

ADVANCED RECIPE FORMULATION – ***Brad Smith*** – Create your own signature recipes and learn the keys to developing the specific grain bill, hop schedule, and ingredient proportions to meet your homebrewing goals. Brad Smith, *BYO* Contributor and BeerSmith software owner, has helped thousands of homebrewers design their own beer recipes and now you'll learn first-hand from this recipe building expert how to use both artistic and scientific approaches to beer design to end up with the beer you envisioned in your glass. You'll also explore ingredients, techniques, and understanding your own brewing system. *Please note this workshop will also be offered on Friday as well.*

SUNDAY, MARCH 24, 2019

INSIDER TOURS OF ASHEVILLE CRAFT BREWERIES

You'll tour – and taste – at four different craft breweries around the Asheville during this post-Boot Camp offering. You'll have the opportunity to meet brewers ask questions in addition to sampling beers. Includes a meal. A great way to wrap-up your BYO Boot Camp experience and check out some of Asheville's booming craft beer scene.

TWO-DAY BOOTCAMP: COMMERCIAL BREWERY START-UP – ***Steve Parkes*** – When you register for this Boot Camp you will attend it for both Friday and Saturday unlike our other offerings to better cover more material in greater depth. Opening a commercial craft brewery is a far cry from just ramping up the amount of beer you brew. Over Friday and Saturday you'll walk through the steps, planning decisions, and keys you need to know on both the brewing and management side to successfully open a commercial craft brewery with the Lead Instructor and Owner of the American Brewers Guild Steve Parkes, who has trained hundreds of professional brewers. Learn from Steve's decades of expertise and wide range of experience to help you better achieve your goals. Over two full days you'll be guided through all the various elements you'll have to know for the next big step toward starting a craft brewery.

Brew Your Own BOOT CAMP

REGISTRATION

ASHEVILLE, NORTH CAROLINA
MARCH 22 & 23, 2019

Name _____

Address _____

City _____ State/Province _____

Zip/Postal Code _____ Country _____

Phone _____

E-mail _____

SAVE UP TO $100 BY REGISTERING FOR BOTH DAYS EARLY!

- ❑ EARLY BIRD DISCOUNT - REGISTER BY JANUARY 22 - $450 - (SAVE $100!)
  BOTH FRIDAY AND SATURDAY BOOT CAMPS (choose one each day)
- ❑ TWO-DAY REGULAR REGISTRATION - AFTER JANUARY 22 - $500
  BOTH FRIDAY AND SATURDAY BOOT CAMPS (choose one each day) (SAVE $50!)
- ❑ ONE-DAY REGULAR REGISTRATION - $275
  EITHER FRIDAY OR SATURDAY BOOT CAMP (choose only one below)

Friday, March 22, 2019

- ❑ Advanced Recipe Formulation
- ❑ Barrels & Wood-Aging
- ❑ Advanced Hopping Techniques
- ❑ Troubleshooting Homebrew Faults & Fixes
- ❑ Advanced All-Grain Techniques
- ❑ Homebrew Experiments
- ❑ All-Grain Brewing Essentials
- ❑ Advanced Yeast Techniques

Saturday, March 23, 2019

- ❑ Hands-On Homebrew Science
- ❑ Sour Beer Techniques
- ❑ Brewing Water Adjustments
- ❑ Advanced Yeast Lab

Please note due to repeated requests we are repeating four of the most popular Boot Camp topics from Friday again on Saturday to give more opportunity to register for the following workshops.

- ❑ Advanced All-Grain Techniques
- ❑ Advanced Hopping Techniques
- ❑ Advanced Recipe Formulation
- ❑ Homebrew Experiments

- ❑ Turning Pro & Commercial Brewery Start-Up - TWO DAY BOOT CAMP

PLEASE NOTE A SEPARATE REGISTRATION FORM & FEE IS REQUIRED FOR EACH BOOT CAMP ATTENDEE

REGISTRATION FOR BOOT CAMP INCLUDES:

- 10 a.m. to 5:00 p.m. Boot Camp limited to 35 people per class
- Lunch with your Boot Camp group plus lunch speakers each day
- Course materials
- Boot Camp Welcome Bag from Sponsors
- One year (8 print issues) Subscripton/Renewal to *Brew Your Own* magazine
- Asheville Craft Beer Reception with local craft breweries pouring samples

(Discounted hotel room needs to be reserved directly with the Crowne Plaza Asheville, go to BYOBootCamp.com for details)

HOTEL INFORMATION

The BYO Boot Camp will take place March 22 & 23, 2019 in Asheville, North Carolina at the Crowne Plaza Asheville. We've reserved a limited number of rooms at a special discounted rate for Boot Camp attendees. Check out BYOBootCamp.com for full details on reserving your discounted room.

4 WAYS to REGISTER

WEB PAGE:
BYOBOOTCAMP.COM

MAIL THIS FORM WITH PAYMENT TO:
BYO BOOT CAMP
5515 MAIN STREET
MANCHESTER CENTER, VT 05255

PHONE:
802-362-3981 EXT. 106

FAX THIS FORM TO:
802-362-2377

ASHEVILLE CRAFT BREWERIES INSIDER TOUR

Thursday, March 21, 2019 ($135)

- ❑ 11 a.m. to 3:45 p.m.
- ❑ 4:00 to 8:00 p.m.

Sunday, March 24, 2019 ($135)

- ❑ 12:00 to 4:00 p.m.

PAYMENT METHOD

❑ Check Enclosed (payable to *Brew Your Own* magazine)
❑ Credit Card ❑ Visa ❑ MasterCard

Card # _____ 3-Digit CCV# _____ Exp. Date _____

Name on card: _____

Signature: _____

By registering for the Boot Camp I give permission for the free use of my name and photo in any media account of this event. I also certify that I am 21 years of age or older. Cancellation policy: For a refund, less a $100 administrative charge per person, send written notice by February 22, 2019. Refund requests received after February 22, 2019 will not be refunded. All refund requests will be processed post-Boot Camp. Early Bird Discount registration must be received and paid for by January 22, 2019.

CAUTION:

HOMEBREWERS AT WORK

By Jason Simmons

SAFETY FIRST

Whether or not you are a new brewer that has just started this hobby, or a seasoned brewer with years of experience, brewing safety should always be the first thing we consider when we start our brew day. Accidents are inevitable in any activity, but with a little knowledge and precautions we can help prevent brewing injuries from happening. Be warned, when bad things happen, they happen fast!

There is a long list of brewing injuries that I have seen over my 15 years of experience as a professional brewer and 11 years as a career EMT/volunteer firefighter. Most injuries are not life-threatening, but will put a hurting on you if you find yourself in that situation. Here are some useful tips for new and experienced brewers to think about while enjoying this hobby.

DRINKING ON THE JOB

This topic always comes up for good reason. If you are intoxicated, even mildly, then your judgement is impaired and bad things can happen when dealing with boiling liquids, operating around open flames, or handling other potentially dangerous objects. I love to have a beer during my brew days, but keep it to a respectable level if you choose to do so. Other than the possibility of injuries, your beer may suffer as well if you are in a condition where mistakes are more likely to happen. Most accidents are preventable and caused by human error, being intoxicated will drastically increase these odds.

HOW DID THIS HAPPEN?

We all get excited on brew day, or sometimes we have *just enough* time to squeeze in a batch. Accidents often happen because we are rushing around or just aren't paying close attention to what we are doing. Pay attention to what you are doing and your tasks, especially while around dangerous situations. Just about every brewing injury that I have experienced or seen over the years, homebrew and professional, was due to rushing around with a cluttered head. Knowing your equipment, how it is operated, the processes that you plan on using, and staying focused on your tasks will greatly reduce the risk of an incident from occurring.

EQUIPMENT CHECK

Before you start your brew day you should always check your brewing equipment to make sure it is in safe working order. Check to be sure that all hose clamps, propane connections, keg and/or fermenter pressure relief valves are free of debris and working properly.

BURNS

Burns of all sorts likely make up the biggest percentage of serious homebrewing injuries. Brew day is full of hotside activity such as heating up brewing liquor, boiling wort, hot equipment surfaces, open flames, pumps and hoses moving hot liquids, and steam. In homebrewing, the most common types of burns we come across are first degree burns (minor superficial burn), and second degree burns (partial thickness burn). On rare occasion we may see third degree burns (full thickness burns), which end in an emergency room visit.

Some things to watch out for to prevent getting burned are:

Boilovers:

These always happen when your back is turned or you look away. Whenever possible, keep your eyes on your boil. When you aren't watching it, keep your distance from the boil kettle and your heating source. This will keep you out of harm's way if a boilover does happen and will allow you to handle the situation without panic. Another tip would be to use FermCap in the boil as it helps prevent boilovers from happening in the first place.

Use gloves for handling hot equipment:

This might seem like common sense, but even I have made this mistake more times than I'd like to admit, burning my hands and fingers in the process. This all could prevented by wearing safety equipment.

As a firefighter we teach that

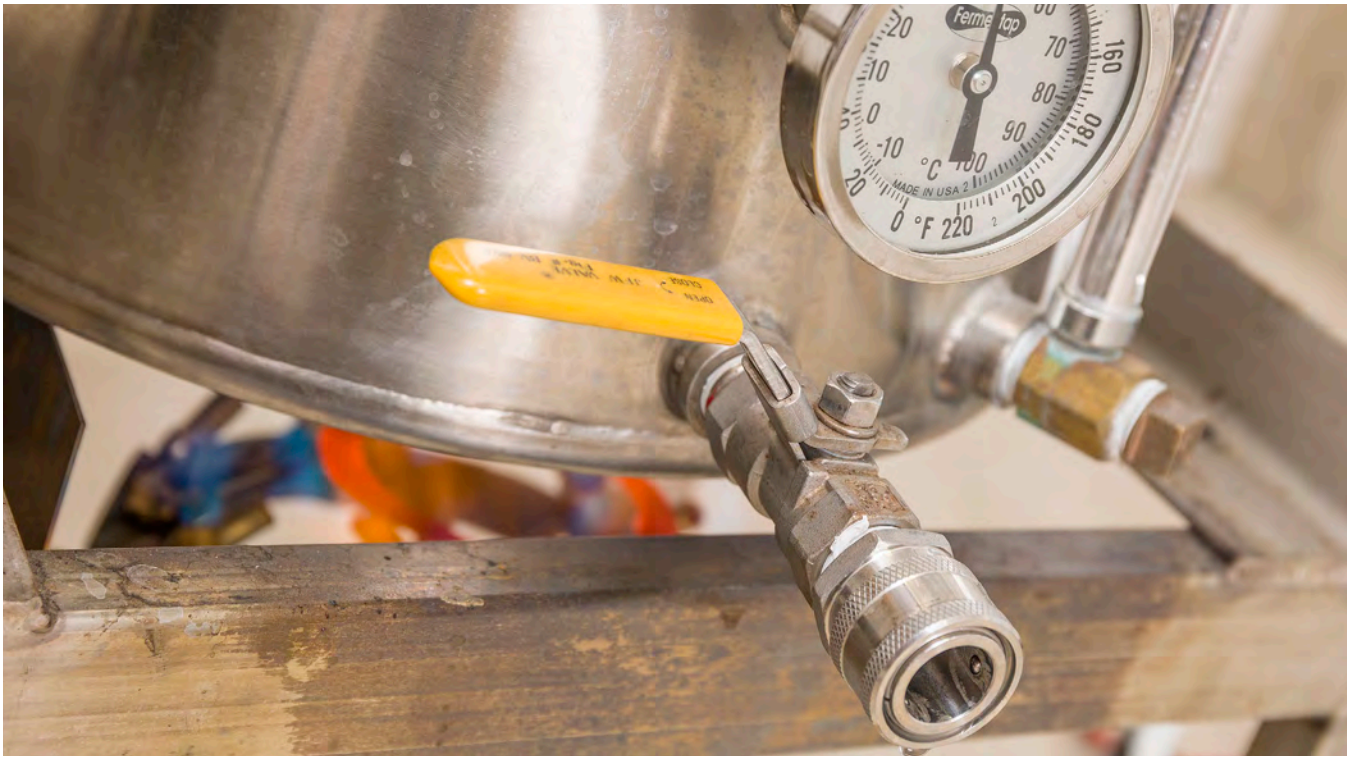


Photo by Charles A. Parker/Images Plus

Photo courtesy of Jason Simmons

This second degree burn was caused when I wasn't wearing gloves and was rushing to empty my kettle, grabbing the scalding hot bottom before I could stop myself. I had to soak my hand in cold water as it blistered over the next 24 hours to stop the burning pain.

when you touch what might be a hot object or surface, to use the back of your hand with a single light tap. Your natural instinct when touching a hot surface is to close your hand which can cause further injury. By using the back of your hand with a quick light tap allows you to gauge how hot an object is without getting burned.

Proper footware:
All professional breweries I've been in require boots and often steeltoes in the brewing areas. Not only is there a risk of something heavy falling on your foot while brewing, but rubber boots will also prevent boiling wort that flows out of an open valve or boils over from scalding your feet.

Avoid splashing:
Brewers get into the habit of throwing things into the kettle when the time calls for it. Whether you are throwing in a bag of hops or trying to mix in extracts, there is a chance for splashback of hot liquids if you aren't careful.

Be aware of your surroundings and keep your brewing space organized:
On several occasions I have turned around to have someone standing there, and have tripped over the propane gas line or equipment that was "in my way." Always be aware of your surroundings, especially when near a flame or boiling liquid. Make sure the working area is clear and safe when introducing hot liquids to the area.

A mention on chemical burns:
Most of the chemicals that we use as homebrewers are safe to handle without much issue, however the most common type of chemical burns that we experience are of burns to the eyes. I have seen on several occasions a brewer drop something into a bucket of a chemical solution, resulting in the solution splashing up toward their eyes and face. While I could have just added a general "wear safety equipment" section, I want to drive this point home to wear safety glasses! I have witnessed this happen too many times with homebrewers as well as professional brewers with horrible consequences. Wear your safety glasses!

If you do somehow get chemicals in your eyes, flush immediately with water. This means planning ahead for eye injuries. In this situation, it's best to call out for help while flushing your eyes with water. Remember to flush in a manner as to not to wash the chemical into the uncontaminated eye. Make sure that you know where your eye wash stations are, even if it's just a bottle of water, sink, or garden hose.

CUTS, LACERATIONS, & AMPUTATIONS

Most of the time cuts and lacerations are not serious, and can be handled by holding pressure and applying a bandage. The main cause of deep lacerations in homebrewing involves glass carboys. These fermenting vessels are heavy, made of thick glass that are often wet and slippery, and can break easily if exposed to thermal shock (eg. placing hot liquids into a cold carboy, causing it to shatter) or dropped. When carboys do break they are sharp and extremely dangerous (I'll spare you the images of these accidents).

When these type of accidents occur the common injury sites are the fingers, hands, and forearm section. These lacerations are often serious as it can cut into veins or arteries causing a significant amount of damage and blood loss. This may require professional medical attention. When handling glass, make sure that you have a firm grip on it and your walking path is clear of any debris to trip over. There are a few companies that offer safer carboy carrying devices that mitigate the risk of them slipping out of your hands from being wet or their awkwardly cumbersome shape.

SERIOUS EQUIPMENT INJURIES

We talked about burns by touching hot equipment or getting splashed with hot liquids already, but if care is not taken, there is also the possibility that kettles can get knocked over, spilling gallons of hot liquids creating a serious hazard. I have also met homebrewers that have slipped on random objects and fallen with a portion of their arm in the boil kettle causing severe injury. These type of burns are serious, and often preventable simply by slowing down and paying attention.

Another serious equipment injury that we come across are mill or auger injuries. I know this sounds obvious for most poeople, but keep your hands out of the cookie jar! There is no reason to stick your fingers in the mill. Once it grabs you, it's safe to say that your brew day will be over. Unplug mills after use or if you have to service them for any reason. As we grow into this hobby we often like to upgrade our automation to make brewing beer an easier process. Moving parts always come with their own hazards, so pay attention.

ASPHYXIATION (PROPANE, CARBON MONOXIDE, CARBON DIOXIDE, & DUST PARTICLES)

Asphyxiation injuries in the homebrew setting are extremely rare, but it does raise concern and requires a little thought and wise practices to prevent any incidents from occurring. Many homebrewers don't have a lot of space when it comes to the hobby, and we work within the space that we have available to us to get the tasks done. For those brewers who decide to brew indoors, your best option is to use an electric heating source.

Milling hazards:
A word of caution on milling, or using ingredients with fine particles or powders, especially in a confined space or small rooms. While it's rare to have an incident involving small particles on a homebrew scale, it is wise to wear personal protective equipment (PPE) to prevent any short-term or long-term lung damage. Usually a simple dust mask or an N95 respirator is enough to prevent any damage. Pretty much, don't mill in a small room without breathing protection or proper ventilation.

Propane:
The best recommendation is to use propane burners outside. Those brewers who insist on using propane burners inside or in their basements should be well aware of proper ventilation safety. Proper ventilation is the key to brewing indoors safely, as well as avoiding confined spaces.

When using a propane burner, you want to make sure that the hoses are properly connected to the tank so they don't leak propane into the room causing an explosion hazard, or a drop in oxygen saturation in the air. Normal saturation of oxygen in atmospheric air is between 20.8 and 21%, while OSHA (Occupational Safety and Health Administration) states that there is an oxygen deficiency once the oxygen levels reach 19.5% and below.

Propane gas (C_3H_8) has a molar mass of 44.10 g/mol, and is heavier than air, which has a molar mass of 29 g/mol (small variation depending on humidity). Propane has an Immediate Dangerous to Life & Health (IDLH) value that is close to its Lower Explosive Limit (LEL), which occurs at 2,100 ppm (parts per million), so OSHA rounded the IDLH number down to 2,000 ppm.

Carbon monoxide:
When you are correctly using the propane burner, two main byproducts produced are heat & carbon monoxide (CO). Carbon monoxide is a colorless, odorless, and tasteless gas that has a molar mass of 28.0 g/mol, which is slightly less dense than air. OSHA limits employees of an 8-hour shift to be in a carbon monoxide environment of 50 ppm or less. Exposure to 100 ppm or greater presents great health risk, or even the possibility of death. Some signs and symptoms that help indicate carbon monoxide poisoning include: Headaches, weakness, dizziness, nausea or vomiting, shortness of breath, confusion, blurred vision, and even loss of consciousness.

Carbon dioxide:
Another issue with small rooms, closets, or other confined spaces is the production of carbon dioxide (CO_2) as a byproduct of fermentation. Carbon dioxide is heavier than air with a molar mass of 44.01 g/mol, and will sink to the ground. On average, for every pound of alcohol created, roughly 1.045 pounds of carbon dioxide are also created.

For example, if you ferment 6 gallons (23 L) of wort with an original gravity of 1.055 you should end up with close to 6% ABV, or 4.8% ABW, beer. With water weighing 8.33 lbs./gallon we can estimate the full weight of the batch by multiplying the fermenting volume by 8.33 by the specific gravity. In this case:

6 x 8.33 x 1.055 =
52.7 lbs. beer weight

so

52.7 x 0.048 ABW% = 2.5

This shows that 2.5 lbs. (1.1 kg) of carbon dioxide is created during fermentation. With 1 lb. (0.45 kg) of carbon dioxide occupying 0.2426 m^3, or 8.566 ft^3 (64 gallons/243 L), the 2.5 lbs. (1.1 kg) of carbon dioxide created in the 6 gallons (23 L) of 4.8% ABW beer should take up 21.415 ft^3. Most of the time fermenters are placed in large areas with good ventilation that allows the carbon dioxide to dilute in the surrounding air. Proper ventilation and large areas of space should prevent the oxygen levels from dropping to unsafe levels that cause hypoxia. Don't ferment in confined spaces without proper ventilation.

Carbon dioxide is a dangerous gas that claims the lives of brewers each year who are caught unprepared or unaware. In brewery settings we like to use the buddy system when working with large amounts of CO_2. We let co-workers know what we are doing so they can keep an eye out if anything might happen. If you see a brewer down, call for help and further ventilate the room if possible. Do not rush in to help, as the area can still be at unsafe oxygen levels, creating two victims instead of one. The coal miners used canaries for the same purposes, because blackouts from a lack of oxygen can happen extremely fast. Again, this is less likely in a homebrew setting, but it is something to keep in mind.

NOT ALL BOTTLES ARE CREATED EQUAL

Different styles of beer call for various volumes of carbonation. Average beer CO_2 saturation for most styles are around 2.60 to 2.70 volumes, with a few styles at a higher level of 3.0+ volumes of CO_2. Soda is bottled around 3.0–3.2 volumes of CO_2, which is close to the top limit of CO_2 saturation that we use in bottles. While working at several breweries over the years I have dealt with different bottle manufacturers, and each bottle manufacturer has their own process, equipment, and specifications that they use to produce their product. Just like each maltster is unique to their craft, the same applies to glass manufacturing. Most of the time we were only ordering 12-oz.

and 22-oz. (350- and 650-mL) bottles, which is what most homebrewers use to bottle condition their beers.

To prevent bottle bombs you need to do a few main things. If you plan on adding priming sugar, you need to make sure that the beer has reached terminal gravity and no more fermentable sugars are left. When you do add the priming sugar, do the math and measurements twice, and dose once. Precision is recommended here. I have seen many 12- and 22-oz. (350- and 650-mL) bottles explode on the bottling lines at around 3.3 volumes depending on manufacturer. Try to use quality bottles, and know exactly how much fermentable sugars are being dosed into each bottle to create the target CO_2 volume to prevent a flying glass shrapnel incident. Bottles will break, so be sure to wear your safety glasses, or a face shield when using counter-pressure bottle fillers.

NOT ALL VESSELS ARE CREATED EQUAL

Just like glass bottles, not every vessel is created equal. Whether you are using a 5-gallon (19-L) plastic bucket, glass carboy, or an expensive stainless steel conical fermenter, make sure that it is in working order and free of obstructions in the blow-off tubes and/or pressure relief valves (PRV). I have seen lids explode off of buckets, carboys shatter, and the top of a 100-barrel fermenter explode due to high pressure, a clogged PRV or airlock, or lack of one altogether.

Kegs are also pressurized vessels that need to be addressed, as we have seen deaths in the industry over the past couple of years. Some kegs like the Cornelius soda kegs have PRV's that are easy to relieve pressure, while other kegs like Sanke kegs need the coupler to be attached to have access to the PRV. Whatever vessel you choose to ferment or package your beer in, make sure that you know all of its specs, check that it's in working order with every use, and do not go over the recommended PSI.

These type of injuries can be deadly and catastrophic . . . The London Beer Flood of 1814 is a great example of the devastation that can happen (on a much larger scale).

Photo by Charles A. Parker/Images Plus

Be sure to measure twice when calculating the amount of priming sugar to add prior to bottling. Too much sugar could lead to bottle explosions, potentially causing serious injury.

INGESTION

Every once in a while, we either fail to follow the proper chemical directions, or make a foolish mistake by not paying attention to what we put in our mouths. I have only seen this happen two or three times, but it does happen. Follow all recommended chemical instructions, as well as keep your food or drinks away from your workstation. If for any reason you do happen to ingest any chemicals, contact the Poison Control Center in the US at 1 (800) 222-1222 immediately. They are open 24 hours a day, 7 days a week, and will be able to give the best, and most direct advice tailored to your specific situation, as well as notifying your local emergency dispatcher to give them a detailed report and their recommended medical direction.

A WORD FROM THE WISE

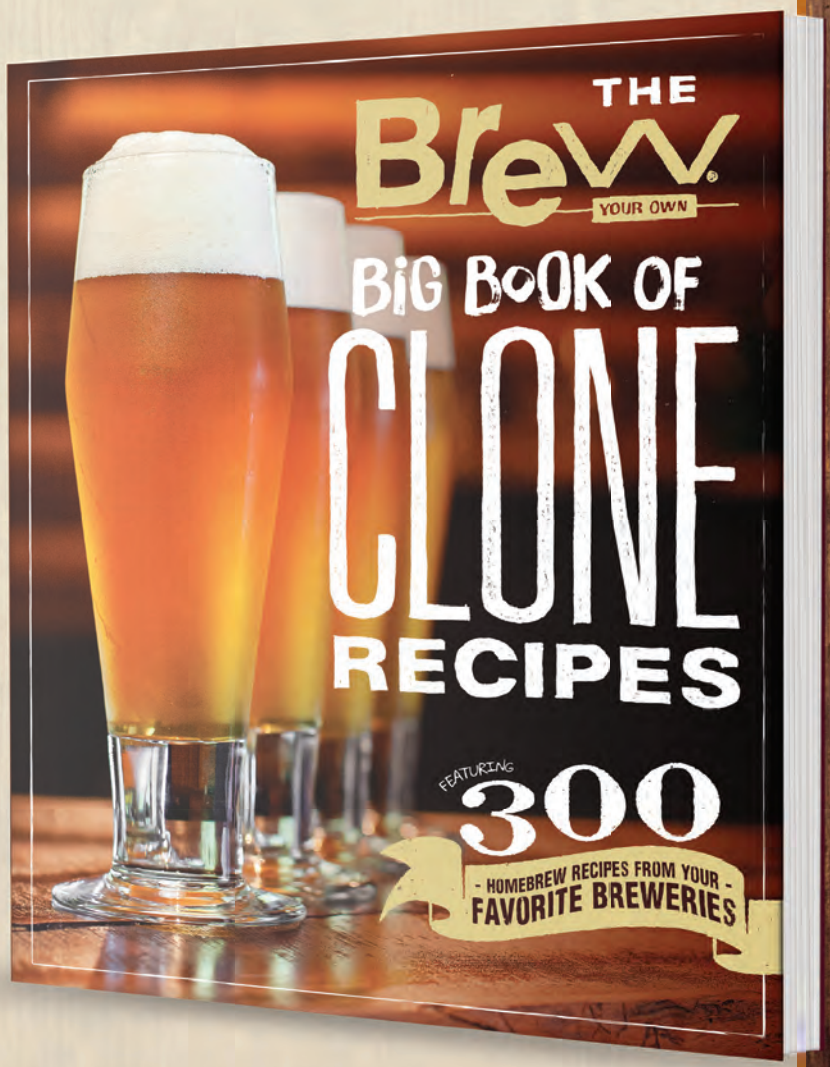
Slow down, relax, and have a homebrew if you choose to do so, but pay attention to your surroundings and what you are doing. Keep a clean work area, measure twice, dose chemicals once, ventilate confined spaces, wear safety equipment, keep food and drinks out of work areas and away from chemicals, watch those hot liquids, and keep those fingers out of the mill to help make a successful and injury-free brew day. BYO

SEND IN THE CLONES!

HUNDREDS OF RECIPES TESTED BY *BREW YOUR OWN*

Enjoy the ultimate collection of our clone recipes, complete with full-color photography. This book contains both the classics and newer recipes from top craft breweries including Brooklyn Brewery, Deschutes, Firestone Walker, Hill Farmstead, Jolly Pumpkin, Modern Times, Maine Beer Company, Stone Brewing Co., Surly, Three Floyds, Tröegs and many more.

Whether you're looking to brew an exact replica of your favorite IPA or get some inspiration on a stout from the greats, this book is your new brewday planner.



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Brew YOUR OWN — THE HOW-TO HOMEBREW BEER MAGAZINE

KOMBUCHA

ANCIENT FERMENTED TEA

By Hannah Crum & Alex LaGory

Photo by Shutterstock.com

Kombucha is an ancient tonic that has been brewed lovingly at home for centuries or perhaps even millenia. But what the heck is it? Fermented tea! Just like chocolate is fermented cacao and sauerkraut is fermented cabbage, kombucha is the end result of microbes converting tea and sugar into an effervescent, lightly tangy, refreshing beverage loaded with nutrition in living form.

Unlike sauerkraut, whose organisms live on the leaves of the cabbage, the microbes that ferment the sweet tea live together in a pancake of bacterial cellulose (primarily *Brettanomyces*) called a SCOBY. An acronym for "symbiotic culture of bacteria and yeast" invented in the 1990s to distinguish the culture from the drink, it also has been called many other names throughout history including "mother," "mushroom," and "tea fungus" to name a few.

If you've consumed raw apple cider vinegar, you may have noticed a similar culture living in the bottle. Kombucha is also an acetic acid-producing ferment, hence the tangy flavor. You might even think of kombucha as "tea vinegar," though it's a very smooth type of vinegar, topping out between 0.25% and 1% total acids, whereas vinegar from the store is typically around 5%. The brew is harvested well before the flavor is too intense to consume as a beverage. The acetic acid bacteria produce cellulose as a byproduct which is why both ferments create a mother.

HISTORY OF USE & DIASPORA

Due to the recent explosion in the popularity of kombucha, many think of it as a novel beverage. But for people in Asia, Russia, Europe, and yes, even here in the United States, it has been a staple for generations. So where did kombucha come from? The mythology claims 220 B.C. China, but there are no known records. The most common theories point to folk origins in Asia. Since kombucha is made from tea and the oldest relics of fermentation are traced back to China, it makes logical sense. From there, various stories link kombucha to the Silk Road, Genghis Khan in the steppes of Mongolia, the Samurai in Japan, and a "Dr. Kombu" from Korea, though again, written records are lacking.

We know for certain that there exist long family histories of making kombucha in Russia, where it was often brewed for a short time (3-4 days) to be served as a sort of homemade soda pop. Stories began to spread, telling of mountain towns where centenarians abounded, who all supposedly drank kombucha daily. These "legends" seem to follow everywhere kombucha goes, and in this case the

stories of kombucha's power led to it being studied in Russian universities as far back as the early 1900s. Owing to these stories, samples of kombucha cultures were collected from all over the Russian countryside and studied to uncover where this ancient brew might have come from and what health-giving properties it may provide.

During and after World War I, European soldiers stationed in Russia were introduced to the kombucha culture, sometimes even at prisoner camps. They brought it back to the European mainland, where it was especially popular in Germany. Waves of research would happen, in Germany and Russia especially, over the next 15 years, with hundreds of studies published about kombucha's effect on everything from asthma to cancer and more. Paper after paper was printed in German scientific magazines of the day relating the ability of kombucha to have a positive effect, often on patients who had been suffering acutely.

While Germany was busy getting scientific, Italy, as it is wont, had a more passionate and brief love affair with kombucha. There, the culture was passed around like a chain letter, with scandalous handwritten instructions and a warning if they weren't followed exactly. Taking these passions to the extreme, Italians, seeking the most blessed batch possible, began swiping holy water from the church fonts for brewing their sacred "booch." This was a step too far for the priests, who started preaching against it from the pulpit, and so kombucha's future in Italy was damned. Though there's a neat pop song from the 1960s by Renato Corosone called "Stu Fungo Cinese" — find it on YouTube!

When World War II broke out, along came rationing of basic supplies like tea and sugar. With fewer nutrients available, kombucha brewing waned. The studies in Germany and Russia dried up around 1950, and kombucha receded into the underground again.

The brew gradually re-emerged in the United States in the 1960s as a hippie fad. As the '80s came along, a few scientists in Germany pick up the trail, and both the German First Lady Veronica Carstens (confirmed) and Ronald Reagan (unconfirmed) are linked to drinking kombucha daily.

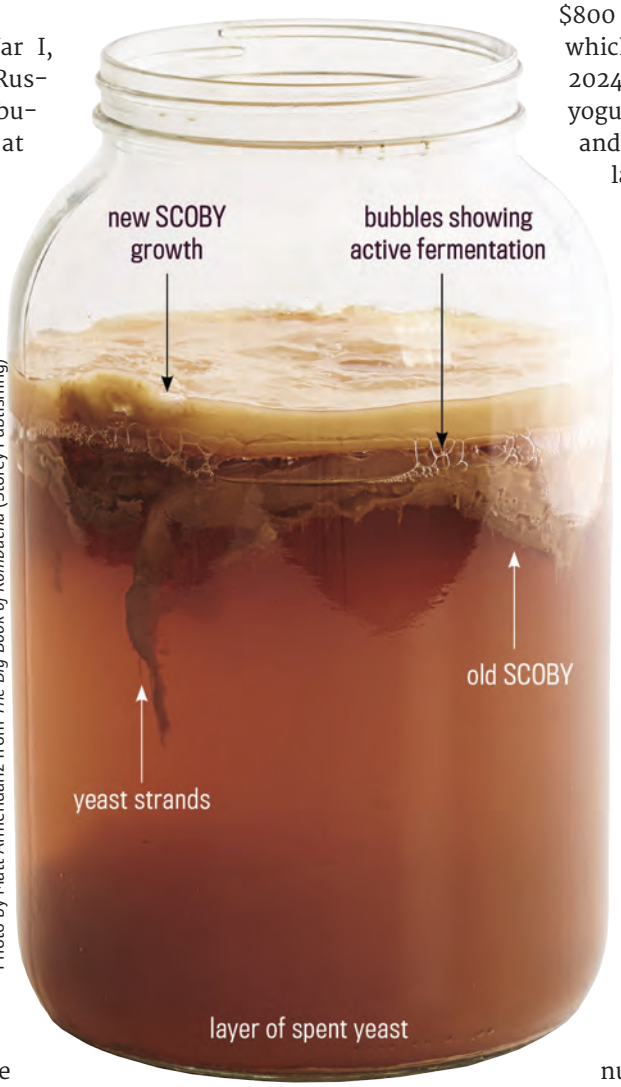


Photo by Matt Armendariz from *The Big Book of Kombucha* (Storey Publishing)

It wasn't until the early 1990s that kombucha was finally put into a bottle and sold on grocery shelves in the USA. GT Dave, a teenager from Los Angeles, bottled the brew made in his mother's kitchen and sold his first cases to a local health food store, and thus an industry was born. The early 2000s saw an increase in brands being offered with the trend hitting a tipping point over the last few years. Now, kombucha's popularity has spawned hundreds of craft and small brands around the world generating jobs and diversifying grocery shelves with healthier choices. Not to mention the industry has an estimated $800 million footprint worldwide, which is on pace to top $2 billion by 2024. Touted as the "21st century yogurt," kombucha is here to stay and if you want to save a few dollars and make some tasty quaffs, then try brewing this ancient elixir at home!

BREWING EQUIPMENT & PROCESS

Other than the SCOBY and starter liquid, the supplies used for making kombucha can often be found around the house. For step by step directions, refer to the recipes on pages 50–51. Tea is simple and only requires a pot or kettle. Stir in the sugar with a spoon of any material and cover the vessel with a tightly woven cloth such as a tea towel or even an old piece of t-shirt provided there aren't any holes. Cheesecloth is not suitable as the weave is too loose and could allow fruit flies into the brew. Bottling can be done with the same technique you bottle beer.

Any type of real tea, i.e. *Camellia sinensis*, will provide the nutrients for a good brew, such as tannins and caffeine for fuel but also all the good things in tea, which are then fermented in the kombucha, making them more bioavailable. A blend of black and green tea is the most popular.

Mixing small amounts of herbal tea like yerba mate or rooibos or even some flavored teas may be acceptable, but those containing oils or other flavoring agents may negatively effect the brew, so stick to real tea for the best results. A steep range of 7–15 minutes provides an opportunity to adjust the flavor to your preference. If

Photo by Matt Armendariz from *The Big Book of Kombucha* (Storey Publishing)

Kombucha is abundance in action as every batch yields a fresh SCOBY culture in addition to the original. If allowed, these SCOBYs can grow quite large!

you like a stronger flavor, let the tea steep longer or even use a bit more tea.

Many types of fermenting vessels may be used in a variety of shapes and sizes. Glass, porcelain, stainless steel, and oak are all excellent choices for fermenting. Some food-grade plastic may be okay, depending on the type, but will wear out over time and may scratch, which makes them less desirable and not recommended. Very skinny vessels, tall but not wide, don't ferment well due to less oxygen exposure for the aerobic brew. Use a tightly woven cotton cloth and rubber band to cover the vessel.

Next, find a place to ferment, typically the kitchen or pantry. Any warm room will do, provided it is out of direct sunlight and at optimal temperature. The yeast, the Y in SCOBY, prefer warmer temperatures (75–85 °F/24–29 °C is the best range, 80 °F/27 °C is the "sweet spot") and they are key to acidifying the brew quickly to protect against mold. Direct sunlight can be antimicrobial, so keep in a lightly shaded (ambient light is fine) area that is also ventilated (cupboard works too). If your home doesn't maintain such warm temperatures year-round, heaters and warming belts do a great job. Choose one with a thermostat to avoid frequent recalibration or repositioning.

The 7–21 day fermentation time varies based on brewing conditions (temperature, size of batch, etc.) and taste preference. If a sweeter flavor is preferred, ferment for a shorter time, as the longer it goes, the more sour it becomes, so, especially in your first few batches you brew, taste each day until you like the flavor. Also, similar to fermenting beer, the cooler the temperature, the longer the fermentation process takes. Taste is king so let your buds tell you when the brew has the sweet/sour balance that works for you.

The trace amount of ethanol produced by the fermentation process acts as a preservative and serves as nutrient for the bacteria. It hovers between 0.3–0.8% on average at bottling, however adding high sugar flavors and capping to store at room temperature can increase those levels to up to 2%. Hydrometers and refractometers can provide a ballpark estimate of the ABV, however excess particulate and multiple acids often skew readings higher. Carbonation will increase during second fermentation, so it is best to refrigerate once the bottle has built up the bubbles you crave to prevent it from carbonating further.

When it comes time for bottling, flip-tops or recycled kombucha bottles from the store are great options. Watch out for metal lids as they can react with the brew in the bottle, and if the cap is too loose, the fizz may fizzle. Kombucha is often available on tap and homebrewers who already have kegging systems may choose to keg their brew. Switch to higher-grade hoses to prevent leaching and store kegs between 40–60 °F (4–16 °C) to prevent over-foaming. **Keep hoses and plastic fittings used for kombucha separate from those used for homebrewing.**

KOMBUCHA FLAVORING RULE OF THUMB

When the kombucha has the sweet-sour flavor that tastes best to you, that means primary fermentation is complete. Many people enjoy the brew just as it is without anything

KOMBUCHA RECIPES

This is Kombucha Kamp's short-cut method for brewing up delicious kombucha quickly and safely. Since the yeast and bacteria are temperature-sensitive, the water should be body temperature (about 100 °F/38 °C) or lower before adding the SCOBY. To shorten the wait time, brew a tea concentrate that is then diluted with cool water to bring the temperature down quickly so you can immediately add the SCOBY and starter liquid. This ensures the sweet tea is not left out and potentially exposed to contaminants.

KOMBUCHA

(1 gallon/4 L)

Scale up or down depending on the size of your fermentation vessel

EQUIPMENT

Tea kettle
Fermenting vessel
Cloth cover
Rubber band

INGREDIENTS

1 cup (200 g) sugar
4–6 loose leaf bags of tea
(1 bag of tea = 1 tsp
SCOBY
1 cup starter liquid
1 gallon (4 L) purified/bottled water

STEP BY STEP

Boil 4 cups of purified water. Add hot water and tea bags to pot or fermenting vessel. Steep 7–15 minutes, then remove tea bags. Add sugar and stir to dissolve. Fill vessel most of the way with purified water, leaving just 1–2 inches (2.5–5 cm) from the top for breathing room with purified cold water. Add SCOBY and starter liquid. Place the cloth over the vessel to cover it and secure the cloth with the rubber band. Place the container in a warm (75–85 °F/24–29 °C is the best range, 80 °F/27 °C is ideal), ventilated area out of direct sunlight and do not disturb for seven days.

After 7 days, or when you are ready to taste your kombucha, gently insert a straw beneath the SCOBY and take a sip. If too tart, then reduce your fermentation cycle next time. If too sweet, allow to ferment for a few more days. Continue to taste every day or so until you reach your optimum flavor preference. Usual fermentation is between 7 and 21 days, depending on desired flavor. An optional next step is to decant and flavor if you would like.

Drink as desired! Start off with 4–8 oz. (120–240 mL) on an empty stomach in the morning, then with meals to help with digestion or as your body tells you it would like some more! Drink plenty of water to flush out any toxins released by the organic acids in kombucha.

TIPS FOR SUCCESS:

Small variations in tea or sugar used are not a concern. Increase or decrease the amounts to find the flavor you prefer, but never use less than ¾ cup (150 g) sugar or 3 bags/tsp. of tea per gallon (4 L).

To dechlorinate tap water, if you prefer to use that vs. bottled or purified water, allow to sit out overnight uncovered or boil for 10 minutes and then cool to needed temperature.

Your SCOBY is a living organism — treat it with care and it will be your "booch buddy" for life!

PEAR GINGER KOMBUCHA

(16 oz./470-mL)

Hands down the MOST popular flavor of kombucha is ginger. Humans and ginger have a love affair as the piquant flavor not only intrigues the tongue but its digestive properties also settle the stomach. Before Prohibition, ginger beer was the most popular beverage in the United States and then became ginger ale once alcohol was outlawed. Enjoy the zippy zing of ginger by adding some to your kombucha!

Pears provide a sweet, floral and fall flavor for the brew; of course any other type of fruit may be substituted in place of pears.

INGREDIENTS

15 oz. (440 mL) kombucha
1 tsp. ginger juice or
1 Tbls. fresh ginger or
1½ tsp. dried ginger pieces
1 Tbls. fresh, frozen, or canned pear, diced. Alternatively, you could use 1½ tsp. pear juice

STEP BY STEP

Combine the ingredients in a 16-oz. (470-mL) bottle and cap tightly. Allow it to sit at room temperature for 1 to 3 days and then move to the fridge (if desired) to slow fermentation. If leaving the pieces in the bottle, consume within a week or it may be strained and stored for longer.

TIPS FOR SUCCESS:

Ginger comes in many formats and they are all delicious providing varying levels of bite. For the most intense ginger flavor, use ginger juice. For a mellower flavor, cut up a thumb of ginger and use chunks or pieces. Since it's more intense, less juice is needed than the pieces, so adjust the recipe according to your personal taste preference. The suggestions below are just that — use as a starting point and then tweak as desired.

KOMBUCHA RECIPES

POMEGRANATE BLUEBERRY KOMBUCHA

(16 oz./470-mL)

Both of these fruits pack an antioxidant punch and provide a beautiful deep hue thanks to the anthocyanins. We'd recommend using pomegranate juice or mashing the arils (pomegranate seeds) for the best flavor.

INGREDIENTS

15 oz. (440 mL) kombucha
1 Tbls. pomegranate juice
2 Tbls. fresh or frozen blue berries, lightly mashed

STEP BY STEP

Combine the ingredients in a 16-oz. (470-mL) bottle and cap tightly. Allow it to sit at room temperature for 1 to 3 days and then move to the fridge (if desired) to slow fermentation. If leaving the pieces in the bottle, consume within a week or it may be strained and stored for longer.

APPLE PIE KOMBUCHA

(16 oz./470-mL)

Nothing says fall like apple pie, and with kombucha's natural tang this is a match made in heaven. The additional cinnamon provides a deeper dimension to the flavor, but it may be omitted if preferred.

INGREDIENTS

15 oz. (440 mL) kombucha
¼ cup diced apples or 1 Tbls. apple juice
½ teaspoon chai spice (blend of dried ginger, nutmeg, clove, and orange peel)
¼ teaspoon cinnamon chips

STEP BY STEP

Combine the ingredients in a 16-oz. (470-mL) bottle and cap tightly. Allow it to sit at room temperature for 1 to 3 days and then move to the fridge (if desired) to slow fermentation. If leaving the pieces in the bottle, consume within a week or it may be strained and stored for longer.

Photo by Shutterstock.com

added. However, one of the most fun parts of brewing kombucha is flavoring it, also called secondary fermentation or 2F. Because of kombucha's vinegar nature, it quickly absorbs nutrients and taste from whatever you put in there. And a little goes a long way! If too much flavoring is added, off flavors and/or too much carbonation will result, which can be dangerous and potentially cause bottles to burst, so start with less.

Also, the form of the flavoring will dictate how much is needed. For instance, you will need more apple pieces than apple juice. That's because the sugars in the apple pieces are not as easily accessible as they are in the juice. But beware, adding juice is like adding liquid sugar, so always start with less. If you want to use fresh fruits and desire more flavoring to absorb, consider chopping up larger pieces into smaller ones, as more surface area increases the effectiveness.

LIVING IT UP IN THE HOTEL SCOBY-FORNIA

A SCOBY hotel is the homebrewer's backup stock. Kombucha is abundance in action as every batch yields a fresh SCOBY culture in addition to the original. This means extras are always being made and since the bacterial cellulose is durable, provided it's kept moist and at the correct pH (2.5–3.8 pH), it will hang out for many weeks or months, until reintroduced to sweet tea. Cover with a cloth and it will grow a new SCOBY that will act as the lid while keeping bugs at bay.

The SCOBY hotel does need to be refreshed from time to time. Once the culture dries out, even just on top, it is vulnerable to mold. Remove dried out cultures and top off the jar from time to time with sweet tea or already fermented kombucha to keep them moist and at the correct pH. The more often it is refreshed, the healthier the SCOBY hotel and its residents will be.

THINK SAFETY!

The safest and most successful way to make kombucha is by creating an environment tailored to its needs. Ideal brewing conditions include selecting the right type of brewing vessel, location, and temperature. The tips that follow will help you avoid common pitfalls and protect the brew from mold. Take care of the kombucha and it will take care of you!

The most important aspect of brewing safety is sourcing the culture. SCOBYs are not created equal and finding a culture that is healthy and strong ensures a lifetime of delicious kombucha. If you have a friend who is already brewing their own, that is a great place to start. Sometimes they are offered on community websites for a fee but without knowing the type of ingredients or conditions that the cultures are grown in, it is wisest to source a culture from a reputable vendor. Do be careful to avoid vinegar eels, which can be found in raw apple cider vinegar and often end up in SCOBYs offered on exchanges or even by low-quality sellers. A reputable source will provide at least one

CROSS CONTAMINATION

As a homebrewer you already know this: Fermentation is fun and when fermentation fervor strikes, nearly every nook or cranny in the house can be filled with yet another culture or project. Each ferment has its own unique microbiome of bacteria and yeasts depending on the substrate and end product being made. However, as a homebrewer, and if you also make wine at home, it is vital to understand the organisms in kombucha as they don't play nice with most types of beer and wine.

Kombucha's most common organisms — *Brettanomyces bruxellensis* (lambic and sour beer yeast) and *Gluconacetobacter* (vinegar) — are considered spoilage organisms for most beer styles and all wines. Some kombucha cultures may have different organisms like *Saccharomyces cerevisiae* or *Lactobacillus*, but according to a recent study conducted by Kombucha Brewers International and Oregon State University, it was found that most SCOBYs are *Brettanomyces* dominant.[1]

Contamination from wild yeasts in beer and wine can result in off flavors, hazy colors, and biofilms forming on the surface. They can also be an absolute nightmare not only due to the loss of product and the time, effort, and ingredients, but also the need to sanitize everything from top to bottom and then pray for no further contamination issues. Even commercial breweries have to take extreme measures when they add sour beers to their roster to prevent contamination. Some will go as far as to brew in separate facilities. Others do not permit employees working with sour beers to enter the other parts of the facility or require a change of clothes before re-entry along with wash up policies worthy of a chemical lab.

So unless your goal is to make only hybrid or sour beer styles, keep the kombucha as far away from your brewing or winemaking as possible. You might even house them in separate areas — i.e. basement or garage and follow the tips below to keep all of your ferments happy. We'd also recommend:

- Use separate brewing and decanting equipment to avoid cross contamination

- Adjust the brewing schedule so that each product is worked with on different days

- Store beer or wine yeast in airtight containers to prevent exposure to airborne wild yeast

cup (240 mL) of strong starter (which is well-fermented kombucha, aged at least a couple of weeks or more) and a 4 oz. (113 g) of culture or larger for a one-gallon (4-L) batch of sweet tea. Some people still attempt to grow one from a commercial brand, and while sometimes a culture forms, because of the changes made to the brew for commercial purposes, often it does not. Even if a culture forms, they tend to be weaker and produce a weak or "watery" beverage, again due to the changes introduced to make store-bought kombucha shelf stable.

MOLD INSPECTION

As a living food, kombucha never expires or "goes bad" once it is brewed, but at the early stages, if the brew is not able to acidify quickly enough, that delicious sweet tea can be colonized by mold. Mold in kombucha only ever grows ON TOP of the new culture forming on the surface of the brew, which means it's easy to spot. It comes in a wide variety of colors including black, blue, green, and white, and is fuzzy and/or dry. If disturbed, it leaves a powdery residue on the finger. If you suspect mold, lightly touch the spot and then check your fingers. If there is any dry residue, dispose of the kombucha including the SCOBY(s), sanitize the vessel and start with a fresh culture.

A common question is if the mold is just on top of the brew, can't I save the SCOBY under the liquid? The answer is no. Once mold appears on top of the brew, the liquid and everything below has now been exposed to the spores. Brewing up a new batch with either the liquid or culture from the moldy batch almost always results in visible mold and leaves anyone consuming the brew potentially exposed. Accidentally consuming mold once is unpleasant but not so bad, but drinking it over and over could cause longer term issues.

Other than weak conditions, direct exposure to mold spores is the only other way kombucha contracts mold. Since the culture is prolific, we recommend storing extras in a SCOBY hotel. Take an inventory of the ideal conditions, tweak as needed, and then simply start over with a fresh culture from the hotel. BYO

RESOURCES

[1] https://kombuchabrewers.org/kbi-osu-dna-sequence-study-analysis-report/

RELATED LINKS:

- For more information and resources about brewing kombucha, visit the authors' website: www.kombuchakamp.com

- Thinking about serving kombucha on your home kegerator? Find advice specific to kombucha brewers about sharing a draft system for both kombucha and beer: byo.com/article/tune-your-taps/

Photo by Charles A. Parker/Images Plus

MASTERING MALT ANALYSIS

INTERPRETING MALT SPEC SHEETS

by Aaron Hyde

Barley is an agricultural product, and therefore changes year to year. As brewers, we typically don't use barley raw from the field — it won't provide us the enzymes we need, nor is it as easy to store. We require another step in the process; malting. This is another variable added to the always changing malt we use. Typical analysis specifications and certificates of analysis that are provided by the maltster help us make sense of these changes. We can be better homebrewers if we understand what those factors and changes are so we can either physically adjust for these variables, or at least emotionally understand that beer ingredients are ever changing. If you'd like to be able to reproduce your beer it's even more critical you understand these barley-to-malt, batch-to-batch, and brew-to-brew changes.

You may already be adjusting your hops based on the given alpha acid units, why not your malt? The first reason may be information access as a homebrewer. You may need to get in touch with the malting company directly and provide them a lot number for your malt if you want to see a certificate of analysis on your particular lot. You may not care if your gravity is different by a couple points each time. Or your color is off a couple degrees batch-to-batch. Still, understanding why this happens is valuable. Some adjustments may be so slight — a few ounces of malt here or there, you may not choose to make them. We can be better homebrewers, worry less, and enjoy our beer more if we see the numbers provided and have a general understanding of what they mean.

LOT ANALYSIS VS. TYPICAL ANALYSIS

Most maltsters will be willing to provide a lot analysis sheet, often called the certificate of analysis, or COA. This analysis defines malt in terms of color, moisture, extract, protein, size, and possibly an assortment of other information. If the malt was kilned or floor malted, and intended for use as a base malt, the analysis will also provide further detail like diastatic power (DP), an indicator of the malt's capacity to turn starch into sugar.

A typical analysis lists ranges or an average for a particular malt. Many maltsters keep their typical analysis numbers online. Although useful, ranges may not be listed, and can be quite dramatic, especially on darker malts. If an average number is given, you may not know what sort of range

Photos courtesy of Briess Malt and Ingredients Co.

Roaster-produced crystal-type caramel malt will have 90% + of the kernels containing only glassy crystal like converted sugar. Kiln-produced caramel malt will have a large proportion, usually about 50% of the kernels mealy and starchy on the inside, just like high-dried or Munich malt. Left: Roasted (note >90% glassy) Right: Kilned (note about 50% mealy).

a malt has. Often a caramel 20 °L malt can finish in a roaster or kiln between 15 and 25 lovibond and still fall within the maltster's color specification.

GENERAL MALT DESCRIPTIONS

It's good to understand that we segregate malt by style, which often is an indicator of process. For the purpose of reading a typical analysis or COA, it's helpful to understand that there are two major categories of malt — base malt and specialty malt. Oftentimes specialty malt has less analysis provided as we aren't relying on it for starch or enzymes during the mash — critical numbers to know with base malt.

Base Malts:

These malts provide most of the wort's starch and enzymes that produce the extract. Base malts include: Pale (American two-row), pale ale, Pilsner (or Pilsen), Vienna, and Munich. All can be quite different but serve as the base of a beer, as they provide the appropriate enzymes to convert starch to sugar. Base malt will make up from 80–100% of the malt bill for most beer styles. The analysis of these malts is often a bit more specific and in-depth because of this. Malting specifications may be a bit more stringent as well to help the brewers receive a consistent product — it matters much more when it's the majority of your beer.

Specialty Malts:

Color or specialty malts are made in a kiln and/or a roaster and include: dark Munich style, caramel/crystal, dry roasted malts, and specialty roasted malts. These malts will contribute significantly to color, flavor, mouthfeel, foam, and aroma. These malts can be a critical player in all of the forementioned attributes.

It's also good to remember that there are always changes in barley variety, growing region, and seasonal weather that can have big effects on how malt tastes and its attributes. Although these considerations are taken into account by the farmer and maltster as they choose barley, these are further variables passed through to brewers looking to make a consistent beer.

MEASURING MALT

Maltsters in the United States use guidelines for testing and analysis from the American Society of Brewing Chemists (ASBC). In Europe, the guidelines are similar (if not the same), and are written by the European Brewing Convention (EBC). These organizations guarantee that everyone is using the same tests, and thus, providing similar values across their lab work.

There are a multitude of maltsters out there these days. Many are smaller, local companies. As the process gets more hands-on, it's often trickier to put processes in place that create consistent batches. It's best to get your hands on a certificate of analysis when using craft malt on a regular basis, as you may need to make adjustments from batch to batch if you'd like to see some consistency

in your own brewhouse. Let's take a look at what analysis is performed in the maltster's lab. You may find some analysis has more or less of the data listed below. I've provided the variables I believe are most valuable to you.

Extract, Dry Basis Fine Grind (DBFG)
This value is provided as a percentage and is used to determine the maximum extract yield a malt can offer. The malt is milled to a near flour consistency, and a "congress mash" is performed. This is typically only 50 grams of malt. The higher the DBFG number the better. It means there's more soluble starch, and less husk and protein in the makeup of the malt. Most maltsters these days strive for at least 80% extract, with a typical range for many base malts between 77–84%. Many brewers like to see this number be as high as possible as they see it as a measure of both quality and value — the higher the extract, the more bang for their buck from their base malt. If you see numbers below 76% on a COA, you may want to question the barley being used or the malt/malting process.

Extract, Dry Basis Coarse Grind (DBCG)
If you've guessed that DBCG is the same test as above with a much coarser grind, you'd be correct! This simulates a more "real world" mashing scenario, and often comes in just slightly lower in extract than the DBFG test, which really should give us our upper limit of extract potential. A more useful and often performed malt test, **"Extract, Coarse Grind As-Is"** can give us an even closer look at how a malt may perform when we brew with it. This malt reflects the closest mash performed in a lab that mimics a brewhouse. Both of these tests have values that typically fall between 76–83%. An "extract, coarse grind as-is" may still prove to be about 10% above the efficiency you'll see in your brewhouse, just due to the testing environment and efficiencies of lab equipment and the testing process.

Difference, Fine Grind vs. Coarse Grind (FG/CG)
The difference between the above two numbers can be valuable information as well. If you're using a malt that's 82% DBFG and 81% DBCG, you have a difference of 1%. "This difference is really an indicator of modification," states Dan Bies, Technical Services Manager at Briess Malt, "anything less than 1.5% indicates a well-modified malt, with the potential for higher extract yields when using just an infusion mash."

Color, Lovibond (L)/Standard Research Method (SRM)
It might go without saying, in most cases 100% of beer color is derived from malt. Sure, you might make an oak-aged chocolate cherry blonde ale from time to time, and those additives will color your beer. When it comes down to it, malt can easily help you dial in the perfect color one day, and throw your perfected Pilsner out of whack the next.

You probably use color quite often to choose a malt. Although malting companies still express color in degrees Lovibond (°L), they probably haven't used the test since the 1950s. Instead, the Standard Research Method (SRM) was developed using a spectrophotometer, giving a much more accurate process with which to test. The two ratings are nearly equivalent, and old habits of using °L to express °SRM color on typical analysis and COAs is near industry wide. In Europe you may find malt measured in only EBC, which can be determined by taking °SRM (or °L) and multiplying by 1.97.

In effect, color can be one of the largest determinants you use when choosing a malt. If a recipe or style calls for Munich malt, understanding the wide range of offerings often comes down to what degree of color it is, from 5 °L to 30 °L. Even a base malt like Pilsen can range from 1.2 °L up to 2.9 °L. The darker Pilsen malt more than doubles the lightest color on offer and more than doubles the color of the beer made from it.

Alpha Amylase, Dextrinizing Units (DU)
This is simply a measure of the alpha amylase present, and is shown in dextrinizing units (DU.) This is a great indicator of whether or not your mash will convert properly given time. A range of 30–50 is typical for a base malt. Lower numbers may mean a more complex mash, or a longer mash time is necessary. Most base malt is well-modified during the malting process, allowing for good alpha amylase numbers. It would not be released (or possibly even malted) if it wasn't able to perform the task of chopping up starch into short chain dextrin, allowing beta amylase to easily convert dextrin into fermentable sugar, a critical performance check.

Diastatic Power (DP)
This is an indication of the total enzyme power of a malt, both alpha amylase and beta amylase. Most base malt has a range shown in degrees Lintner of 50 °L to 150 °L (not to be confused with degrees lovibond).

"Even a base malt like Pilsen can range from 1.2 °L up to 2.9 °L. The darker Pilsen malt more than doubles the lightest color on offer and more than doubles the color of the beer made from it."

Malt Analysis Specifications and their Expected Ranges

Analysis	Value (Range Expected)
Extract, FGDB	77-84%, typically the higher the better.
Extract, CGDB	66-83%, typically the higher the better.
Difference, FG/CG	Less than 1.5% for well-modified malt, though intentionally under-modified malt may be more.
Color	Varies, look for consistency batch to batch.
Alpha Amylase, DU	30–50 typical, lower base malts may not convert your mash easily.
Diastatic Power, DP	Varies, but be sure your overall grain bill averages to at least 50 °L.
Assortment, Plump	Screens 7/64 and 6/64 should be above 80% total. Thru should be less than 3%.
Friability	Should be at least 85% to avoid mash issues.
Glassy/Mealy	Most caramel should be 90% glassy or higher. Base malts should be 100% mealy.
Viscosity	Less than 1.7 cP for best lauter performance.

Often if your mash average is below 40 °L you'll find your conversion will take much longer, if it converts fully at all. Lintner for a batch = (lintner total of grain X weight of grain) / (total batch weight).

Assortment, Plump

You may find neither of these words on a typical analysis, but the numbers should be available. What assortment refers to is kernel size, and the values you will see are expressed as a percentage of kernels that do not sieve through screens with gaps of 7/64 and 6/64 inches.

The test consists of four trays stacked from top to bottom with diminishing screen sizes — the top with a 7/64-inch screen bottom, the next with a 6/64-inch screen, the third with a 5/64-inch screen, the final tray at the bottom is solid. The trays are placed on a shaker with a 100-gram sample. After three minutes each tray is weighed.

What we want to see as brewers is that most of the kernels are plump, or not falling through the first two top trays. 80% plump, would mean that 80 percent of the kernels were in the 7/64-inch and 6/64-inch screen. We typically want base malt that's at least 80% plump or it could affect brewhouse efficiency, as it is more difficult to evenly mill various sizes with a two-roller mill. Adding a third roller with some finer adjustment may help. Specialty malt, due to the process or type of barley used may not be as plump. You may consider milling this malt separately if you have a two-roller mill with an adjustable gap.

If more than 3% of grain is making it to the final tray (also called "thru" or "thin" malt,) you may want to have a talk with your maltster — this can lead to extract issues due to milling and due to the quality of the malt. Seeing a high thru number may also translate to lower than expected extract numbers (FGDB) on your analysis as well.

Friability

Friability is a test of malt modification. The malt is crushed using a friability tester. When crushed, the ideal result of most base malt is that it easily crumbles, showing that the starch will be easily soluble in a mash. In general, specialty malts like roasted barley are highly friable, and are not tested. When measured as a percentage we want to see results at or above 85%. As brewers, we can easily single-step infusion mash any malt with this kind of friability. If you're using a malt with a friability of less than 85%, say a floor-malted Pilsen that has been left under-modified (hopefully intentionally), you would want to perform a step mash to help convert the malt.

Glassy/Mealy

Finally, a test almost specifically for specialty malt! Although you may find glassy or mealy percentages on your base malts, it's mostly used to let you know if your caramel malt is filled with sugars that have "crystallized" and turned glassy inside the kernel. Malt is cross-cut with a device called a farinator and examined for a mealy white center, or a "glassy" bead of sugar (find images of this on page 56).

Most caramel or crystal malt should be at least 90% glassy, though some lighter-colored crystals may be "half glassy" or could be only 80% glassy, depending on the process. This test may also be used on special process malts that are roasted. These malts may have their own typical glassy and half-glassy percentages. If you're not seeing your base malt at close to 100% mealy, then you know something went wrong with the malting process.

Viscosity
Measured in centipoise units (cP), viscosity is a measure of wort flow through tiny capillary tubes. If the wort is able to run quickly through this viscometer it indicates that you'll have an easy time sparging out. A high wort viscosity would indicate the malting process did not properly break down the endosperm cell walls of the barley kernel. Anything indicated over 1.7 cP may struggle to runoff (lauter) efficiently when sparging. If you think you might have issues, you can decoction or step mash starting with a 15 to 20 minute rest at 104 °F (40 °C) to help dissolve some of these beta-glucans.

These items we have run through so far are some of the most valuable, and useable numbers you'll find on a typical malt analysis, or a certificate of analysis for a certain lot of malt.

OTHER ANALYSIS PROVIDED

You can argue that all analysis is valuable, but with the values gone over up to this point you can determine if some other items will be valuable or not. The items I will briefly describe now may be as valuable to brewers as the previous analysis, and will help build a better picture of your malt.

Protein: Expressed as a percentage, most brewers hope to see this below 12%. Anything higher may show up as haze in your beer. It may also lead to lautering issues.

Soluble Protein (SP): Also expressed as a percentage, its primary task is to provide us a ratio of protein in our beer shown as S/T (soluble protein/total protein.) When dividing soluble by total protein, we want a number above 30% or we could run into lautering issues.

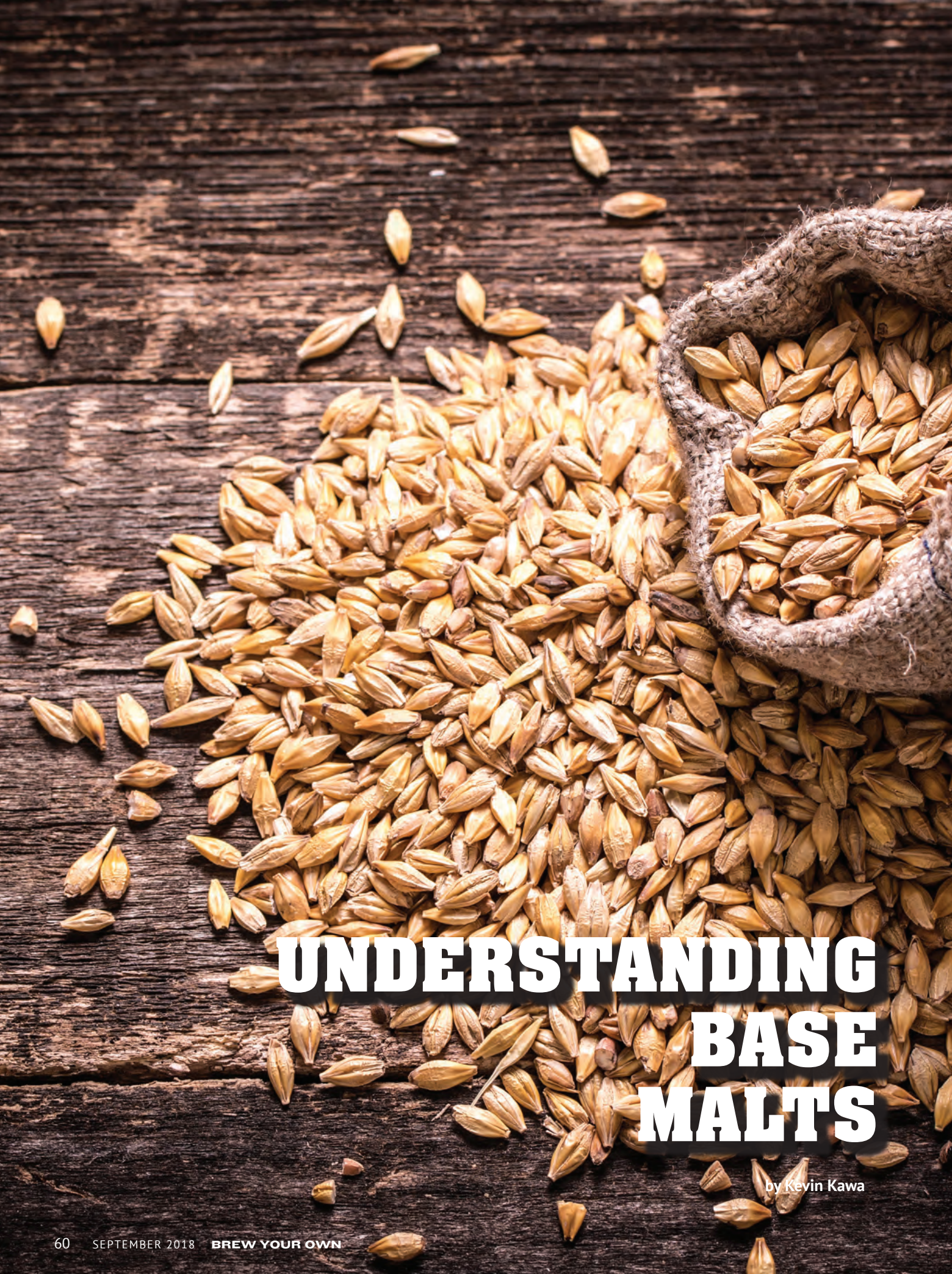
Free Amino Nitrogen (FAN): This measures the amount of free amino nitrogen available. It's critical for yeast growth during fermentation. Many brewers want to see at least 170 ppm available in their base malt, although others argue that a lower FAN will help with beer stability as FAN influences oxidative stability.

Beta Glucan (b-glucan): High levels are associated with lautering issues. Numbers above 180 ppm in your base malt may be worth a mash step at 115–120 °F (46–49 °C) for 15–20 minutes.

Turbidity: Measured in Nephelometric Turbidity Units (NTU), turbidity above 15 NTU listed may mean you're in for a bit of haze in your beer. Typically 5 NTU or less will signify a good clarity, and less solids, in your beer.

DEMYSTIFYING MALT ANALYSIS

Malt analysis doesn't need to be random numbers that mean little to you. Consistency isn't always a given, and quality can be measured. As homebrewers strive to make even better beer, unlocking the potential of your malt is a logical step. BYO



UNDERSTANDING BASE MALTS

by Kevin Kawa

THE BASE OF EVERY BEER

Photo courtesy of Shutterstock.com

Malt, hops, yeast, water. There have been extensive studies into each of these ingredients and their impact on the final beer product, but often it is the large flavor contributors such as hops, yeast, and specialty malts that get the most attention. While the influence of base malts in the final beer product might be subtle in comparison, it still will have an effect on your beer and knowing how they impact the final product can help you to better predict how your final beer will turn out. Base malts are exactly as they sound, the foundation the beer is built on. They are the major contributor of the carbohydrates (from starch), proteins, and enzymes in the beer. They are the workhorse of a malt bill and sometimes are just treated as such, but just because they are used primarily as a carbohydrate and enzyme source, that does not mean they are all interchangeable. Base malts have their subtle differences as well, and often there is a good reason why a specific base malt was used in a given recipe. Knowing the differences in the malts can help you choose the right base malt for your brew.

Base malts are the foundation beer is built on. They are the major contributor of the carbohydrates (from starch), proteins, and enzymes in beer.

2-ROW VS. 6-ROW MALT

The first aspect to consider in choosing a base malt is whether it is a 2-row or a 6-row malt. Outside of the US, 2-row is basically the standard for all base malts, and you would be hard pressed to find a 6-row malt for brewing. Even in the US, for the most part, base malts will almost always be 2-row for a number of reasons. 2-row grows fewer grains on the head of the barley (2 per head instead of 6 per head). This allows the grains to grow plumper, and will typically result in a larger and more consistent grain size. 6-row on the other hand will usually grow different sizes of grains, partly because the barley head is more crowded, but also because the grains grow in pairs directly across from each other on the head of the barley, and often times two of the grains on the head grow larger than the rest. This leads to an inconsistent grain size with some of the grains being larger than the rest. Because of the larger grain size in 2-row malt, it is described as having a mellower/maltier flavor whereas 6-row is described as having a grainier flavor. 2-row also has a higher starch content and can produce a higher extract, which is one of the reasons it is often the barley of choice for most maltsters.

The grainy flavor of 6-row is partly due to the higher husk-to-malt ratio of the grain. The husks contain a majority of the tannins, polyphenols, and proteins in the malt, so with a higher husk ratio, you will extract more of these qualities in the produced beer. One advantage of the higher husk ratio of 6-row malt is in building the filter bed during the lautering process. Having more husks helps to build a better filter bed, so 6-row malt is often easier to lauter. 6-row malt also has higher enzymatic activity and it is a good choice when using adjunct starch sources or a large ratio of highly under-modified malt due to its increased enzymatic activity. That is one of the reasons why it is often the choice of large production breweries. Large breweries will use cheaper adjuncts such as corn and rice, and they need the increased enzymatic activity to fully convert the adjuncts. Another reason they will choose 6-row malt is that it may cost less than 2-row malt depending on where the brewery is located. The cost savings comes from the fact that more grain is produced per barley stalk than 2-row, so you can produce more malt per acre of planted barley, which lowers the cost per pound of the finished product.

As mentioned before, for the most part you will only be using 2-row malts in brewing, but 6-row does have its place in beer production so it is good to be aware of its characteristics.

One final note, malted barley is not always going to be the only source of starch in a mash. Some styles will often call for other grains such as rye, oats, sorghum, and wheat. These will need the enzymatic activity from the malt to convert the starches, or enzymes will need to be added. If you are looking for a high ratio of adjunct grains, and you are not adding any extra enzymes, consider using 6-row malt for its higher diastatic power.

DIFFERENCES IN BASE MALTS

Another aspect to consider is the origin of the base malt.

Outside of the US, base malts will almost exclusively come from 2-row barley, and can have slightly different flavor characteristics. There are a number of reasons that the flavor can differ in base malts of the same style, including where the barley is grown (*terroir*), what barley variety the maltster uses, the malting and kilning process the maltster uses, what characteristics the maltster is targeting, what moisture level the maltster is targeting, and many more choices that the maltster will make. Without going into too much detail about malt production, the maltster will determine the best way to produce a malt that falls within specification, and is as consistent as possible with their previous malt batches. The maltster will work closely with the farmers, and usually will receive and test the barley before committing to using it for malting. They will be looking for a number of parameters including, but certainly not limited to, dormancy of the malt, protein content, moisture content, and grain size. The maltster goes through a lot of hard work to produce a high-quality, consistent base malt, and will oftentimes make adjustments on the fly to ensure that the malt is within specified parameters.

A good starting point in choosing which base malt to pick for your beer would be looking at the data the maltster provides. They will often give an accurate description of the malt itself, and what characteristics you can expect when using their malt. Along with flavor descriptors, a maltster will provide some other specifications about the malt. The specifications may vary slightly depending on what methods were used, for example ASBC, IBD or EBC, and how many tests the lab decided to perform, but typically you can find information on the target range or minimum/maximum of specific qualities of the malt such as color, moisture, protein totals, expected extract, and usage rates. There may be more or less information, again depending on what the lab is testing for, but these characteristics are generally tested with most base malts and can offer some valuable information. In general, lower moisture malt will hold up better for storage. Higher protein can help with better head retention in the beer, and can offer greater nutrition for the yeast during fermentation. This information can give you an idea of how the malt will impact the final beer outside of its flavor and aroma contributions. (For more on understanding and interpreting what the different specifications that are commonly listed on malt spec sheets, read "Mastering Malt Analysis" beginning on page 54.)

There are some general guidelines you will find in malt from various malt growing regions. North American malts can sometimes have an earthier and grassier characteristic, but for the most part are considered fairly neutral. British malts are often described as being more biscuity, bready, and malty. Maris Otter, a barley variety often used in British malts, is a perfect example of the sweet, biscuity flavors that you will get in British malts. German malts can have a mild malty and sometimes slightly medicinal phenolic characteristic.

If you are looking to replicate a specific style, it can be a good idea to try and get base malt from that region the style originated, as that is most likely what the brewers producing that style are using. It is one of the best ways to try to be true to style, although imported malts will usually come at a higher price than domestic malts so that is something to take into consideration. You can sometimes see price savings buying malt in bulk by the bag, but when committing to a full bag of base malt you will want to be sure you find something that you like and converts well.

If you are new to the different base malts, one of the best ways to understand them is to get your hands on the different varieties and give them a taste. If possible, try to get a few samples of the same style (I would recommend pale malt or pale ale malt) from a few different maltsters. It can help you to better understand regional differences, and give you a better idea of what base malt you prefer. Certain styles will call for different base malts and using the right base malt will give you the best chance of brewing an awesome beer. Like specialty malts, base malts also come in a number of varieties. These include: Pale malt, Pilsner malt, pale ale malt, Vienna malt, and Munich malt.

PALE MALT

Pale Malt is the most common of the base malts used in beer. It is oftentimes called simply called "2-row" malt. This can be a little confusing to new brewers as basically all the malt they will be using is a type of 2-row malt. Just know that if a recipe calls for 2-row malt by name, they are referring to pale malt. Another name for the same type of malt might be the barley variety itself such as Maris Otter.

Pale malt is light in color and usually will be around 2–2.5 degrees Lovibond. It can be used to make basically any beer style and is highly modified so you will not have any trouble getting extract out of it. If you are not sure what base malt you should be using, start with pale malt. It works well in almost all situations. If you are looking to buy malt in bulk and store it yourself, this is definitely a must-have.

PILSNER MALT

Pilsner malt is typically lighter in color than pale malt, falling into the 1.5–2 degrees Lovibond range. It is used for, as you probably guessed, making Pilsner beers — typically traditional German and Czech Pilsners. It has a lighter and crisper flavor than pale malt and the flavor is very subtle so it is best to use this malt with other light malts, or as the entire mash bill.

Within a region, Pilsner malts can sometimes have a bit higher soluble protein content versus other base malts depending on the barley variety the maltster uses, which can provide an added benefit for better head retention in the beer. This may not always hold true when comparing from a single maltster, as oftentimes the maltster is using a single barley variety for multiple malts they produce. You should check the soluble protein of the malt before using it, but if you are looking to add a little extra protein content to your beer, you can consider adding a high-protein Pilsner malt in smaller portions. If you want to replicate a traditional Pilsner style, using 100% Pilsner malt is definitely the best way to go.

PALE ALE MALT

Pale ale malt is slightly more kilned than pale malt and will have a slightly darker color. Usually in the 2.5–3 degrees Lovibond range. Pale ale malt has a more full-bodied flavor and you will get more of the malty aromas with pale ale malt.

It is a great choice for almost any ale — from pale ales and IPAs to porters and stouts. This is an especially good choice for English pale ales, and really any beer that you want a bit more body. Pale ale malts often have a sweet or honey characteristic to them as well, but this can vary by maltster so check if the maltster lists honey as one of its malt descriptors if searching for this characteristic.

VIENNA MALT

Vienna malt is a bit more highly-kilned than the other base malts, and will really shine with its malty flavors and aromas. It is slightly darker than other base malts and will usually be in the 4 degrees Lovibond range. Even though it is more highly-kilned than the other base malts, it still has enough enzymatic activity to complete conversion on its own.

Vienna malt will typically have a grainy, sometimes sweet, malty flavor and will be much more pronounced than any of the other previous base malts. Vienna malt is typically used in Oktoberfest lagers and Vienna-style lagers.

MUNICH MALT

Munich malt is the last on the list and is the most highly kilned of the base malts. Its color can range the most out of the base malts, weighing in anywhere in the 7–30 degrees Lovibond range, so it is good to check the color of the malt before using it as darker Munich malts and lighter Munich malts can have very different characteristics. Lighter Munich malts are less kilned than their darker counterparts so they will have more enzymes still intact and should still be able to convert the mash fairly easily. Darker Munich

malts, on the other hand, because of the higher temperatures of the kilning, will have much less enzymatic activity and you should compensate with some other base malts in the mash bill to achieve full conversion.

The flavor of Munich malts tends to be deep grainy/malty, sometimes bordering on toasty depending on how highly they were kilned. Munich malt is usually called for in German-style dark lagers, bocks, Munich dunkels, and Oktoberfest styles.

You might be wondering why Vienna and Munich malts are on the list of base malts. This is mostly because of their ability to convert starches to sugars and because these malts are used as base malts for classic styles from these areas. They still have enough diastatic power to do the work of base malts. They kind of bridge the gap between base malts and specialty malts and can be used as either. Vienna and light Munich can be used upwards of 100% in recipes, but more often they are used in lower percentages to add some color, body, and flavor to the beer.

STORAGE

Finally, a quick note on storage of base malts. Because base malts are not as highly-kilned as other specialty malts, they are usually not able to be stored as long as specialty malts. With proper storage, base malts can start to see loss of quality and flavor after 6 months. Specialty malts, on the other hand, can start to see loss of flavor and quality after 12–18 months.

A base malt that has started to go bad will see loss of enzymatic activity, may be harder to grind, and sometimes can add a haze to the final beer product. Moisture is going to degrade the quality of the malt so storing it in a cool, dry place will prolong the life and quality of the malt. Keeping the malt whole and protected by the husk until brew day is another important step in keeping the quality of the malt the same as when you bought it. If you do need to crush it and then store it, or if you purchased pre-crushed malt, keep it in a dark, cool, extremely dry place, and use it as quickly as possible. Unlike whole malts, crushed malts do not have an intact husk to add an extra layer of protection from excess moisture and can go stale much more quickly.

One quick and easy check is to give the malt a taste. If it tastes stale or unusual, it might have gone bad or be on the downturn. Another quick test would be to weigh the malt to see how much moisture the malt has picked up. If you had an exact weight of the fresh malt (say 50 lbs./22.7 kg) and the malt now weights significantly more (say 50.5 lbs./22.9 kg) it has picked up moisture and that can lead to mold or undesirable flavors.

Base malts are some of the best to purchase in bulk because of how much of the grain bill typically consists of base malts and the savings that come along with purchasing 50-lb./22.7-kg sacks vs. just enough for each single batch individually. Investing in good malt storage containers can definitely help to prolong the life of the malt. Good storage containers should be made of a strong, durable material (plastic works great), and should be airtight. They should be able to keep out moisture and bugs to keep the malt dry and free of contaminates.

“Because base malts are not as highly-kilned as other specialty malts, they are usually not able to be stored as long as specialty malts. With proper storage, base malts can start to see loss of quality and flavor after 6 months.”

Base malts do more than just add carbohydrates and aroma to the beer, they play an important role in the final beer product. There are many base malt options available (maybe not as much as specialty malts), but knowing the subtle differences and choosing the right base malt can take your beer from great to amazing. Using the correct base malt will also help you to accurately replicate styles from around the world. While big, bold flavor contributors may be seen as the stars of the show, base malts still play an important role in your beer. Knowing the options of base malts available and choosing the right one is the foundation to building an awesome beer.

MALT MILLS

COMPARING HOMEBREW MILLS ON THE MARKET

By Dawson Raspuzzi

For those brewing all-grain batches, the malt mill is one of the most important pieces of equipment in the homebrewery. And even if your brew days consist of extract batches or partial mashes, a mill is still the easiest way to ensure the freshest taste in every batch of beer.

When I first started dabbling in the hobby of homebrewing I was told all about how buying whole grains and waiting until brew day to crush them was going to result in the freshest malt flavor, so that's just what I did. What I wasn't told about is just how big of a pain crushing grains with a rolling pin would be, or how throwing them into a blender was going to result in malt flour! So it didn't take more than a batch or two until I started having my grains crushed at the point of purchase. This was easy, saved me some time, and worked out well when I was buying ingredients for one batch at a time. But before long, a new problem arose as I began stocking up with ingredients for multiple brews during each trip to the homebrew shop and then sat on the crushed grains for weeks and sometimes months before I'd find the time to brew. The taste of these batches suffered, and I quickly realized it was time to start milling my own grains at home.

Having a mill at home allows homebrewers to purchase whole grains — and save money through bulk grain purchases — and keep the grains for a minimum of six months before they show any sign of degradation. When brew day comes, a quick crush through the rollers of a mill makes for an easy start to the brew day with the freshest grains going into the mash tun.

As homebrewers in the 21st century we are fortunate that we have choices when it comes to all of our equipment; mills included. However, it can also become confusing shopping for a product when so many manufacturers offer their own model. To make it easier, we've pulled together the details of the homebrew mills on the market and put them in one place for you to compare. They spread the spectrum in price point, design, and capabilities. Whether it's for a pound (0.45 kg) of specialty malt to add flavor to your extract-based batches, or 20 times that for your next all-grain barleywine, there is sure to be a mill that fits every homebrewer's needs.

Adventures in Homebrewing Cereal Killer Grain Mill

The Cereal Killer Grain Mill from Adventures in Homebrewing/Austin Homebrew Supply includes two hardened knurled steel rollers with a ball bearing design that measure 5 inches (12.7 cm) in length and 1.25 inches (32 mm) in diameter. It has a 10-millimeter steel crankshaft. The parallel roller gap adjustment can crack grains down to 100th of an inch (0.25 mm). Loosening two screws, sliding the rollers based on marked adjustments, and then retightening the screws make gap adjustments easy and precise. The mill comes with an anodized aluminum hopper attached to the hardened steel roller casing that can hold up to 7 lbs. (3.2 kg) of grain. The mill also comes with the wooden base.

If you have a lot of grain to crush and prefer to attach a power drill to the mill instead of hand cranking it, removing a single screw from the handle and attaching the drill makes for an easy upgrade. With an optimal speed of 300 RPM, the Cereal Killer can crush up to 7 lbs. (3.2 kg) of grain per minute. This mill comes with a one-year warranty and retails for $129.99.

MSRP: $129.99

www.homebrewing.org/Cereal-Killer-Grain-Mill_p_2310.html

BC Products Barley Crusher Malt Mill

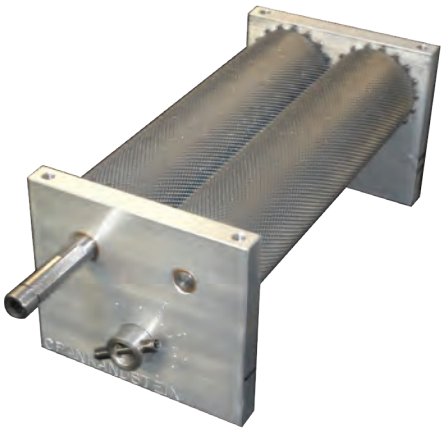
The Barley Crusher from BC Products has two 1.25-inch (32-mm) diameter 1018 cold rolled steel rollers with 12 TPI knurl. The rollers can be adjusted parallel using feeler gauges to set the gap or can be adjusted at an angle, if desired, for a gap spanning roughly 0.01 to 0.075 inch (0.25 to 1.9 mm). The Barley Crusher comes with two hopper size options: 7 lbs. (3.2 kg) or 15 lbs. (6.8 kg) (the larger option is shown) that are made of aluminum. The mill body is also aluminum.

The Barley Crusher comes with a handle, but if you prefer to use a power drill it has a crankshaft diameter of ⅜ in. (9.5 mm) and using it at a recommended 250 RPM will result in up to 6 lbs. (2.7 kg) of grain crushed per minute. If you want to go for some extra frills, a high-torque motor kit for the Barley Crusher is also available, starting at $200. Another available add-on is a predrilled base for those looking for the complete package. The Barley Crusher has been on the market for 20 years, comes with a lifetime warranty, and is 100% made in America. The Barley Crusher retails for $147, or $170.50 with the hopper extension.

For the larger-scale homebrewers or microbrewers, BC Products also has a new addition to their lineup — the Micro Brew Series Malt Mill — that runs on two half-horsepower TC motors. Currently available is a two-roller model with 2-inch (5-cm) diameter rollers, a heavier-duty steel body, and 30-lb. (13.6-kg) hopper. A three-roller option is expected to be available by the end of the year.

MSRP: $147–$170.50 **www.barleycrusher.com**

Crankandstein Brewing Mills



Crankandstein has multiple mill options in their line that run the spectrum in price and features. The largest is the 328G Geared Up Brewing Mill (shown here and retailing for $400), which features three knurled steel rollers that measure 2 inches (50 mm) in diameter and 8 inches (20 cm) in length. With the ability to crush 25 lbs. (11.3 kg) of grains per minute while running at 200 rpm, it may be overkill for 5-gallon (19-L) brewers but is perfect for large-batch or nanobrewers. The roller gap adjusts to 0.025–0.065 inches (0.64–1.7 mm) at indexed 0.005 (0.13 mm) increments. A power drill can be attached to the ½-inch (12.7 mm) crankshaft, but the best option is using a 1 HP motor to run at 240 rpm or less (sold separately).

If this size sounds like overkill, Crankandstein offers mills for as little as $88 with the 2S Homebrewing Mill. This mill features two 1.5-inch (38-mm) diameter cold rolled, knurled steel rollers that are 4 inches (10 cm) in length. Dual eccentric bearings can be removed, turned, and locked back into place to adjust the gap with a range of 0.025–0.065 inches (0.64–1.7 mm). It features a steel ⅜-inch (9.5-mm) driveshaft with three flats for positive drill chuck attachment.

None of the Crankandstein mills come with a hand crank handle, hopper, or base. A 2-gallon (8-L) steel hopper (which holds ~9 lbs./4 kg of grain) with hardwood base can be purchased separately to fit any of their mills for $50. Prices for Crankandstein mills range from $88–$400, with multiple two- and three-roller options falling in between.

MSRP: $88–$400 **www.crankandstein.net**

Keg King MaltMuncher

The MaltMuncher mill from Keg King comes as a two-roller or a three-roller option. The smaller option (shown here) features two 5-inch (12.7-cm) cold rolled steel rollers with a 1.25-inch (32-mm) diameter. The rollers are 12 TPI knurl to effectively pull grain through while still leaving the hulls intact. The rollers are adjustable at both ends allowing for a gap range of 0.025–0.1 inch (0.64–2.5 mm). The body is made from 6061 grade aluminum, as is the 6-lb. (2.7-kg) hopper that comes included. This option has a 10 mm crank shaft.

The three-roller option is made from the same materials but sees everything increase in size. The three rollers measure 6 inches (15 cm) with a 1.5-inch (3.8-cm) diameter that turn in precisely machined ball bearings. The gap adjustments range increases from 0–0.63 inch (up to 16 mm) and has a 12 mm crank shaft. It also sees an upgraded hopper capacity, holding up to 12 lbs. (5.4 kg) of grain, which is the upper amount of grain you can expect to crush per minute with a power drill at 200 rpm.

Both options come with a crank handle that is easily removable if you want to use a power drill. Each also comes with a one-year warranty. A bamboo base for either mill is sold separately, as is a 240-volt motor coupled with a high-torque gearbox to bring the RPM down to a milling speed of 180 RPM. Prices for the mills range from 89.99 to 189.99.

MSRP: $89.99–$189.99 **www.morebeer.com/category/grain-mills.html**

Monster Brewing Hardware Monster Mills

Monster Mills offers a handful of mills that vary in size and capabilities, many of which have options available to upgrade features such as the roller material and drive shaft sizes. Ranging in price from the base two-roller MM-2 starting at $139 up to the MM-3Pro PD that retails at $479, there is a mill for every homebrewer's needs and price point. The MM-2 has 1.5-inch (38-mm) diameter knurled rollers available in 1144 alloy steel or, for an additional $40, a 303 stainless steel option recommended for those living in salty or moist environments, or for those who want to wet mill. Both of these roller options measure 6 inches (15 cm) in length. Utilizing a ⅜-inch (9.5-mm) driveshaft, a power drill can crush 6 lbs. (2.7 kg) of grain per minute at 100 rpm. A ½-inch driveshaft can be purchased for an additional $5. With dual eccentric adjusters, the gap ranges from 0 to 0.07 inch (up to 1.8 mm).

Want more? The MM-3ProPD features three 1144 alloy steel rollers heat-treated to approximately 51-54 Rockwell C hardness. With a fixed gap of 0.06 inch (1.5 mm) and a fully adjustable second gap up to 0.065 inch (1.7 mm), it can crush 13 lbs. (5.9 kg) of grain a minute.

Worth mentioning, Monster Brewing Hardware also offers a two-roller mill with helical slotted rollers vs. the knurled rollers on the other designs — a first on the homebrew mill market. Prices start at $379.

None of the Monster Mills come with a hopper or stand. A 12-or 38-lb. (5.4- or 17.2-kg) hopper from 304 stainless steel or galvanized steel and base made from medium-density fiberboard are sold separately.

MSRP: $139–$479 **www.monsterbrewinghardware.com**

Northern Brewer Hullwrecker

The Hullwrecker from Northern Brewer features two, 5-inch (12.7-cm) knurled cold rolled steel rollers with 1.29-inch (33-mm) diameters. It has a fully adjustable roller gap from 0.025 to 0.1 inch (0.64 to 2.5 mm). The body and included hopper are made from anodized aluminum. The hopper holds up to 7 lbs. (3.2 kg). It also comes with a handle with a rubber grip that can be removed if you'd prefer to use a drill with a ⅜-inch chuck. With a drill, the Hullwrecker can crush up to 8 lbs. (3.6 kg) of grain at the recommended 300 RPM. This mill also comes with sealed ball bearings (vs. bushings).

One of the unique features of the Hullwrecker is a custom-designed printed steel base that fits perfectly on any standard 5-or 6.5-gallon (19- or 25-L) plastic bucket. The Hullwrecker retails for $119.99 and comes with a one-year warranty.

MSRP: $119.99 **www.northernbrewer.com/hullwrecker-2-roller-grain-mill-base**

Ss Brewtech Ss Grain Mill

Expected to arrive on the market this fall is the newest grain mill that features an innovative design. This mill operates using an internal drive motor with a pair of fluted 304 stainless steel rollers that operate on differential speeds. The unique design causes the husk of the grain to be sheared off the endosperm instead of pulverized like most homebrew mills on the market. The idea behind this is that keeping the husk intact helps to improve lautering performance and prevent stuck sparges. Each roller has a diameter of 3.9 inches (100 mm) and a width of 3.5 inches (90 mm). The rollers can be adjusted without the need for tools. The Ss Grain Mill has a body made from extruded aluminum and has a sealed system designed to isolate the drivetrain and motor from grain dust.

Included with the mill is a stainless steel hopper that holds half a cubic foot of grains (about 17–19 lbs./7.7–8.6 kg.) The mill will come with a one-year warranty. As of publication, a price had not yet been finalized.

MSRP: TBD **www.ssbrewtech.com**

The Vintage Shop Evil Twin Roller Mill

The newly rebranded Evil Twin Roller Mill (previously just called Twin Roller Mill) from The Vintage Shop comes standard with everything needed to start crushing grains. It features with two stainless steel 5-inch (12.7-cm) 12 TPI knurled rollers that measure 1.25 inches (33 mm) in diameter. Gap adjustments can be set at 0, 0.025, 0.05, 0.075, or 0.1 inch (0, 0.64, 1.3, 1.9, 2.5 mm). The body is made of aluminum, as is the included hopper that holds up to 10 lbs. (4.5 kg) of grain. Also included is the base and a wooden handle that can be removed to use a power drill instead, in which case up to 6 lbs. (2.7 kg) of grain can be milled per minute at 500 RPM. The Evil Twin Roller Mill comes with a 1-year warranty and retails for $120.

MSRP: $120 **http://thevintageshop.ca/products/twin-roller-mill.html**

Corona Hand Mill

Patented in 1921, the Corona Mill is a simple grinder that uses two 3 ⅝-inch (9.2-cm) cast iron grinding burrs to grind any grain, bean, or nut. Unlike the mills that utilize rollers to crack the grains, the Corona Mill is a grinder that crushes or tears the grain, reducing it into smaller particles or powder. The grind can be adjusted from over 0.125 inches (3.2 mm) down to a very fine grind to make flour. Two rolled steel hopper options are available — the low hopper has a 1.5-lb. (0.68-kg) capacity, and the high hopper has a 3-lb. (1.36-kg) capacity. Up to 1.5 lbs. (0.68 kg) can be ground per minute on the coarse setting and twice that can be ground per minute on the finest setting. The Corona Mill includes a 10½-inch (27-cm) handle, which attaches to a ¾-inch (1.9-cm) feed auger (shaft). Although not manufacturer sanctioned, the mill can easily be motorized at 120 RPM.

This classic has remained basically unchanged in its nearly century on the market. Since the entire body and feed auger is made from tin-coated cast iron, these mills will last a lifetime if properly cared for. The Corona Hand Mill retails for $99 and comes with a 5-year warranty.

MSRP: $99 **http://coronamill.com**

Victoria Grain Mill

Ideal for malt extract homebrewers who need to mill small amounts of specialty grains, the Victoria Grain Mill utilizes two plates grinding together to crush the grain. The plates are fully adjustable to provide a crushing range from very fine to coarse. This mill is made of cast iron with a tin finish, which means it should last a lifetime if properly cared for. The mill easily clamps on to any flat surface and comes with a handle that is removable (however hooking a drill or motor to it is not recommended). The Victoria mill comes with a hopper large enough to hold 1 lb. (0.45 kg) of grain. Retail price is $59.99.

MSRP: $59.99 **https://www.morebeer.com/products/victoria-grain-mill.html**

MALT MILLS

	ADVENTURES IN HOMEBREWING CEREAL KILLER	BC PRODUCTS BARLEY CRUSHER	CRANKANDSTEIN	KEG KING MALT MUNCHER	MONSTER MILLS
PRICE (US)	$130	$140–$170	$88–$400	$90–$190	$139–$479
NUMBER ROLLERS	2	2	2–3	2–3	2–3
ROLLER DIAMETER	1.25 in. (32 mm)	1.25 in. (32 mm)	1.5 in.–2 in. 38 mm–50 mm	1.25–1.5 in. (32–38 mm)	1.5 in.–2 in. 38 mm–50 mm
ROLLER MATERIAL	Hardened Steel	Cold Rolled Steel	Cold Rolled Steel	Cold Rolled Steel	1144 Alloy Steel/ Stainless Steel
ADJUSTABLE GAP RANGE	0.02–0.1 in. (0.5 to 2.5 mm)	0.01 to 0.075 in. (0.25 to 1.9 mm)	0.025 to 0.065 in. (0.64 to 1.7 mm)	0.25–0.1 in. (0.65–2.25 mm)	0–0.07 in. (0–1.8 mm)
HOPPER INCLUDED	✓	✓	✗	✓	✗
HOPPER CAPACITY	7 lbs. (3.2 kg)	7 lbs. (3.2 kg) or 15 lbs. (6.8 kg)	9 lbs. (4 kg) (sold separately)	6 or 12 lbs. (2.7 or 5.4 kg)	12 or 38 lbs. (5.4 or 17.2 kg) (sold separately)
GRAINS MILLED PER MINUTE	7 lbs. (3.2 kg)	6 lbs. (2.7 kg)	up to 25 lbs. (11.3 kg)	up to 12 lbs. (5.4 kg)	up to 13 lbs. (5.9 kg)
BODY/HOPPER MATERIAL	Hardened Steel/Anodized Aluminum	Aluminum	Aluminum/Steel	6061 Aluminum	303 SS/304 SS or Galvanized Steel
CRANK SHAFT DIAMETER	10 mm	⅜ in. (9.5 mm)	⅜ in. (9.5 mm) or ½ in. (12.7 mm)	10 mm/12 mm	⅜ in. (9.5 mm) or ½ in. (12.7 mm)
HANDLE INCLUDED	✓	✓	✗	✓	✗
BASE INCLUDED	✓	✓	✗	✗	✗

COMPARISON CHART

NORTHERN BREWER HULLWRECKER	Ss BREWTECH Ss GRAIN MILL	THE VINTAGE SHOP EVIL TWIN ROLLER MILL	CORONA HAND MILL	VICTORIA GRAIN MILL
$120	Coming This Fall	$120	$99	$60
2	2	2	2 Plates	2 Plates
1.29-inch (33-mm)	3.9 in. (100 mm)	1.29 in. (33 mm)	N/A	N/A
Cold Rolled Steel	304 Stainless Steel	Stainless Steel	N/A	N/A
0.025 to 0.1 in. (0.64 to 2.5 mm)	To Be Determined	0–0.1 in. (0–2.5 mm)	0–0.125 in. (0–3.2 mm)	N/A
✓	✓	✓	✓	✓
7 lbs. (3.2 kg)	19 lbs. (8.6 kg)	10 lbs. (4.5 kg)	1.5 or 3 lbs. (0.68 or 1.36kg)	1 lb. (0.45 kg)
8 lbs. (3.6 kg)	To Be Determined	6 lbs. (2.7 kg)	1.5 lbs. (0.68 kg)	1.5 lbs. (0.68 kg)
Anodized Aluminum	Extruded Aluminum /Stainless Steel	6061 Aluminum	Tin-Coated Cast Iron/Rolled Steel	Tin-Coated Cast Iron/Tin-Coated Plate Steel
⅜ in. (9.5-mm)	N/A (Internal Drivetrain)	5/16 in. (8 mm)	N/A	N/A
✓	N/A	✓	✓	✓
✓	✓	✓	N/A	N/A

Return of the Classic Sour Ale

By Paul Zocco

Traditional lambic, gueuze, and fruited lambic may be "Love 'em or hate 'em" beer styles, but in the recent past, more homebrewers have ventured into making these classic sour ales. Once rarely attempted by homebrewers, these beer styles have been drawing the adventurous to brew clone versions of world-class examples. Names such as "Cantillon" and "Lindemanns" are commonly heard, and small-batch clone recipes for these classic sour ales are finding their way into the homebrewer's portfolio. In the following pages, I will use the word "lambic" to include gueuze (a blend of young and aged lambics) and fruited lambics (i.e. kriek, framboise, etc.).

There are many sours currently being produced in North America by commercial breweries on both coasts and in between that are quite good. By no means am I insinuating in this article that they are inferior, but I believe to understand where these beer styles came from we must go back to the Old World and see where sour ales originated. So for this article I will specifically focus on Belgian lambic brewers, blenders, recipes, brewing techniques, and their interesting history. The following text will give the hombrewer some necessary facts to understand lambic brewing, its roots, and the complex parameters incorporated in its variations of gueuze and fruited lambics.

I will refer primarily to the Brewers Publications, Classic Beer Style Series *Lambic* by Jean-Xavier Guinard. This is a "must have" reference for those who wish to learn, understand, and cherish this very distinctive Belgian ale. It has been out of print for many years, with copies often selling for above $100, but luckily it was re-released on Kindle.

EXPLORING LAMBIC COUNTRY

The coolship at Cantillon, where hot wort is pumped to cool and pick up ambient yeast and microbial flora in the air of Brussels, Belgium.

STYLE PARAMETERS OF LAMBIC

A brief review of the Beer Judge Certification Program (BJCP) Style Guidelines for straight unblended lambic will help the brewer understand some flavor and aroma characteristics one should expect in this complex ale. According to the guidelines, the aroma typically has sour, earthy, barnyard, goaty, and horse blanket characters. The appearance of the beer is typically hazy with color in various shades of golden. Flavors and aromas typically change with age. Young versions are quite sour and acidic, with aged examples mellowing with complex notes of *Brettanomyces*, lactic and acetic acids, and fruity esters.

Commercial lambic breweries such as Cantillon tend to develop a "house character" from their blend of fermentation agents and brewing techniques. As one walks through this Brussels landmark brewery, the ambient aromas in the air are very similar to those in their beers. When home and enjoying a Cantillon, the fragrance brings me back to the little brewery in the Brussels neighborhood of Anderlecht.

As I traveled throughout the Senne Valley area (lambic country) in Brussels and around the outskirts of the city a few years ago, I visited many lambic breweries. In the vicinity of each are small neighborhood cafes serving local lambic made right up the road. Usually the person pouring would be the cafe owner or someone in the immediate family who is on a first name friendship with the lambic maker. One memorable small lambic pub that brings pleasant memories to me is the In De Oude Smis Van Mekingen cafe in the small village of Sint-Pieters-Leeuw, near Brussels. The person pouring my lambic was a co-owner and a personal friend of Frank Boon, the brewer who made the Moriau Oude Geuze I sipped on and enjoyed while chatting with the pourer. The brewery was right up the road.

As we toured a loop around Brussels, Belgium called the Pajottenland, we visited many small lambic breweries and small cafes in the land I like to call "lambic country." Each of the sour beers I enjoyed was distinctive, with "*terroir*" and characteristics that made each stand out as representative of the individual lambic brewery and their master brewer.

HORAL AND THE LAMBIC BREWERS AND BLENDERS OF BELGIUM

There are currently eleven commercial breweries in Belgium producing lambic. They are: Cantillon, Belle-Vue, Boon, De Keersmaeker (Mort Subite), De Troch, Girardin, Lindemans, Oud Beersel, Timmermans, Van Honsebrouck (St. Louis), and 3 Fonteinen.

There are also three others that don't brew, but instead buy freshly produced wort from several of the lambic breweries and then ferment/age, blend, and bottle it in their own facility. The three active lambic blenders are: Tilquin, De Cam, and Hanssens Artisanaal.

Many of these brewers and blenders are also part of a consortium that was formed in 1997 by Armand Debelder, the Brewer and Owner of 3 Fonteinen brewery located in Beersel. This collective group is called HORAL, an acronym for *Hoge Raad voor Ambachtelijke Lambiekbieren*. This translates to "High council for artisanal lambic beers." It is a group of like-minded lambic brewers and blenders who work together to promote lambic beer and the very rare culture that surrounds it. Quoting

the goal of HORAL, "In the face of continued decline, we wish to promote and protect traditional lambic beers." Interestingly, Cantillon is not a member.

I personally have seen this organization's success. In the past few years, the interest and resulting growth of Belgian lambics has soared beyond expectations. This has also affected the exponential growth of American brewers who are producing lambic-style beers. I spent some time in Italy a couple years ago, and saw a similar interest there in producing spontaneous ales.

LAMBIC BREWING BASICS EXPLAINED

Spontaneous fermentation has been well-documented over the years. It's been said that lambic brewing is the oldest method of making beer still in use. Belgian brewing expert and beer historian Marcel Gocar describes similarities of beer produced 5,000 years ago in Mesopotamia by the Sumerians and the typical lambic brewing process still in use today. If one were to research the history of another Belgian beer style — saison — they would find similarities in their sour, rustic, and earthy flavors. The understanding of bacterial and yeast fermentation was not clearly understood until the late 1800s with the important research and discoveries by the esteemed microbiologist Louis Pasteur.

I'll quote directly from Guinard's book with his perfect explanation describing spontaneous lambic fermentation. The following is from a lambic-loving companion who bought Mr. Guinard his first lambic in a Paris pub and introduced him to this style of beer. I cannot describe the brewing process any better, and wish I were there in that pub when it was explained. It goes like this;

"Lambic is the only beer of its kind in the world. It is made by spontaneous fermentation of a wort produced from 40 percent unmalted wheat and 60 percent malted barley malt. Mashing follows a temperature profile. The temperatures are increased by one or two decoctions

TRADITIONAL LAMBIC

(5 gallons/19 L, all-grain)
OG = 1.045 FG = 1.008
IBU = 10 SRM = 3 ABV = 4.8%

INGREDIENTS

6 lbs. (2.7 kg) pale malt
2 lbs. (0.9 kg) malted wheat.
2 lbs. (0.9 kg) unmalted wheat
1 oz. (28 g) aged Styrian Goldings hops (60 min.)
Wyeast 3278 (Belgian Lambic Blend) or White Labs WLP 655 (Belgian Sour Mix 1) yeast
Wyeast 3335 (Lactobacillus buchneri) or White Labs WLP673 (Lactobacillus buchneri)
Wyeast 5733 (Pediococcus damnosus) or White Labs WLP (Pediococcus damnosus)
Wyeast 5112 (Brettanomyces bruxellensis) or White Labs WLP650 (Brettanomyces bruxellensis)
Wyeast 5151 (Brettanomyces claussenii) or White Labs WLP645 (Brettanomyces claussenii)
¾ cup corn sugar (if priming)

STEP BY STEP

Combine 2.5 gallons (9.5 L) of 168 °F (75°C) water with the crushed wheat and barley. Mix well and adjust the temperature of the mash to 153 °F (68 °C). Let the mash rest at 153 °F (68 °C) for one hour and then recirculate until the wort runs clear. Sparge with 168 °F (75 °C) water until you get 6.25 gallons (24 L) into the boil kettle, which will be boiled down to 5.25 gallons (20 L).

Add hops when the wort comes to a boil and boil for 60 minutes. After the boil is complete, proceed to chill the wort to below 80 °F (15 °C), and transfer the contents into your fermenter. I ferment my lambics in a 5-gallon (19-L) oak barrel, but if you do not have a barrel then feel free to use your traditional fermenter. Pitch your yeast and bacterial blend (which contain strains of *Saccharomyces* and *Brettanomyces* yeasts and the bacterial strains of *Lactobacillus*, and *Pediococcus*) and aerate wort.

Aging times can vary but allow it to remain in the fermenter at least a year. After my initial pitch of a yeast/bacteria blend on brew day, I pitch the *Lactobacillus* and *Pediococcus* bacteria into the fermenter at three months from the initial brewing date. I then allow the fermentation to continue. At eight months, I pitch separate starters of *Brettanomyces bruxellensis*, and *Brettanomyces claussenii*. I don't perform a secondary transfer, but continue my fermentation in the original vessel.

After a year I like to pull monthly samples to taste how the beer is evolving. Bottle or keg when the taste is what you were shooting for. Bottles can be kept for years and flavors will continue to evolve as they are cellared.

TRADITIONAL LAMBIC

(5 gallons/19 L, partial mash)
OG = 1.045 FG = 1.008
IBU = 10 SRM = 4 ABV = 4.8%

INGREDIENTS

4 lbs. (1.8 kg) golden light liquid malt extract
2 lbs. (0.9 kg) malted wheat.
2 lbs. (0.9 kg) unmalted wheat
1 oz. (28 g) aged Styrian Goldings hops (60 min.)
Wyeast 3278 (Belgian Lambic Blend) or White Labs WLP 655 (Belgian Sour Mix 1) yeast
Wyeast 3335 (Lactobacillus buchneri) or White Labs WLP673 (Lactobacillus buchneri)
Wyeast 5733 (Pediococcus damnosus) or White Labs WLP (Pediococcus damnosus)
Wyeast 5112 (Brettanomyces bruxellensis) or White Labs WLP650 (Brettanomyces bruxellensis)
Wyeast 5151 (Brettanomyces claussenii) or White Labs WLP645 (Brettanomyces claussenii)
¾ cup corn sugar (if priming)

STEP BY STEP

Place crushed wheat in a large grain bag. Heat 1.5 gallons (5.7 L) of water to 168 °F (75 °C) and submerge the grain in the water. Try to mix the grain so no dry pockets exist. Let the mash mixture rest at 153 °F (68 °C) for one hour. When the mash is complete, place the grain bag in a large colander and wash with 1.5 gallons (5.7 L) of hot water. Stir in the liquid malt extract and top off the kettle with water to get 6.25 gallons (24 L) of wort into the boil kettle. Follow the remainder of the all-grain recipe.

of portions of the mash, and by additions of boiling water. The wort is boiled for at least three hours with aged hops that have lost their bittering power but have retained their antiseptic properties. Lambic is brewed mostly within ten miles of the city of Brussels, because the proper microbial flora is found only in that limited area. Production is concentrated in the western districts of Brussels, spreading out into the nearby farming villages collectively known as the Payottenland. Traditionally, lambic is brewed only from October 15 to May 15 because high summer temperatures can spoil the fermentations. The inoculation of the wort with the local microbial flora is achieved by letting the hot wort cool overnight in a wide and shallow cooling tun, which leaves a large wort surface area in contact with the atmosphere. The next morning, the wort is pumped into wooden casks in which it picks up some additional microorganisms among those lodged in the wood from previous use. The fermentation involves a sequence of yeasts and bacteria, the combined action of which over a period of several months is a lambic that is fruity, acetic, and sour but not bitter."

Perfect explanation!

BREWING THE BEER

My brewing technique and recipe are similar to Guinard's. I've performed decoction and straight infusion mashes using both malted and unmalted wheat (using only un-malted wheat is one of the requirements to brew a true lambic, but I've found malted wheat works fine). Unfortunately, I don't have a coolship in the neighborhood of Brussels' local microbial flora, but instead I use a 5-gallon (19-L) oak barrel that I've inoculated with various lambic bacteria and yeast over the years. Occasionally, I'll pour the dredges of a favored lambic into my barrel to add some additional complexity. Though there are many recipe variations used by different brewers to produce lambic, these are always fermentation-driven ales. The percentage of wheat (30–40%), the type of pale malt, and the brewing technique are very important, but this style is really all about the microbial aspect of the fermentation and its byproducts. Lambic fermentation depends on a very specific and complex fermentation regime. This is a slow process of fermenting that takes months or years to complete. It helps to have the patience of a saint.

Lambic brewing, though its process is similar to brewing other beer styles, does have its own idiosyncrasies. My research about classic lambic brewing techniques describes many variations of mashing procedures and ingredient use.

Belgian lambic brewers typically incorporate unmalted wheat into the grain bill, warranting an additional step called the cereal mash process. Decoction mashing may suffice, but I like to follow Guinard's suggestion of the alternative method of adding unmalted wheat flakes directly to the mash. The starch in wheat flakes is already gelatinized (making it more soluble), so conversion by the enzymes utilizing a typical infusion mash temperature of 153–158 °F (68–70 °C) is effective.

For grain/water (grist) ratio, I use the rate of one pound (0.45 kg) of crushed grain per quart/liter of water. In the case of the example recipe on page 77, I combine 10 quarts (9.5 L) of 168 °F (75 °C) water with 10 lbs. (4.5 kg) of the crushed wheat and barley to mash at 155 °F (68 °C). After mash-

Photo by Paul Zocco

Barrels decorate near the entrance of Brouwerij Boon in Lembeek, Belgium.

Photo by Paul Zocco

Barrels on display outside Brouwerij de Troch in Ternat, Belgium.

ing for an hour I sparge (rinse) with 168 °F (75 °C) water until I collect 6 gallons (23 L), which subsequently will be boiled down to 5.25 gallons (20 L).

This recipe calls only for 1 oz. (28 g) of hops added at the start of the 60-minute boil. The hops used to brew lambics are typically aged warm for one to three years, which causes oxidation to occur and leads to the loss of bitterness from the alpha acids. The hops do, however, retain their preservative qualities.

YEAST AND BACTERIA; THE DEFINING FACTORS IN BREWING CLASSIC LAMBICS.

One factor I have found to improve my lambics is pitching sequential additions of specific yeast strains and bacteria over a long period of time. Using the evolutionary graph designed by Van Oevelen, found in Guinard's *Lambic* book, a brewer can see when peak activity occurs with particular yeasts and bacteria over a 24-month timeframe. You can refer to this book to find the chart and read more about his recommended sequential additions. My interpretation of the fermentation process has encouraged me to initially pitch a starter yeast blend that contains *Saccharomyces cerevisiae* and other typical lambic strains of yeast and bacteria (*Lactobacillus, Pediococcus*, and various *Brettanomyces* strains). Commercial yeast companies offer these blends, making it easy to pitch. My favorites are Wyeast 3278 (Belgian Lambic Blend) or White Labs WLP655 (Belgian Sour Mix 1), both of which offer the brewer the yeast/bacteria blends necessary to create a great lambic. If you choose, single packs of various *Brettanomyces*, *Pediococcus*, and *Lactobacillus* strains are also available and you can come up with the mix on your own.

Referring to the Van Oevelen's evolutionary graph, after my initial pitch of a yeast/bacteria blend on brew day, I've chosen to pitch separate strains of *Lactobacillus* and *Pediococcus* directly into the fermenter at three months from the initial brewing date. I then allow the fermentation to continue. At eight months, I pitch separate starters of *Brettanomyces bruxellensis*, and *Brettanomyces claussenii*. I don't perform a secondary transfer, but continue my fermentation in the original vessel. Though the homebrewer may do the entire fermentation in a glass carboy, I conduct mine in a 5-gallon (19-L) oak barrel. As fermentation continues, complex reactions take place causing acid production and development of various by-products.

My last batch of lambic was fermented for 8 years in an old Buffalo Trace Bourbon barrel. Though I don't think that much time was necessary, it was a barrel aging process I've always wanted to try. As fermentation progressed, I tasted and documented the evolving flavors of the beer monthly to see how they had changed and learned how this style of beer develops. An important note for homebrewers considering extended barrel aging is the importance of topping off the barrel. This can either be done with another lambic (preferred, and a great way to make gueuze) or with a neutral beer (I used a light American lager). The beer added will fill the air space caused by evaporation through the barrel staves. This evaporative loss is lovingly called the "angel's share." The brewer must perform this important step every few weeks as to not develop elevated levels of acetic acid (vinegar). The alcohol produced during fermentation may be chemically converted to vinegar by the presence of acetobacter bacteria and oxygen (air is 22% oxygen) in the space left by evaporation.

Lambic fermentation is a long and slow process that utilizes many complex "controlled spoilage-type components" that brewers usually dread. But in this case, these by-products make the lambic what it is; a complex sour ale with wine-like and estery characteristics. Complex notes of acetic acid (vinegar), lactic acid, and *Brettanomyces* develop over time. *Saccharomyces sp.* does not ferment the longer chain starches present in unmalted wheat, but over time the presence of *Brett* strains and *Lactobacillus* will do so, producing additional complex textures and flavors in the beer. Research has shown that hundreds of complex reactions occur during this long-term fermentation. The brewer's technique, choice of ingredients, and especially the fermentation agents incorporated, will produce a lambic with his or her own signature.

Experience, patience, and an adventurous soul will reward the brewer with the complexities of a lambic they would be proud to put their name on. BYO

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HIGHLIGHTS

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Nanobrewing is growing fast with the majority of new commercial craft breweries opening up falling into this small-scale, hyper-local segment working on brewing systems 5 barrels or under. But often this Nano niche can't relate to current educational events for the pro brewing industry because their scale of brewing and distribution models are so different from larger craft brewery companies.

Now's there's a conference just for you: The small-scale craft brewery. Learn the business, marketing, and brewing strategies targeted for your sized needs. From strategies to maximizing taproom sales to more accurately forecasting future ingredient purchases, you'll learn over two days from experts and fellow Nano colleagues about actionable ways to improve – or launch – your brewery with ideas targeted just for your small-scale size and business direction.

28 BIG SEMINARS

Expert speakers will cover topics on brewing operations, sales and marketing, business operations, start-ups and lots more all geared to Nanobreweries!

ROUNDTABLE DISCUSSIONS

Peer-to-peer learning bringing full audience discussions on a variety of subjects so you can learn what is working – and what isn't — from others working in the Nano Craft Beer segment.

TWO LUNCHES WITH KEYNOTE ADDRESSES

Hear from fellow Nanobreweries during lunch on different hot topic items both Friday and Saturday so you can learn while you eat.

NANO-FOCUSED VENDORS

Check out the latest in equipment, supplies, and ingredients from leading companies focused on your Nano market and your specific scale and needs.

OPENING & CLOSING VERMONT BEER RECEPTIONS

Wrap up your full day of learning with sampling some of Vermont's finest craft beers served by the breweries on the trade show floor.

OPTIONAL 2-DAY PRE-CONFERENCE START-UP BOOT CAMP

Spend two full days leading into NanoCon learning from Steve Parkes, Lead Instructor and Owner of the American Brewers Guild, about the keys to starting up a new craft brewery both on the business side as well as the brewery side. This popular class regularly sells out at our past events.

OPTIONAL PRE- AND POST-CONFERENCE VERMONT BREWERY TOURS

Here's your chance to easily check out Vermont's famed craft beer scene. We'll offer two different tours on both the day before and the day after NanoCon. One trip will head out to the Stowe, Vermont region including a stop at The Alchemist to drink some Heady Topper at the source while the second tour hits Burlington-area craft breweries.

ONE-YEAR PRINT SUBSCRIPTION TO BREW YOUR OWN

Included with your NanoCon registration, a $29.99 value. Features our regular Nanobrewing column by Technical Editor Ashton Lewis.

NANO LEARNING TRACKS

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BREWERY OPERATIONS

- Quality Control Testing for the Nano
- Mobile Packaging Do's & Don'ts Roundtable
- Nano-Sized Yeast Management
- Cleaning Secrets & Small-Scale CIP Systems
- Evaluating Raw Materials
- Recipe Scaling
- Brewing Safety in Tight Quarters
- Nano Peer-to-Peer Table Topics

START-UPS

- Creating (and Financing!) Your Brewery Business Plan
- Infrastructure Sizing for Your Nano Building
- Planning & Starting Up a Quality Control Program
- Transitioning to Working Directly with Ingredient & Supplier Vendors
- Pro Options for Heating: Choosing Between Steam, Electric, Gas, Direct Fire & More
- Start-Up Brewery Law 101
- Brewery Branding 101
- Nano Peer-to-Peer Table Topics

BUSINESS OPERATIONS

- How Much Was That Last Batch?: Brewery Cost Accounting
- Accurately Forecasting Ingredient Purchases
- Top 10 Legal Mistakes Made By Small Breweries
- 1 Person, Many Hats: Keys to Being the Business Owner & Head Brewer
- Conducting an Operations Audit to Achieve Savings
- Can I Get "X" Hop?: Contracts, Spot Buys & Locking Down What You Need
- Maximize Brewing Flexibility While Minimizing Expenses on Less Equipment
- Nano Peer-to-Peer Table Topics

SALES & MARKETING

- Social Media Strategies to Build Your Nano
- Tasting Room Special Events Roundtable
- Make Your Brewery's Website Work Harder
- Maximizing Customer Clubs to Boost Sales & Loyalty Roundtable
- Building on Your Brewery Branding
- Strategic Email Marketing to Pack Your Tasting Room
- Build a Tasting Room Community Roundtable
- Nano Peer-to-Peer Table Topics

PRE-CONFERENCE

- Starting Up a Commercial Brewery (2-day class)
- Burlington-Area Craft Brewery Tours
- Stowe/Waterbury-Area Craft Brewery Tours

POST-CONFERENCE

- Burlington-Area Craft Brewery Tours

BYO.COM/NANOCON **REGISTER BY SEPTEMBER 14 TO SAVE $100**

SEMINARS & EVENTS

BYO NANO CON

FRIDAY, NOVEMBER 2, 2018 | 9:30 – 10:30AM

CREATING (AND FINANCING!) YOUR NANO BUSINESS PLAN
START-UPS

There are plenty of templates out there for creating a business plan. But the brewing business has its own specific needs and specialized considerations to keep in mind when you want to convert your dreams into a potential brewery launch. Plus even after writing a business plan figuring out how to finance that vision is a huge hurdle for most start-ups. Luckily we have Audra Gaiziunas who helps craft breweries in planning write better business plans that will in turn help raise money to get your new brewery off the drawing board and into business.

AUDRA GAIZIUNAS - OWNER, BREWED FOR HER LEDGER, LLC

EVALUATING RAW MATERIALS
BREWERY OPERATIONS

Your next batch of beer is only as good as the ingredients you are using, but many commercial brewers don't take the time to properly evaluate the malts, hops, and other materials they'll be using. Veteran craft brewer Ashton Lewis also works within the supply chain of ingredients as a rep for BSG Craft Brewing so he knows both sides of the business. He'll walk you through what you should be doing before you add that next item to your next batch so you can make sure your beer will be as good as it can be.

ASHTON LEWIS
BREWMASTER & CO-OWNER, SPRINGFIELD BREWING COMPANY
SALES REPRESENTATIVE, BSG CRAFT BREWING
TECHNICAL EDITOR, BREW YOUR OWN

SOCIAL MEDIA STRATEGIES TO BUILD YOUR NANO
SALES & MARKETING

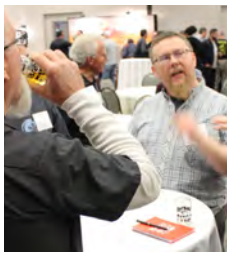
Anyone can use social media, but how to use it correctly as a brewery business is another story. From Facebook to Instagram to Twitter there are plenty of opportunities to build your Nano business and create a loyal community of potential customers. Find out the key strategies for a successful Nano social media program from Tabitha Tice who spends her workdays managing social media for several different breweries.

TABITHA TICE
COMMUNICATIONS AND MARKETING SPECIALIST, ALCHEMY & SCIENCE BREWING

ONE PERSON, MANY HATS: KEYS TO BEING BOTH THE BUSINESS OWNER & HEAD BREWER
BUSINESS OPERATIONS

Juggling all the various duties of being a small business owner is always challenging, but when one of those responsibilities is also brewing beer in addition to running a business your workday gets pretty complex. Doing everything as well as it needs to get done takes some careful planning and organization so key items don't fall through the cracks in the brewery or at your desk. Steve Parkes who wears both the Brewmaster and Business Owner hat at his Drop In Brewing as well as running the American Brewers Guild will help you make better decisions on how best to divide your time and duties so things run smoothly.

STEVE PARKES
BREWMASTER & OWNER, DROP IN BREWING COMPANY
OWNER & LEAD INSTRUCTOR, AMERICAN BREWERS GUILD



10:30 – 11:00AM

COFFEE BREAK & EXHIBITS

NANO EXHIBITS

Grab a coffee and check out the latest in Nano-sized equipment, gear, ingredients, and supplies from dozens of craft brewing's top vendors.

11:00AM – 12:00PM

QUALITY CONTROL FOR THE NANO

BREWERY OPERATIONS

Establishing and following through with a quality control program is key to the success of your brewery – no matter what the size of your output. Even the smallest of breweries need to run certain key tests on their beer and can without taking up too much space, resources or cost. QC expert Amy Todd will walk you through what you should be doing as a small-scale commercial brewery to make sure the beer you are selling to customers is truly good to go.

AMY TODD
OWNER AND ANALYST, ZYMOLOGY LABS

BUILDING ON YOUR BREWERY BRANDING

SALES & MARKETING

You make great beer, but many Nanos forget that they also need to keep building a brand around their beer. Have you emphasized the right back story to tell and is that story and personality reinforced through design and all marketing materials? Plus does your marketing voice work with or against other efforts? Craft beverage branding expert Glenn Clark will help you take a look at doing a branding audit to make sure you are focused on the most effective stories, but are also united in reinforcing that story with customers.

GLENN CLARK
PRESIDENT, CRAFTING A BRAND, CO.

TOP 10 LEGAL MISTAKES MADE BY CRAFT BREWERIES

BUSINESS OPERATIONS

Are you unknowingly making legal mistakes that will negatively hurt your brewery? From intellectual property to trademarks to navigating permits to employment law, there are plenty of legal mistakes a Nano can make in the course of just doing business. Lawyer Matthew McLaughlin who specializes in representing craft breweries and distilleries will walk you through the 10 most common legal pitfalls other commercial breweries have faced so hopefully you don't have to as well!

MATTHEW MCLAUGHLIN
FOUNDER, MCLAUGHLIN, PC

INFRASTRUCTURE SIZING FOR YOUR NANO

START-UPS

When you are looking for locations and space for your new Nano there are quite a few things to consider other than just the cost. From utilities like electric, gas, and water to other key items such weight loads, ventilation, floor drain possibilities, ease of inbound/outbound deliveries, and wastewater there are plenty of items to add to your location checklist. Brewing equipment guru and engineer John Blichmann will help you sort out what to keep on your radar as you hunt for a home for your new Nano.

JOHN BLICHMANN
PRESIDENT, BLICHMANN ENGINEERING

LUNCH & NANO IDEA-O-RAMA ROUNDTABLE

GROUP SESSION
NANO EXHIBITS

Get ready to listen in as fellow Nanobrewers each share their top favorite five ideas in a rapid fire discussion after you wrap up lunch. Nano exhibits will also be open for you to explore during the lunch session.

12:15 – 1:45PM

SPECIAL EVENTS TO PACK YOUR TASTING ROOM ROUNDTABLE

SALES & MARKETING

Find out from your fellow Nanobreweries what's working in terms of hosting special events at your tasting room and what hasn't. From themed parties to special releases to different competitions, Nanobreweries have gotten very creative coming up with new ways to bring old and new customers in their doors. We'll have a panel as well as opening up discussions for the entire room so everyone can learn new ideas from each other.

2:00 – 3:00PM

HOW MUCH WAS THAT LAST BATCH?: BREWERY COST ACCOUNTING

BUSINESS OPERATIONS

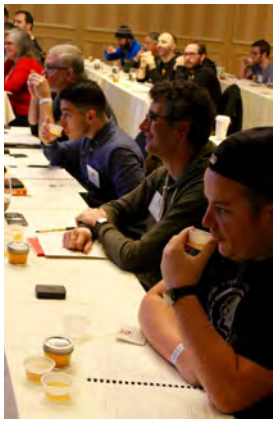
82% of existing breweries have no idea how much one run of their beer even costs. Learn the keys to make sure you don't fall into that trap as well as keeping an eye on other important cost aspects of your Nano business with Audra Gaiziunas who has helped over 120 craft breweries and cideries in the last five years make sense of the cost-side of your business so you can make better decisions overall.

AUDRA GAIZIUNAS
OWNER, BREWED FOR HER LEDGER, LLC

TRANSITIONING TO WORKING DIRECTLY WITH INGREDIENT & SUPPLIER VENDORS ROUNDTABLE

START-UPS

One area of change for homebrewers launching a commercial brewery is working for the first time directly with the companies that sell their brewing ingredients and supplies instead of just purchasing the same items from a local or online retailer. And there is definitely more of a learning curve involved than you would think. You'll learn from a panel made up of different vendors you might end up doing business with after launching your brewery about the best ways to start off what will be an important business relationship for the success of your new Nano.



CLEANING SECRETS & SMALL-SCALE CIP SYSTEMS

BREWERY OPERATIONS

We all know how important a clean brewery is for quality beer. But knowing the ins and outs of small-scale CIP (clean-in-place) systems as well as secret trouble spots to keep an eye on when cleaning any commercial brewery is not always clearly understood or given enough attention or consideration. Plus there are a host of different cleaning products out there to consider. Get the inside dirt from a fellow craft brewer on how to best clean your way to better beer with Vilija Bizinkauskas, Lead Brewer at Drop In Brewing in Middlebury, Vermont.

VILIJA BIZINKAUSKAS
LEAD BREWER, DROP IN BREWING COMPANY

3:00 – 3:45PM

VERMONT NANO BEER BREAK & EXHIBITS

NANO EXHIBITS

Sample some local Vermont Nano craft beer as you check out the latest in Nano-sized equipment, gear, ingredients, and supplies from dozens of craft brewing's top vendors.

4:00 – 5:00PM

ACCURATELY FORECASTING INGREDIENT PURCHASES

BUSINESS OPERATIONS

One of the keys of running a successful brewing business is accurately managing the ordering of ingredients for future batches of beer. Not having enough of a certain ingredient will keep you from brewing what you want when you want. But having too much of another ingredient will just tie up your financial resources that could be used elsewhere. Veteran craft brewer Ashton Lewis also works within the supply chain of ingredients as a rep for BSG Craft Brewing so he has both handled the forecasting of ingredient purchases personally for his own brewery as well as helped other breweries strategically manage how they accurately predict ingredient purchases. He'll help walk you through what you need to know to be as accurate as you can be with your own ingredient purchase forecasting.

ASHTON LEWIS
BREWMASTER & CO-OWNER, SPRINGFIELD BREWING COMPANY
SALES REPRESENTATIVE, BSG CRAFT BREWING
TECHNICAL EDITOR, BREW YOUR OWN

BREWERY BRANDING 101

START-UPS

Get ready to be immersed in the world of branding your brewery. Creating a brand behind your beer, defining your brand's personality, reinforcing the brand through design, and finding your brewery's public voice are all key elements that will attract and keep future customers in addition to the great beer you'll be brewing. Glenn Clark works with breweries on branding every day and he'll share the keys you need to consider before even opening your doors.

GLENN CLARK
PRESIDENT, CRAFTING A BRAND, CO.

MOBILE PACKAGING DO'S & DON'TS ROUNDTABLE

BREWERY OPERATIONS

With space and cash flow at a premium for many in the Nano niche of craft beer, the option of mobile canning and bottling lines opens up new sales channel possibilities without the required investment and upkeep with on-site equipment. Learn more about how to make the most of using a mobile packaging option from a panel made up of both Nanobrewers as well as mobile packaging companies so you can better take advantage of the flexibility these can provide you as a brewer and as a business.

STRATEGIC EMAIL MARKETING FOR YOUR BREWERY

SALES & MARKETING

Strategic email use can be a cost-effective way to boost beer sales, brand awareness, customer loyalty, and business in the taproom. But the key word is strategic – how much do you send, when do you send, and how do you even best build an email list? In this session you'll learn how to best use email effectively to build your brewery's business from Alex Standiford who helps craft breweries with their digital strategies.

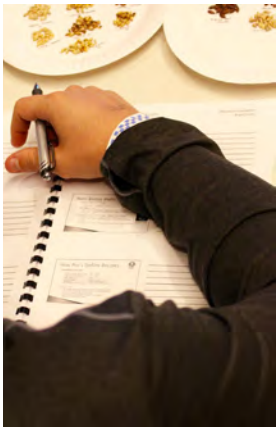
ALEX STANDIFORD
DIRECTOR, FILLYOURTAPROOM.COM

VERMONT CRAFT BEER OPENING RECEPTION

NANO EXHIBITS

5:00 – 6:30PM

We've invited some of our favorite Vermont craft breweries to join us to pour samples of their beer for you as a fun way to wrap up your first full day of NanoCon. You'll have the chance to talk with attendees, Vermont brewers, and visit with our exhibitors before you head out on the town to check out Burlington's breweries and craft beer taprooms for the evening.



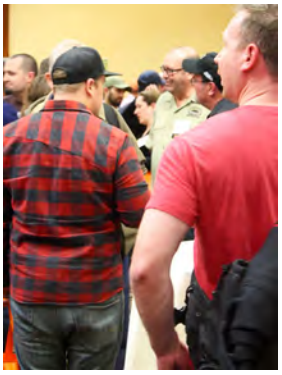
SATURDAY, NOVEMBER 3, 2018 | 9:30 – 10:30AM

START-UP BREWERY LAW 101

START-UPS

One of the biggest blind spots and areas of concern for new breweries starting up is getting a grasp on all the legal paperwork required for both a small business and especially a small business producing and selling alcohol. Federal, state, and local permits and licenses need to be completed as well as a host of other legal considerations as you get ready to open your doors. We're lucky to have Matthew McLaughlin, an attorney with years of experience helping start-up craft breweries, lead this seminar so you can have a better overview on the legal side of your business well before you ever pour your first pint.

MATTHEW MCLAUGHLIN
FOUNDER, MCLAUGHLIN, PC



RECIPE SCALING

BREWERY OPERATIONS

As you work on different sized brewing systems there are many factors to consider when you want to scale up a favorite beer recipe. As most brewers know it isn't a matter of just proportionately increasing ingredient amounts when you boost your batch size, but what is truly the most accurate way to adapt your old recipes to a larger system? Steve Parkes of the American Brewers Guild and Drop In Brewing Company will give you all the details you need to scale up that recipe so you recognize that beer in the glass as the same recipe you used to make on a smaller system.

STEVE PARKES
BREWMASTER & OWNER, DROP IN BREWING COMPANY
OWNER & LEAD INSTRUCTOR, AMERICAN BREWERS GUILD

MAXIMIZING CUSTOMER CLUBS TO BOOST SALES & LOYALTY ROUNDTABLE

SALES & MARKETING

Hear great ideas from fellow Nanobreweries using different variations of customer clubs to help drive sales and build a loyal core of customers. From exclusive limited release beer clubs to traditional mug clubs to monthly beer CSA-type clubs, breweries are creating specific customer communities within their communities to boost sales and goodwill. We'll have a panel as well as opening up discussions for the entire room so everyone can learn new ideas from each other.

OPERATIONAL AUDITS TO ACHIEVE SAVINGS

BUSINESS OPERATIONS

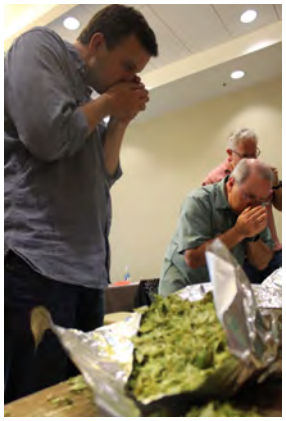
Unless you take a step back and truly make an objective audit of your brewery business you won't know if there is room to operate more efficiently, effectively, and consistently. Learn what the key metrics are to keep in mind and how to best tackle this internal audit with Audra Gaiziunas who regularly works with craft breweries on operational audits and how to improve their processes, accounting procedures, and other key aspects often overlooked in small-scale breweries.

AUDRA GAIZIUNAS
OWNER, BREWED FOR HER LEDGER, LLC

10:30 – 11:00AM

NANO EXHIBITS & COFFEE BREAK
NANO EXHIBITS

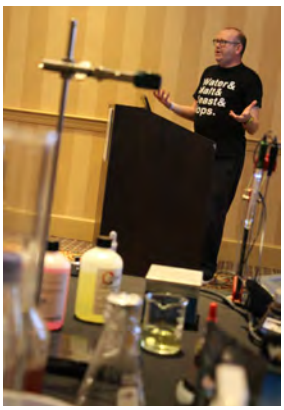
Refuel with a cup of coffee and check out the latest in Nano-sized equipment, gear, ingredients, and supplies from dozens of craft brewing's top vendors.



11:00AM – 12:00PM

NANO TABLE TALKS
GROUP SESSION

Peer-to-peer learning from your fellow Nano industry people at its best. We'll have dozens of tables each assigned a different topic of interest to Nanobreweries spanning brewing, sales, business, and start-ups. For 30 minutes you will trade advice and tips with the other people at your table on that specific topic. Then you'll switch tables to another subject of interest to you. So you'll have the chance to gain knowledge on two different specific subjects you want to explore (and maybe make some new friends and contacts along the way!)



12:15 – 1:45PM

LUNCH & NANO TRENDS ROUNDTABLE
GROUP SESSION
NANO EXHIBITS

Listen and learn after you enjoy lunch as a range of craft beer industry veterans discuss trends specific to the Nano segment from both the business as well as beer side. Nano exhibitors will also be available over lunch to visit.

2:00 – 3:00PM

NANO-SIZED YEAST MANAGEMENT
BREWERY OPERATIONS

Yeast is obviously the workhorse of any brewery, but what are some of the ways a small-scale commercial brewery can get the most of their yeast? Learn about the keys to managing your yeast in a small-scale brewery from re-pitching, taking yeast counts, and keeping the yeast healthy for a good fermentation with Dr. Chris White of White Labs, one of the top suppliers of yeast for the craft beer industry.

DR. CHRIS WHITE
PRESIDENT, WHITE LABS, INC.

MAKE YOUR BREWERY'S WEBSITE WORK HARDER
SALES & MARKETING

You've got a website for your brewery, but is it getting the job done to boost interest in your beer and events resulting in more income for your business? From selling swag, event tickets, tours, and customer club memberships to up-to-date tap lists, beer release calendars, and avoiding age verification search headaches, you'll learn some easy and actionable ways to make your brewery website help drive interest in your brand and drive customers to your brewery while generating online income. Join Alex Standiford who specializes in website strategies for craft breweries and helps them get the most of their digital efforts.

ALEX STANDIFORD
DIRECTOR, FILLYOURTAPROOM.COM

CAN I GET "X" HOP? ROUNDTABLE: CONTRACTS, SPOT BUYS & LOCKING DOWN WHAT YOU NEED ROUNDTABLE

BUSINESS OPERATIONS

2:00 – 3:00PM

Today's hop market is constantly changing so we're pulling together a panel of hop industry experts to talk more about how you as a small-scale brewery business can best navigate getting the hop varieties you want in the quantities you need. Are spot buys the way to go? What's the current take on contracts? And where is the hop market heading? It's a moving target lately and our experts are here to share their advice as you look to fulfill your brewery business' hop supply needs.

PRO OPTIONS FOR HEAT: CHOOSING BETWEEN STEAM, ELECTRIC, GAS & MORE

START-UPS

There are quite a few choices when you take a look at how you will supply heating for your start-up Nanobrewery. There are pros and cons to consider whether to go with steam, electric or gas. And do you keep using direct fire from your homebrew days? Utility costs will also become a factor to consider in addition to equipment choices for your set-up. You'll understand the pluses and minuses of each after this session with John Blichmann of Blichmann Engineering.

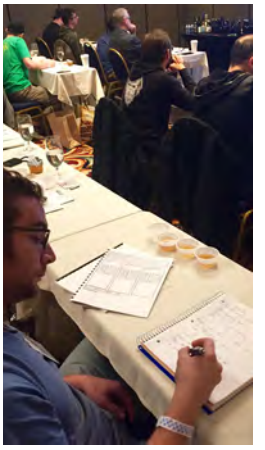
JOHN BLICHMANN
PRESIDENT, BLICHMANN ENGINEERING

VERMONT NANO BEER BREAK & EXHIBITS

NANO EXHIBITS

3:00 – 3:45PM

We've invited a new group of local Vermont Nanobreweries to pour samples and visit with as you check out the latest in Nano-sized equipment, gear, ingredients, and supplies from dozens of craft brewing's top vendors.



BUILDING A TASTING ROOM COMMUNITY ROUNDTABLE

SALES & MARKETING

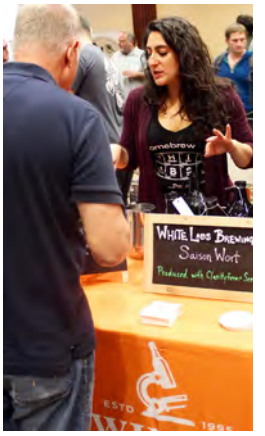
4:00 – 5:00PM

The most loyal of your customers see themselves as part of your community. But how do you go about fostering that sense of community in your taproom? We'll hear from a panel representing several Nanobreweries who have helped create this key dynamic at their taprooms and we'll also open up the floor for free-flowing discussions so everyone can learn from each other about strategies to build customer community that will end up driving more sales for you.

BREWERY SAFETY IN TIGHT QUARTERS

BREWERY OPERATIONS

Commercial brewing, no matter the scale, is filled with potential hazards if you don't have a solid safety plan in place. These possible problems can increase when the size of your brewery doesn't allow much extra space around your equipment. But above all else you need to have your safety procedures identified, documented, and in place to protect yourself and anyone else in the brewery. "Safety Matt" Calcagnie is the Safety Manager overseeing two longtime Vermont craft breweries – Long Trail and Otter Creek. He'll help give an overview of what you need to establish for brewery safety – no matter the size of your system – and why it so important.



MATT CALCAGNIE
SAFETY MANAGER, OTTER CREEK BREWING COMPANY & LONG TRAIL BREWING COMPANY

4:00 – 5:00PM

PLANNING & STARTING UP A QUALITY CONTROL PROGRAM

START-UPS

If you are going to charge the public money for your beer and want repeat customers you have to put a solid quality control program in place for your new brewery. That means budgeting some space and resources to run some basic QC tests on your beers before they head out to customers. Having a QC program is more than simply troubleshooting beer faults, it is a business necessity no matter the scale of your new brewery. Learn what you need to budget for and have in place from day one at your brewery with Amy Todd who runs her own commercial beer and cider testing lab after a career in craft beer QC.

AMY TODD
OWNER AND ANALYST, ZYMOLOGY LABS

MAXIMIZE BREWERY FLEXIBILITY & SAVE MONEY WITH LESS EQUIPMENT

BUSINESS OPERATIONS

You can cut costs using less equipment and gain flexibility with your brewing? Craft brewing veteran Ashton Lewis says yes and he'll walk you through ideas targeted just for the smaller-scale Nano market by marrying equipment with raw materials in efficient ways including milling, augmenting wort strength, hop extracts, and multi-tank fermentation and aging strategies.

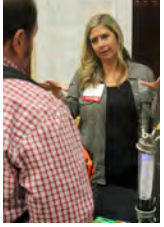
ASHTON LEWIS
BREWMASTER & CO-OWNER, SPRINGFIELD BREWING COMPANY
SALES REPRESENTATIVE, BSG CRAFT BREWING
TECHNICAL EDITOR, BREW YOUR OWN

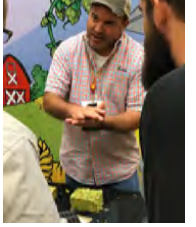
5:00 – 6:30PM

VERMONT CRAFT BEER CLOSING RECEPTION

NANO EXHIBITS

We've invited some more of our favorite Vermont craft breweries to join us to pour samples of their beer for you as a fun way to wrap up NanoCon. You'll have this final chance to talk with attendees, Vermont brewers, and visit with our exhibitors before you head out on the town to check out Burlington's breweries and craft beer taprooms for Saturday night.






As an attendee, you'll have the opportunity to check out the latest Nano-sized brewing equipment, products, supplies & services from leading craft brewery vendors Friday & Saturday in the Lake Champlain Exhibit Hall.

Thanks to our BYO NANO CON Sponsors!

ABS COMMERCIAL

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List current as of July 20, 2018

GREAT CONFERENCE HOTEL IN CRAFT BEER-LOVING VERMONT!

Burlington Doubletree Conference Center • Burlington, Vermont

The 2018 NanoCon is being held at the Burlington Doubletree Conference Center. Burlington is a fun college town with a vibrant craft beer scene with dozens of local breweries and tap rooms to discover. You not only have the chance to learn strategies to be more successful at your own brewery all day at the conference, but you can also explore Vermont's craft beer scene at night and see for yourself what all the hype is about.

Telephone Reservations: 800-325-3535

Mention group name "NanoCon" to receive a special discounted rate.

Web Reservations:

byo.com/nanocon

Group Discounted Room Rate:

$155 per night for a room with either one king/queen bed or two double beds.

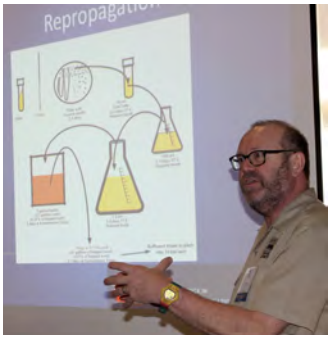
Hotel Information: We have reserved a limited number of rooms at a special discounted rate for attendees. Contact the hotel directly for your room reservations. When making your reservations make sure to say you are attending the "NanoCon" to receive the special discounted group rate for your room. Rooms are available on a first-come, first-served basis. The special discounted rate will be available until the conference group block of rooms is sold out or until October 12, 2018, whichever occurs first. Reserve your room right after registering for the conference.

**Please make sure you have already successfully registered for the conference before making your hotel room reservations or any other travel plans.*

COME EARLY OR STAY LATE: PRE- AND POST-NANOCON ACTIVITIES

BYO NANO CON

WEDNESDAY, OCTOBER 31 & THURSDAY, NOVEMBER 1



STARTING UP YOUR OWN COMMERCIAL BREWERY BOOT CAMP

10 a.m. – 4:30 p.m. both days

With Steve Parkes ($450 for NanoCon attendees, $525 for non-attendees)

Over Wednesday & Thursday you'll walk through the steps, planning decisions, and keys you need to know on both the brewing and management side to successfully open a commercial craft brewery with the Lead Instructor and Owner of the American Brewers Guild Steve Parkes, who has trained hundreds of professional brewers. Learn from Steve's decades of expertise and wide range of experience to help you better achieve your goals. Over two full days you'll be guided through all the various elements you'll have to know for the next big step toward starting a craft brewery. The perfect lead-in to the main NanoCon event if you already have a brewery in planning or are just starting to consider the possibility of opening one up yourself.

THURSDAY, NOVEMBER 1 AND SUNDAY, NOVEMBER 4

STOWE/WATERBURY, VERMONT AREA CRAFT BREWERY TOURS ($150)

Thursday, November 1

11 am to 4:00 pm

This five-hour tour includes round-trip transportation between our NanoCon hotel, the Burlington Doubletree, and Stowe while tasting and visiting four different breweries. You'll have the chance to visit The Alchemist while in Stowe sampling the famed Heady Topper and other of their tough-to-find selections. A meal and more beer is included during your trip up to this Vermont ski town that's now become a craft beer destination.

BURLINGTON, VERMONT AREA CRAFT BREWERY TOURS ($125)

Thursday, November 1

11 am to 3 pm

5 pm to 9 pm

Sunday, November 4

11 am to 3 pm

This four-hour tour includes round-trip transportation from our NanoCon hotel, the Burlington Doubletree, while tasting and visiting four different breweries in the Burlington area. A meal and more beer is included as you explore a variety of different craft breweries here in the big city in the little Green Mountain State.

SCHEDULE AT-A-GLANCE

BYO NANO CON

Pre-Conference NanoCon Event • Wednesday, October 31, 2018

10AM - 5:00PM	Starting Up a Commercial Craft Brewery (Day 1)

Pre-Conference NanoCon Events • Thursday, November 1, 2018

10AM - 5:00PM	Starting Up a Commercial Craft Brewery (Day 2)
11AM - 3:00PM	Burlington, Vermont-Area Craft Brewery Tours
11AM - 4:00PM	Stowe/Waterbury, Vermont-Area Craft Brewery Tours
5 - 9:00PM	Burlington, Vermont-Area Craft Brewery Tours

Day #1 Friday • November 2, 2018

8:00 - 9AM	REGISTRATION			
9 - 9:15AM	WELCOME & INTRODUCTION			
9:30 - 10:30AM	Creating (and Financing!) Your Nano Business Plan	Evaluating Raw Materials	Social Media Strategies to Build Your Own Nano	1 Person, Many Hats: Keys to Being Both the Business Owner & Head Brewer
10:30AM - 11:00AM	COFFEE BREAK & NANO EXHIBITS			
11:00AM - 12:00PM	Quality Control For The Nano	Building on Your Brewery Branding	Top 10 Legal Mistakes Made by Craft Breweries	Infrastructure Sizing For Your Nano Building
12:15 - 1:45PM	LUNCH & NANO IDEA-O-RAMA ROUNDTABLE			
2 - 3:00PM	Special Events to Pack Your Tasting Room	How Much Was That Last Last Batch? Brewery Cost Accounting	Working Directly With Ingredient & Supplier Vendors	Cleaning Secrets & Small-Scale CIP Systems
3 - 3:45PM	VERMONT NANO BEER BREAK & NANO EXHIBITS			
4:00 - 5:00PM	Accurately Forecasting Ingredient Purchases	Brewery Branding 101	Mobile Packaging Do's & Don'ts Roundtable	Strategic Email Marketing For Your Brewery
5:00-6:30PM	VERMONT CRAFT BEER OPENING RECEPTION			

Day #2 Saturday • November 3, 2018

8:30 - 9:30AM	REGISTRATION			
9:30 - 10:30AM	Brewery Law 101	Recipe Scaling	Maximizing Customer Clubs to Boost Sales & Loyalty	Operational Audits to Achieve Savings
10:30AM - 11:00AM	COFFEE BREAK & NANO EXHIBITS			
11:00 - 12:00PM	NANO TABLE TALKS			
12:15 - 1:45PM	LUNCH & NANO TRENDS ROUNDTABLE			
2 - 3:00PM	Nano-Sized Yeast Management	Make Your Brewery's Website Work Harder	Can I Get "X" Hop? Roundtable	Choosing The Right Heating Option
3 - 3:45PM	VERMONT NANO BEER BREAK & NANO EXHIBITS			
4-5:00PM	Build a Tasting Room Community Roundtable	Brewery Safety in Tight Quarters	Planning & Starting Up a Quality Control Program	Maximize Brewery Flexibility & Save Money with Less Equipment
5-6:30PM	VERMONT CRAFT BEER CLOSING RECEPTION			

Post-Conference NanoCon Event • Sunday, November 4, 2018

11AM - 3:00PM	Burlington, Vermont-Area Craft Brewery Tours

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☐ Thursday, November 1, 5:00PM-9:00PM Burlington-area Breweries $125
☐ Sunday, November 4, 11:00AM-3:00PM Burlington-area Breweries $125

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BY AARON HYDE

WORT AERATION

Providing an environment to flourish

Without proper wort aeration lag time can increase, making your beer more susceptible to other organisms growing in your beer. You can kick fermentation off quicker with some oxygen. No need to be nervous about oxidative off-flavors — post-boil beer has little oxygen present, making pre-ferment the perfect time to aerate or oxygenate your wort.

Let's discuss the difference between aeration and oxygenation, as both will get you to the same goal of adding oxygen, albeit using slightly differently methods. Aeration requires only a system for adding air to your beer, which contains about 21% oxygen (as well as 78% nitrogen, 1% argon, and a trace amount of carbon dioxide.) You may have deduced that oxygenation of your wort would be adding 100% pure oxygen to your beer. This would require a tank of pure oxygen, or an oxygen machine. When discussing the process of adding oxygen, many simply refer to it as aeration.

Yeast are amazing little fungi that can live aerobically, respiring oxygen, or anaerobically, fermenting sugar. Brewers yeast, *Saccharomyces cerevisiae*, prefers to eat sugar than use oxygen when enough sugar is presented to them. Although yeast can survive without oxygen completely, the overall health of the yeast can be affected, as can budding (the yeast's reproduction method) and growth.

What oxygen really provides is a better way for yeast to produce fatty acids and sterols; both also known as lipids — important components of the cell membrane which influence budding ability and growth. While oxygen is present, yeast can be respiro-fermentative, consuming both oxygen as needed for producing lipids, and sugar, for energy. Another way yeast obtain the lipids needed is to actually have them available to the yeast in the form of dead yeast (trub). The cold break, which settles in the bottom of your fermenter, contains a mix of lipids.

HOW MUCH OXYGEN DO MY YEAST NEED?

Unfortunately, your post-boil wort is oxygen deprived, and has almost no oxygen. Hot wort will not do a good job of holding oxygen, it leaves with the steam when the boil gets volatile. Once you've cooled your wort, you are ready to aerate.

The goal when adding oxygen is to get your wort to around 8 parts per million (ppm) dissolved oxygen. This is ample oxygen for the yeast, and is often consumed quite quickly during the first stages of fermentation. Many commercial brewers are comfortable getting their beer in a range of 5–10 ppm. If you own a dissolved oxygen meter you'll be able to check this with some accuracy. If you are like most homebrewers (and even many small breweries), you will not own an oxygen meter of your own. The saturation point of oxygen through aeration in wort is around 8 ppm — which just so happens to be your target!

It's hard to add too much oxygen when aerating. If using pure oxygen though, you can over-oxygenate. If you're under-pitching your yeast, you may have a situation you'd want a bit more oxygen than 8 ppm in your beer. In this scenario you'd want to use oxygenation instead of aeration.

What oxygen really provides is a better way for yeast to produce fatty acids and sterols; both also known as lipids . . .

Photo by Charles A. Parker/Images Plus

Oxygenation involves injecting pure oxygen into wort, best done with the aid of a regulator, filter, and diffusion stone.

HOW CAN I AERATE MY WORT?

Agitation: Shake, Splash, and Stir Methods

I've grouped a few techniques together, as these are all the most manual solutions to aeration, and all work quite well. Although these agitations can vary in approach and volatility — splashing, shaking, and stirring have been shown to be highly effective method for adding oxygen.

Splashing may be the easiest method to implement — maybe you're doing it already accidentally. Moving your cooled wort via a siphon hose from your kettle to your fermentation vessel, leave the hose end near the top of the vessel. This will allow the wort to splash into the vessel. Some companies do make a device you can attach to the end of your tubing that will spray your wort often called a "siphon spray wort aerator." This adds additional oxygen, though a single splashing transfer of wort through an aerator (or not) probably requires additional oxygen. You could continue to transfer between two cleaned and sanitized vessels a few additional times to increase your oxygen to an acceptable level. Or, once transferred, you could stir or shake your wort to help further aerate the wort.

Stirring your wort is a logical approach to aeration. By using a stirring rod or perforated paddle you agitate the wort using either a powered drill, or your own brute strength. Most stirring rods (sometimes called aeration rods or aeration paddles) that you connect to a drill will be perforated or have hollow paddles. This allows for excellent agitation, creating a whirlpool. Paint stirrers can work as well from your local hardware store. Depending on the rod you may see a good amount of foam. Be careful if using a stir rod in a glass carboy. If you've splashed your beer into your carboy 1-2 minutes should suffice. I'd recommend trying 2-3 minutes if this is your only agitation.

If you're in an open pail, or open-top fermenter, using a brewing paddle or a whisk will work as well. You'd probably want to whisk and stir pretty aggressively for around 15-20 minutes to get somewhere near 5-8 ppms. Maybe have a few additional arms around to help when you wear out.

Shaking is another agitation method that's proven successful. If you're able to safely splash the wort around in your carboy for a minimum of 15 minutes, you'll have dissolved an ample amount of oxygen in to your wort. Simply sitting and rocking your fermenter back and forth will do — the more splashing you create the better. Always be careful when doing this with glass, it's easy to slip and lose a batch of beer, your carboy, and potentially cause bodily harm.

Injection: Aeration & Oxygenation

The most effective method of adding oxygen is to use pure, 100% oxygen. Most folks don't have the means or machines to create pure oxygen, so we typically buy it in a tank from a gas supplier. A typical homebrewer's oxygenation injection system will include:

- an oxygen tank
- an oxygen tank regulator
- two sections of tubing
- in-line air filter
- diffusion stone

Combined, these items give you everything you need to properly oxygenate your wort in 60 seconds. Pure oxygen (flammable, so be careful) passes out of the tank though the regulator into the tubing and an in-line sanitary filter (to your second section of tubing) and to the diffusion stone in your wort. Without a diffusion stone the oxygen will be released in large bubbles and will not dissolve as easily in to your liquid. There are different grades of oxygen, and all grades will work, just be sure to put an in-line filter in your tubing. If you do happen to get medical-grade oxygen, you wouldn't necessarily need the filter, but it doesn't hurt to leave it in.

> **"The saturation point of oxygen through aeration in wort is around 8 ppm — which just so happens to be your target!"**

Aeration injection looks similar, but doesn't require the oxygen tank or regulator. Instead a simple aeration injection set up would be:

- aquarium pump
- two 3-foot (91-cm) sections of ¼" tubing
- in-line air filter
- diffusion stone

A small pump is needed to pressure the outside air through the filter, and down through your diffusion stone in the wort. If using aeration, 15-25 minutes is recommended.

Any micron-sized stone will do, most commonly they are 0.5-micron, or 2-micron stones. A 0.5-micron stone creates very fine bubbles, but can often become clogged if not kept completely clean. Look for a pump with a ¼" barb, as most in-line air filters and diffusion stones come in this size.

CAN I GET AWAY WITHOUT AERATION OR OXYGENATION?

Although the answer is yes, that answer is completely situa-

tional. As mentioned earlier, dead yeast cells and trub have a good concentration of lipids. If you're repitching onto some yeast trub, you'll likely have your lipids covered. If you're using appropriate quantities of fresh yeast that was aerated during propagation (you made a starter on a stir plate or aerated during the process), then providing more oxygen is strictly supplemental, and a lesser amount can be added.

Another consideration is that aeration provides you with extensive yeast growth and activity. The more yeast, the more yeast by-products are produced. This can lead to higher esters and fusel alcohol in your beer. This is often dependent on the yeast strain. Over-pitching your yeast can also have the same effect. In exceptionally clean styles of beer, less aeration may be preferred. This is especially true in say an imperial stout or Scotch ale, big beers that will produce a lot of yeast over time. Letting them ferment at a slower pace may provide a cleaner finished beer than aerating.

AERATING IS BENEFICIAL

Aeration can be vital to yeast health and growth. If you can provide oxygen early on, your yeast will be more robust and have an easier time propagating. You'll also see a reduction in lag time giving your yeast a better opportunity than bacteria to colonize your wort. It also increases your odds of a quick and complete fermentation. Aeration is an easy and effective brewing technique to add to your brew day. BYO

Photo by Les Jorgenson

Aerating the wort with an aquarium pump, filter, and diffusion stone is a cost-effective alternative to pure oxygen since it provides a level of oxygen ideal for most all situations.

BY MICHAEL TONSMEIRE

SOUR SANS BACTERIA

Brewing with lactic acid-producing yeast

A microbial gold rush is underway. Prospectors from universities and yeast labs are swabbing trees, flowers, and insects looking for strains of yeast and bacteria valuable for brewing. Finding microbes isn't difficult (they are everywhere after all) and identifying the species is becoming more economical with the decreasing cost of PCR (polymerase chain reaction) identification. A more daunting challenge is to determine whether or not a new microbe is valuable to brewers, and under what conditions.

The most exciting finds so far are yeast that readily produce lactic acid; significantly those in the genera: *Wickerhamomyces, Lachanacea, Zygosaccharomyces, Schizosaccharomyces*, and *Hanseniaspora*. The pitch is that these "lactic acid yeast" can quickly sour beer without bacteria. The associated benefits are to eliminate the risk of bacteria infiltrating the cold-side equipment; streamline the process as compared to kettle souring; and encourage a unique yeast profile.

One of the things I got wrong in *American Sour Beers* (Brewers Publications, 2014) was when I wrote that *Lactobacillus* are able to produce a beer of standard alcohol content on their own. Subsequent tests by Lance Shaner of Omega Yeast demonstrated that even heterofermentative *Lactobacillus*, capable of producing ethanol and CO_2, reduce the gravity of the wort by no more than about 0.004 (while creating less than 0.3% ABV)[1]. Yeast is required for substantial attenuation and alcohol production, but high amounts of lactic acid stresses brewer's yeast (see "Acid Tolerance of Brewer's Yeast" - *BYO* December 2016).

There is no way a single strain can replicate the depth and complexity of a spontaneous-fermented gueuze or a mixed-culture Flemish red. That is not our goal. Rather, lactic acid yeast have the potential to compete with kettle sours and other quick-souring methods. These techniques excel in beers that are tart and refreshing, or loaded with fruit that would obscure delicate flavors. Lactic acid yeast are especially intriguing for hoppy sours ("Hoppy Sour Beers" - *BYO* December 2016) because even without isomerization, hops inhibit *Lactobacillus*. Lactic acid yeast can sour a batch even with a large flame-out charge of hops.

My hot-take on lactic acid yeast was that they wouldn't gain a foothold with brewers. I wasn't sure if most would consider them any safer to introduce into their fermenters than *Lactobacillus* (which are easy to kill and inhibited by the hopping rate in most styles). A pure culture also reduces your control over the souring process, whereas with *Lactobacillus* you can step on the brakes with pasteurization or dry hops when you reach the desired pH. I also had not heard much about the flavors created by lactic acid yeast beyond lactic acid, not a good sign. I decided to try them for myself to see what they had to offer.

WHERE TO FIND THEM

Like mineralogical prospectors some labs aren't excited to share the exact location of their claims, while others know that most people would rather buy a ring than pan for gold. The two strains that I used from Wild Pitch Yeast were harvested from trees found on land in southwestern Pennsylvania: YH72 and YH82 were names given to these two particular strains.

A more daunting challenge is to determine whether or not a new microbe is valuable to brewers, and under what conditions.

Photos by Michael Tonsmeire

While you can search for lactic acid yeast with sterilized swabs and petri dishes, it is nice to have a microbiologist do this work for you. Often it takes dozens of samples to find a useable isolate. Not only does the strain need to produce lactic acid, but it also must exhibit similar traits to brewer's yeast: Attenuation (fermentation of maltose and maltotriose), fermentation speed, alcohol tolerance, lack of off-flavor production, flocculation, etc.

With these considerations in mind, I contacted Dr. Matt Bochman of Wild Pitch Yeast (WPY). He selected samples of two favorite strains for me to evaluate: YH72 *Hanseniaspora vineae* and YH82 *Wickerhamomyces anomalus*. Both strains were originally harvested from trees on Dr. Bochman's parents' land in southwestern Pennsylvania: YH72 from the bark of an ash and YH82 from a Shumard oak. WPY is eventually hoping to scale up production or partner with a yeast lab to make his strains more readily available to homebrewers, but for the moment WPY is focused on commercial pitches. Mainiacle Yeast sporadically has their own lactic acid yeast strains available to homebrewers through their website. I expect we'll see more and more yeast labs introducing their own strains over the next year!

LACTIC ACID YEAST SPECIES

I've worked hard to dissuade brewers from the false notion that *Brettanomyces* produces the acidity in sour beers. Up until now it has been the bacteria, *Lactobacillus* and *Pediococcus*, that were responsible for lactic acid production. While both yeast and bacteria are microscopic, they are members of two separate kingdoms of life. Separated from bacteria by at least 1.5 billion years of evolution, fungi actually share a more recent common ancestor with humans than with either bacteria or plants.[2] Considering that humans produce lactic acid (as a byproduct of generating energy from glucose without oxygen), it isn't all that surprising that some yeast do so as well.

Hanseniaspora's anamorph (asexual) form is *Kloeckera*; in the past Vinnie Cilurzo credited *K. apiculata* with providing grapefruit notes to Russian River Beatification. Given that *K. apiculata* can't ferment maltose, it wouldn't be effective for solo-fermentation. Luckily, this isolate of *Hanseniaspora vineae* can ferment wort well enough (reaching 71% apparent attenuation (AA) after three weeks in my tests). There is also some interesting research on *H. vineae*'s role in wine where it produced a "more fruity and flowery wine . . . strong presence of phenyl ethyl acetate."[3] This ester in particular is described as having an aroma like rose, raspberry, and honey.

Wickerhamomyces is intriguing in that it is positive for the enzyme beta-glucosidase as is *Hanseniaspora vineae*.[4] See "The Science of Hop Glycosides" *BYO* July/August 2015 for more about how this enzyme frees interesting aromatics from hops and fruit. Some strains of *Wickerhamomyces anomalus* produce compounds that inhibit susceptible yeast (causing issues for co-fermentation with *Saccharomyces*). Luckily YH82 does not harm brewer's yeast. It was a bit more attenuative in my tests, reaching 81% AA in three weeks. Another isolate of this species is available with several other oxidative yeasts in East Coast Yeast ECY31 Senne Valley Blend.

A paper by Claire Ingrid Svendsen describes her experience fermenting with *Lachancea thermotolerans NCSU*. The name refers to its need for cool temperatures. The species was previously known as *Kluyveromyces thermotolerans*. This strain is more attenuative, taking the sample 1.057 wort to 1.005, while simultaneously reducing the pH to 3.6.[5] It too has been used experimentally in co-fermentation with *Saccharomyces* to increase acidity in wine fermentations.[6]

Another yet unnamed species is simply referred to as "GY7B." When I talked to (discoverer) Dr. Matt Farber, Director of USciences Brewing Science Program, he indicated that they are still investigating commercial partners for releasing the strain. Their general timeline appears similar to others mentioned above, with relatively rapid acid production down to a pH of 3.5 in as little as five days, followed by complete attenuation (~95%) in two to three weeks. One novel note is that "GY7B" is a good glycerol producer, which can help improve mouthfeel. They also note it produces some apple esters,[7] which seems to be common among lactic acid yeasts.

BREWING CONSIDERATIONS

I suggest treating these strains like brewer's yeast unless you have specific guidance to the contrary. Pitch a healthy culture of a similar size to brewer's yeast, aerate, and add yeast nutrient. In general, fermentation temperatures similar to ales or even Belgian strains are typical (68-80 °F/20-27 °C). As you might expect, warmer temperatures increase the rate of fermentation.

The mechanism by which these strains produce lactic acid is still a topic of discussion and research. One hypothesis, put forward by Svendsen, is that fermentation proceeds normally on the path from sugar to ethanol. The break from routine occurs at the final step: Rather than acetaldehyde being converted into ethanol, the enzyme lactate dehydrogenase converts it to lactic acid. As in our muscles, this is a process best suited for an anaerobic environment, so don't expect a large amount of acidity in a starter grown on stir-plate. Bochman suggested that the affinity for simple sugars might suggest a low mash temperature able to boost lactic acid production.

I wanted to try the *Hanseniaspora* and *Wickerhamomyces* provided by Wild Pitch Yeast in a relatively bland base, plus a beer with aroma hops to take advantage of their hop-tolerance. Accordingly, I ran off two gallons (8 L) of wort post-boil through my plate-chiller. I then sent additional cooled wort back into the kettle, lowering the wort to 175 °F (79 °C) for the whirlpool addition of Mosaic® and Amarillo®. I have found that a cooler whirlpool retains no more hop aroma than a similar addition at flame-out, but it does reduce alpha acid isomerization and thus bitterness. While the yeast were billed as not minding iso-alpha acids, intense sour and bitter flavors are incompatible.

While the hoppy portions eventually finished at the same final gravity as their low-hopped counterparts, both

took longer (especially *Hanseniaspora*). I was worried when attenuation was only at 25% after a week at 70 °F (21 °C) despite a quick start. This slow progress may have been a result of a factor other than hops (I didn't precisely measure out the yeast when pitching). In a time-sensitive situation, pitching an aggressive brewer's yeast in tandem or staggered may be beneficial (although potentially tricky given the kill factor some *Wickerhamomyces* can produce). Pitching brewer's yeast could also serve to minimize continued acid production.

After dry hopping, the hoppy-versions were both good, but generally similar to *Lactobacillus* with a mild Belgian strain than anything approaching a classic mixed-fermentation. The lactic acid provided a quenching acidity that balanced the malt and made the citrus-zesty hops sing. I had a slight preference for the *Hanseniaspora*, as it was slightly more acidic (pH 3.38 vs. 3.52) and had a hint of peppery spice.

Without aroma hops, both *Hanseniaspora* and *Wickerhamomyces* displayed cidery apple-like aromatics; in the case of *Hanseniaspora* pushing almost toward apple cider vinegar. I do wonder if this observation was related to residual acetaldehyde, despite a four-week primary fermentation and three weeks of bottle conditioning. These flavors were hidden behind the hops, so not that strong.

Compared to kettle souring, these lactic acid-producing yeast allow for a simplified process. No need to heat the wort to pasteurize after reaching the target pH, although you don't have that level of control to instantly "lock-in" acidity as you do when kettle souring.

A video of my brewing process of these soured beers is available on YouTube: https://www.youtube.com/watch?v=xeTMqPF-cTc

CROSS CONTAMINATION CONCERNS

The risk of unwanted microbes taking up residence in your equipment can be evaluated on a sliding scale. As brewers we usually talk about sanitation (reducing microbes by at least 99.9%) rather than sterilization (99.999%). That may not seem like a significant difference, but it is equivalent to reducing 1 million cells to 1,000 or 10. Even with ideal process, some cells may survive into a subsequent batch. While a potential concern, in most cases the 100 billion new cells you add out-compete any maimed stragglers. Under ideal circumstances, you should reserve post-boil equipment for a single yeast strain, but this isn't practical as brewers like yeast variety. More attenuative yeast strains, especially those capable of fermenting dextrins, offer bigger concern. *Brett* and hyper-attenuative *Saccharomyces cerevisiae* var. *diastaticus* fall into this category.

Conversely most lactic acid yeast are less concerning, so if you can get rid of a hyper-attenuative French saison, you should be fine with them as well. That said, *Wickerhamomyces* and *Hanseniaspora* are found in lambics months into fermentation.[8] That suggests that they can grow from a few cells initially in post-*Saccharomyces*-fermentation conditions, which worries me a little. What makes a dangerous microbe isn't necessarily that it is hard to kill (although some are), but rather that it can reproduce and work in difficult conditions.

For me it was less of a risk to run my test batches through my sour gear and tempting a little extra acid or funk, rather than through my clean gear and risk those beers developing low-level acidity during storage.

LACTIC ACID YEAST

To recap, lactic acid yeast show a great deal of potential. It isn't often that I get the opportunity to brew a sour beer in a novel way. Only a couple craft breweries are playing with these microbes including Hellbender Brewing Co. (Washington, DC), and Saucy Brew Works (Cleveland, OH). I'm excited to keep working with these yeast, trying new isolates, and learning from what other brewers discover. This is a clear time when the price of a yeast is fully justified. Rather than just taking a microbe from a bottle of beer or a cell bank, microbiologists and yeast wranglers are getting out of the lab to investigate interesting microbes that could change the way we brew! BYO

SOURCES

[1] http://www.milkthefunk.com/wiki/100%25_Lactobacillus_Fermentation#Lance_Shaner.27s_Experiment

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[6] https://www.ncbi.nlm.nih.gov/pubmed/23200661

[7] https://beerandbrewing.com/a-surprise-in-the-yeast/

[8] *The Microbial Diversity of Traditional Spontaneously Fermented Lambic Beer.*

General Interest: https://www.craftbrewingbusiness.com/featured/heres-a-yeast-strain-makes-lactic-acid-and-the-yeast-only-beer-made-as-a-result/

BY ASHTON LEWIS

FREEDOMS OF NANOBREWING

Things I would do in my nanobrewery

Nanobreweries tend to be opened by brewers transitioning from homebrewing as a hobby to brewing as a profession. While this is still the trend with most new craft breweries, there are more large companies and investment groups investing in the general business of craft brewing. Somehow I don't envision corporate buyouts and consolidation of businesses in the future of nanobrewing. Right or wrong, this is my view, and along with this view are some thoughts about what I would do if I were to have a nanobrewery. Oh, to retire and open a nanobrewery to serve just a small handful of beer loving friends, that would be cool! The following article is about brewing, so if you are hoping for a great short story about great beer, famous musicians stopping by for unannounced jams, and crazy food truck creations, this is not your story!

So here is the basic premise of my thinking. Most breweries these days are striving for efficiency in every facet of the business, because brewing is business. And the US beer scene has arguably been the world's most vibrant for the better part of 30 years. Along the way, we have seen massive improvements in the technology of brewing, yet, some of these tremendous advances potentially, and quite unintentionally, dampen beer diversity. A nanobrewery should differentiate itself from other breweries because without a point of real difference, a nano may just be a smaller version of another brewery doing the same thing. So here are my views on how ingredients can help lend beer diversity. Oh, and a note about diversity; the modern brewery needs to be bilingual, so I will use the metric system for units in this article without conversions!

IT'S THE WATER!

Water tanks are great for water and energy storage in larger breweries. Go to any brewery brewing more than about 1,000 hectoliters (852 barrels) annually, and you will likely see an ambient or cold water tank to store water prior to wort cooling, and a hot water tank to store hot water generated from the wort cooling process. This system just makes sense, and it's how things are done. One of the convenient things that can be done to a system like this is to treat the water going into the ambient/cold water tank so that the brewing water is consistent. Consistent water used to cool wort, leads to consistent water in the hot water tank, and that leads to the perfect water for brewing! Right? Perhaps it is right if all of the beers brewed benefits from the same water. Need something different, simply add brewing salts and this problem is solved.

But does a small brewery really benefit from storing hot water after wort cooling? Let's assume that a 3 hL nanobrewery produces 360 liters of hot water when wort is cooled; this is a good ratio that produces a nice balance of water that can be totally used in the next brew. If the water is heated from 20 °C to 80 °C (70 °F to 175 °F) during wort cooling, this system captures 90 megajoules of energy, which equates to about $3 (USD) based on the average price of electricity in the US ($0.12/kilowatt-hour). The hot water is now stored in a hot water tank and used in the next brew. What's not to love about this?

The water generated from wort cooling needs to stay hot, so hot water tanks are well-insulated and equipped with heaters to offset heat loss to the environment. That hot water just required investment in equipment and

. . . yet, some of these tremendous advances potentially, and quite unintentionally, dampen beer diversity.

Photo by Pagosa Brewing & Grill

energy to prevent it from cooling. You can complete the financial analysis of this problem or simply take my word that hot water recovery in a nanobrewery is not a great investment if the goal is to save energy. I am not suggesting that water should be wasted; the hot water from wort cooling can be recovered and used for cleaning or other uses, but the energy value is minimal. A much better fit for many nanos with limited space in the brewery is the use of instant hot water heaters. If you go this route, make sure the heaters are properly sized and installed to permit acid de-scaling; this means that you need to have stainless water lines before and after the heater because acid cleaning will corrode copper water pipes.

Now that we have eliminated the hot water tank, the water used to cool our Cookie Monster Pastry Stout wort does not need to be compatible with that Brutally Dry Pilsner that is scheduled as the next brew. My suggestion here is to uncuff yourself from worrying about the next brew when it comes to water. Take advantage of the small size of the brewery and treat water as a specialty ingredient. Eliminating the "traditional" type of hot water will really help in this pursuit. It also reduces equipment cost and saves space.

BASE MALT ≠ BLANK CANVAS

I have heard other brewers describe base malt as a blank canvas for so many years that I sometimes forget how wrong that analogy really is. There are so many exceptional beers brewed from limited grist bills that clearly demonstrate the fallacy with this argument. What is true, however, is that changing base malts can indeed have a very profound effect on beer flavor, yet many larger breweries only use one, sometimes two, because of the cost and logistics required to use multiple base malts. And because malt stored in silos represents a huge cost savings for breweries brewing enough beer to justify the investment in equipment and inventory cost, there is a real motivation to choose a base malt that can be used for most beers. Nanobrewers, by definition, do not use enough malt to make this an option, and should not restrict themselves to only a few base malts.

Experimenting with base malts is fun because there are so many options. If a brewery decided to brew rotating helles lagers with different pilsner malts from around the globe, several years of experiments could be brewed. Add ale malts, more highly kilned lager malts, like Vienna and Munich, and heritage varietals to the mix and a brewer could make a career specializing in this type of brewing. Larger breweries simply cannot resist the temptation to settle on a base malt or two and to seek other malt colors and flavors from specialty malts. Take advantage of being small!

Consumers love stories, and great base malts often have great stories. Tell the story of the barley field, the climate of that field, and ultimately how your beer flavor is influenced by these environmental factors. Also tell the story of the maltster; who converted that great barley into the malt used for your brews? Those are all very real connections that consumers enjoy having with their products, so explain the source of your base malts to get people interested in tasting your special beers.

HOP LIKE A CHEF

The cool chefs with their own TV shows are often seen shopping for food before cooking. They don their Crocs and smocks, go to the market, choose what is fresh and available, and get down to business. In contrast, many brewers make decisions about hops well before brewing, sometimes years, because of the relationship between brewer and hop farmer. Few hop farmers are real keen on planting hop varieties that may not sell, so hop contracting is the way that most brewers secure their hops for the future.

While hop contracts are good for both brewer and hop farmer, the thought of having to choose what hop variety you will want to use next year or the year after is daunting for nanobrewers who are more interested in going with the flow than building a rigid brand portfolio. Add to the equation the relatively small amount of hops required for the typical nanobrew batch, and hop contracting becomes even less attractive. So hop like a chef and design your beers around what hops you can find in the market. One of the really great things about modern hop processing is shelf life; pelletized hops that are properly processed, packaged, and stored have the ability to retain their brewing value (bitterness and aroma) for several years (up to 5 years based on research by the German Hop Growers (HVG) group).

So where are some good places to look for hops? Hop growers, cooperatives, and merchants sell hops in two basic ways; through hop contracts and on the "spot market." The spot market is where brewers without contracts go looking for hops, and most hop merchants these days have spot hops posted on a website. If you live near hop growers, the spot market may be the hop farm. Another place to shop for hops is through the Lupulin Exchange website. This exchange allows brewers, hop growers, hop merchants, and others who want to buy and/or sell hops to make connections. The Lupulin Exchange was started in 2014 by John Bryce, Shane Kunkle, Jesse Pappas, and Darren Kopp and is a great contribution to the commercial brewing world.

Although Lupulin Exchange is an awesome trading space, some breweries don't want to mess around with selling boxes of hops to other breweries when shipping is required, but are happy to sell excess inventory, usually as a result of over-contracting, to local brewers who will pick up the hops. Brewers don't normally have issues becoming friends with fellow brewers, and there are many times when having brewer friends just makes good sense. Searching for hops on the open market is a great example. So be nice to your neighbor, you may benefit too!

THE INVISIBLE ARMY

You got it; the last section of this focus on ingredients is about the invisible troops that convert wort to beer. Just like a brewery could choose to riff on base malts, a brewery could easily do the same thing with yeast strains. And if the strains are different enough, the same wort could be used for dozens of different beers that may be fun to rotate through a handle or two. Although throwing caution to the wind is a relatively low risk proposition when experimenting with water, malt, and hops, it is not so with yeast and

bacteria. Indeed, brewers using new equipment and selling beer for the first time are best advised to take a conservative approach with yeast and bacteria until the kinks are worked out of a new system.

The great thing about brewing today is the excellent selection of yeast strains from yeast suppliers all around the globe. For the majority of the readers of *BYO* in the US, we have liquid yeast labs in all major regions of the country, as well as diverse and high-quality options for dried yeast. The bottom line is that there is no reason for a brewery to feel restricted by the lack of selection when it comes to yeast. And the nice thing about nanobrewing is that buying enough yeast to pitch a full batch of wort is not going to break the bank. It is also easy to use your old homebrew kettle to make a starter from DME and grow up a homebrew pitch. The 10-fold multiplier is a good rule of thumb; divide your batch size by 10 and that is your propagation volume.

A couple of things that I would hold off doing in a nanobrewery are growing yeast from slants, feeling the need to harvest and re-pitch yeast, and using bugs that are capable of causing problems. These suggestions deserve a bit of a defense, so here goes. Growing yeast from slants is serious work, and there is plenty of work to go around when brewing with a limited staff; the payback is simply missing and there are bigger issues that deserve full attention without running your own yeast lab. As far as harvesting and re-pitching, it is best to harvest yeast within a few days following the end of primary fermentation and to re-use as soon as possible to prevent loss in vitality and viability. If you only use a couple of strains and brew frequently, this may be an option. And now onto funky bugs; don't bring these into your brewery unless you really know what you are doing. This includes *Brettanomyces*, lactic acid bacteria, diastatic and lactic acid yeast strains. There is nothing wild and spontaneous about how to operate a brewery that brings wildfire into the cellar.

So those are some of my thoughts about exploring beer through ingredients in a nanobrewery. I did not cover ingredients outside of malt, hops, water, and yeast/bacteria, and there is a whole world of beer that includes fruit, spices, nuts, etc., so there is no real limit to this exploration. The commonality with these ideas is experimentation, embracing small batch size, wandering from technological advances that may curtail creativity, and to tell stories. BYO

BY DONALD & CARA GROFF

GLASS RINSER

A portable cup rinsing station

One of our biggest pet peeves at a brew fest is not being able to rinse the glass in between brews. We all know that tasting a stout right after an imperial IPA is not good form without rinsing first and yet it's such a difficult thing at most tasting events. As a homebrewer at events, you want to put your best foot forward and don't want the last beer's flavors to clash with yours, but you never know if the event organizers will provide you with water pitchers and if they do, will it get refilled? I didn't want to lug big water jugs with me, as those can be costly, take time and effort to maneuver & make a mess. We had been at a brewfest in Maine a few years ago that has glass-rinsing stations fashioned out of half kegs. It was brilliant and I've yet to see them at any other brewfest. It was something that I've never been able to get out of my head. Being a DIY guy, I wanted to figure out a way to be able to quickly and efficiently rinse glasses, like the brewfest in Maine had done so that my beers can shine.

I had made a foot-pump 5-gallon (19-L) bucket camping sink. It came in handy, but then I bought a camper and the bucket sink was relegated to the corner. It was the inspiration for this glass washer. I converted it into a glass rinser that when you stepped on the pump, it sprayed water into the glass. This worked well, but still was clunky to travel with and you had to pump each time you rinsed a glass. I knew I could do better.

After sitting in a bar that had a built-in glass rinser and actually paying attention to how it was built, I really started thinking about how it worked. I looked at the parts to build one in a home bar online forum. It wasn't exactly what I was looking for, but it gave me a start and a partial parts list. I was struggling with the "sink" portion — the part where the rinser head and drain would be mounted. While talking through the ideas with my wife, she suggested "a little pan, like restaurants use in steam tables." Final piece of the puzzle solved! I hopped on the Internet and started searching for one.

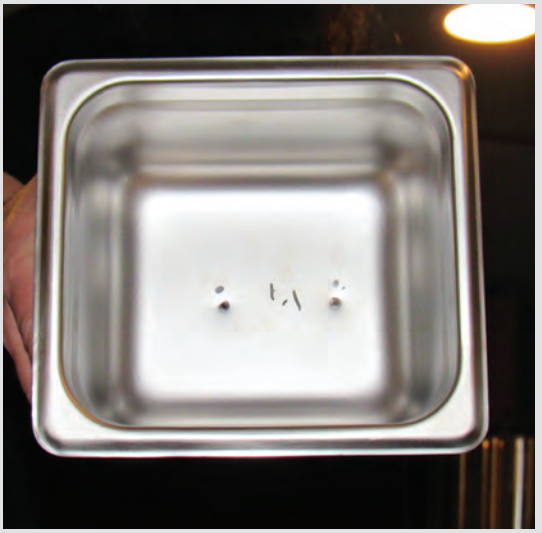
Most of the materials are things I already had laying around the garage brewhouse: Hose, keg, keg connectors, etc. The hose was left over from another project. My first thought had been to use CO_2 for the pressure. After a little more thought on that, though, I remembered that I still had the foot pump from the bucket sink. Why waste CO_2 on a rinser when I could just use the foot pump to pressurize the keg? I chose one of our older kegs that we didn't want to use for beer anymore, so we wouldn't tie up one of the "good" kegs with water. After some tinkering with the stand, it all came together with the help of a couple of pressure clamps. It's a hit every time I use it and the beer-drinkers are happy to have a clean glass!

Materials & Tools

5-gallon (19-L) corny keg
6.5-inch (16.5 cm) x 4-inch (10.2-cm) stainless steel steam pan
Sprayer replacement for a coffee bar (We used JZBRAIN brand)
(2) ⅜" barb x ½" NPT female pipe
Drain assembly for a drip tray
Tubing
Hose clamps
Keg connections: Gas & beer lines
Foot pump (We used a marine boat baby foot pump)
Plumber's tape
6 ft. (1.8 m) of ½" PVC pipe
(4) ½" PVC 90-degree elbows with side outlet
(4) ½" PVC 90-degree elbows
Drill with step drill bit
Hammer & punch
Crescent wrench
Screwdriver

As a homebrewer at events, you want to put your best foot forward and don't want the last beer's flavors to clash with yours . . .

Photos by Cara Groff

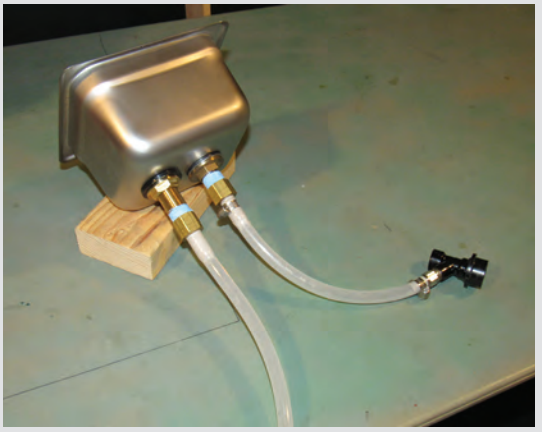


1. PREPARE THE SINK

Place the washer head and drain in the pan and mark for placement. Use a punch to start your hole. Using the step bit, drill the holes in the pan for the washer head and the drain. Be sure to use oil while drilling! You may also need to file the edges of the hole a little to remove any burrs.

2. SECURE SPRAY HEAD AND DRAIN

Place the washer head into the hole, add the washers, nut and tighten. Place the drain in the hole, add the washers, nut, and tighten. After the nuts are tightened, wrap a little plumber's tape on each piece. Then add a ⅜" barb to each piece.

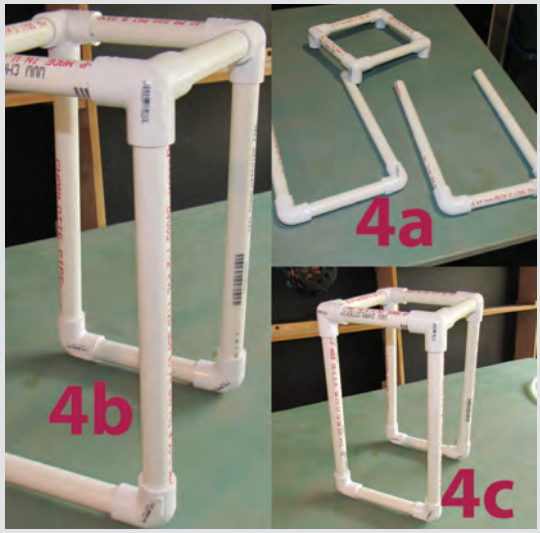


3. WATER LINE IN & OUT

Assemble a piece of tubing for the beer out line. Attach it to the sprayer side using the hose clamps to hold it in place. Cut a second piece of tubing long enough to reach into your waste container, such as a bucket. Build a gas-in line long enough to reach your pump from the top of the keg. Attach it to the pump, use a hose clamp if needed.

4. BUILD THE STAND

To build the stand that will hold the sprayer basin, cut (4) 12" (30 cm) pieces, (2) 5.5" (14 cm) pieces, (4) 6" (15 cm) pieces of PVC pipe. Take (2) 6" (15 cm) pieces, the (2) 5.5" (14 cm) pieces and the (4) 90° elbows with side outlets to make a rectangle to fit the pan. Be sure that the outlets are facing down because that's where the legs will attach. Each leg consists of (1) 6" (15 cm) piece and (2) 12" (30 cm) pieces with (2) 90° elbows to make a "U". You should have enough material to make (2) "U"s (**4a**). Attach the U-shapes to the square top piece by inserting the tops of the pipes into the empty outlets on the rectangle. (**4b** and **4c**). Putting the legs on the 6" (15 cm) side of the rectangle gives a better fit to the top of the keg.



5. PUTTING IT ALL TOGETHER

Assembly time! Fill your keg with water. Set the stand on top of the keg. We use a couple of clamps to help hold it to the keg. Place the pan through the top portion of the stand. Connect beer line side to the keg. Be sure to put the drain tube into your waste container. Remember, this project is to help you not make a mess while rinsing! Connect the gas-in line from the pump to the keg.

6. CHECK & USE

Once everything is connected, pump it! Check for any leaks while pumping to ensure the keg is being pressurized; make any necessary adjustments. Once you've pressurized the keg, gently press a glass down onto the washer head. Presto! A freshly-rinsed glass, ready to be filled with the next brew. BYO

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BY KIEV RATTEE

A BREWER'S STORY

Discovering the world through beer

Ty Stevenson joined the US Marine Corps at age 17. He received a Business Administration and Management degree from Sonoma State University and took the Concise Course in Brewing Technology from Siebel Institute. He went from being an avid homebrewer to Tasting Room Manager, and then Head Brewer, of Old Redwood Brewing in Windsor, California in just three years. Ty also launched his own business, Waters Brewer, selling brewing water treatments to homebrewers. All this, by the age of 26. That list of accomplishments in itself is quite a story, but the former Marine wasn't satisfied with the rapid ascent to his brewing dreams . . . no, he decided to forego the stability of his day-to-day existence brewing commercially in Northern California to leave the US for the first time to travel the world learning brewing culture and meeting brewers. In the fall of 2017 Ty made the decision to venture off into the world and booked a flight to Europe in pursuit of brew.

His international journey began in Spain in January 2018 where he brewed a kettle sour with Riley Finnigan, Head Brewer for Edge Brewing in Barcelona (and formerly of Avery Brewing Co. in Boulder, Colorado). Ty's brewing adventures continued in Rome, Italy with a three-person collaborative imperial porter homebrew on an all-in-one electric brew system similar to The Grainfather. He did his first decoction mash brewing a 7-bbl batch of witbier with Andreas, the Head Brewer at 1516 Brewing Company in Vienna, Austria. Before leaving Vienna, Ty sampled beers with the brewers from Brew Age and Beaver Brewing Company.

He got to talk with the owners of a small, 3-bbl brewery – Calverly Brewing Company in Cambridge, England – about the dynamics of operating a nanobrewery and making all of your revenue out of a taproom. He met the brewers from Northern Monk Brewing Company in Leeds, England. He drank helles in the historic beer halls of Germany. He partook of Pilsner in Prague. He gazed upon the St. James Gate Brewery (Guinness) in Dublin, Ireland.

The genesis for Ty's journey was based in beer and brewing. However, it struck me over and over while following his travels on his blog, or while communicating with him to write this piece, that what really stuck with him were the people he met along the way. Despite any cultural or language barriers, Ty was able to find common ground with strangers through their passion and appreciation for beer. He bonded with brewers over the challenge of combining four basic ingredients to create a beverage that brings people together in a pub, a livingroom, or a hostel thousands of miles from his home.

Ty's European beer adventure lasted four months, took him through 30 different cities in 11 countries, and countless beers. So what's next for this beer adventurer? Ty had tentative plans to continue his beer travels in South America after a brief return home to Northern California this spring. However, as fortune would have it, he has heard from an angel investor interested in setting him up with a small-scale commercial brewing operation. He's feeling the itch to brew again in his own brewery, too, but it may not be here in the US. According to Ty, "The next goal, which was/still is a hard decision for me to make, is to pack up my life again, and move to Sevilla or Malaga, Spain to start my own microbrewery. I'm planning on visiting Sevilla and Malaga one more time in late summer/autumn to solidify the city and look for specific locations to start this brewery." In the meantime he is enjoying sampling some of the homebrews he tucked away before his travels and working on a business plan for "One Life Brewing Company." Follow Ty Stevenson's beer adventures on his blog at www.abrewersstory.com. BYO

Despite any cultural or language barriers, Ty was able to find common ground with strangers through their passion and appreciation for beer.

Photo courtesy of Ty Stevenson

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