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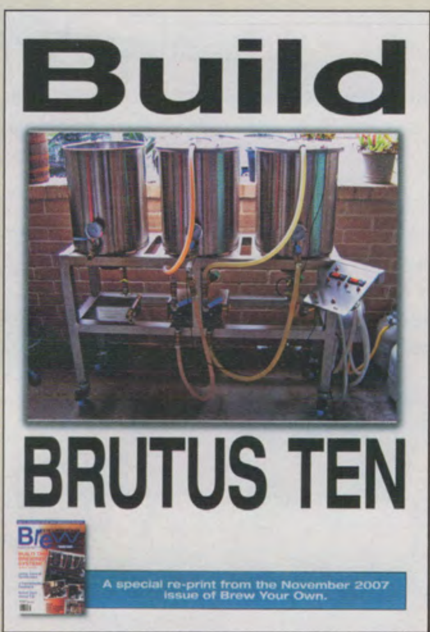

A special re-print from the sold out November 2007 issue of *Brew Your Own*. Build your own single-tier, all-stainless brewery! In this piece we lay out everything you need to construct your own Brutus Ten brewing system, a 10-gallon (38-L) semi-automated, completely awesome work of brewing art. Includes a detailed materials list with pricing, step-by-step diagrams, photos of the construction in progress and diagrams on how to use the system. Just $3.00 each (plus postage).

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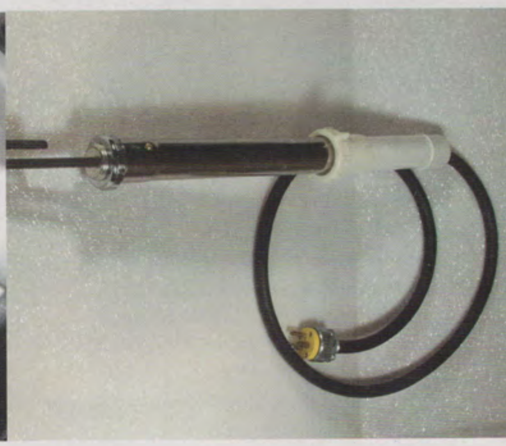
25 GREAT HOMEBREW PROJECTS

Homebrewers have a lot of choices when it comes to equipment. From setups as simple as a stovetop brewpot and a carboy all the way up to automated all-grain systems with temperature-controlled fermenters, you can outfit a home brewery as frugally or as lavishly as your budget (and space) allows. If homebrewers were content with only store-bought beer, however, they wouldn't brew. And the same is true for brewing equipment.

The DIY spirit has been alive and well at *Brew Your Own* from the very beginning in 1995, not only in the brewhouse - but in building the brewhouse itself. We have featured many homebrewing build-it projects, so we've collected 25 of our favorites for this special issue. Some of our writers over the years built projects to solve space or budget constraints, others simply because they like the challenge of making their own gadgets - because where is the fun in simply creating your own beer when you can build your own custom equipment as well? Hopefully some of these projects will not only come in handy in your home brewery, but also inspire you to create your own brewing projects!



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25 GREAT HOMEBREW PROJECTS

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ALL-GRAIN SYSTEMS

Build A Cooler Mash Tun

Story and photos by **Forrest Whitesides**

The heart and soul of any all-grain homebrewing system is the combination mash/lauter tun. "Mashing" is the hot water steeping process that results in sweet fermentable wort, while "lautering" is the process of separating the wort from the spent grains.) A third critical step in the process is sparging (technically a part of the lautering process), which is the post-mash rinsing of the grain in order to capture as much as fermentable sugar from the barley as possible. (For some ideas on building a continuous sparging system, see page 10. For more information about sparging, go to www.byo.com/component/resource/article/1016.)

Commercial brewing setups may split the processes of mashing and lautering into their own respective vessels (commercial brewers have a mash mixer or mash tun and a lauter tun, but there is not a third vessel for sparging; the sparge water does come from a hot water tank, but that is not considered a brewing vessel), but for small-scale homebrewing, combining these functions into one is more efficient in terms of time, money and space.

There are two main functional requirements for a quality mash/lauter tun: the ability to hold the mash at a constant temperature for at least an hour, and a way to drain off the wort while leaving the crushed malted barley behind. The first requirement is very nicely accommodated by a typical insulated beverage cooler. And the wort separation (lautering) can be accomplished with the combination of a gravity-fed ball valve and a straining manifold made from copper pipe and fittings.

During the initial mashing phase, the grain and hot water mixture (the mash) needs to be held at a constant temperature for approximately one hour. A cooler with thick, well-insulated walls is ideal. Also, choose a cooler with a removable drain valve or spigot. I have had great luck with the Coleman Xtreme line of coolers. For 5-gallon (19-L) batch sizes, a 52-quart (49-L) cooler is a good volume that will allow even fairly high-gravity recipes with some headroom left over for stirring. That is the model used in this project.

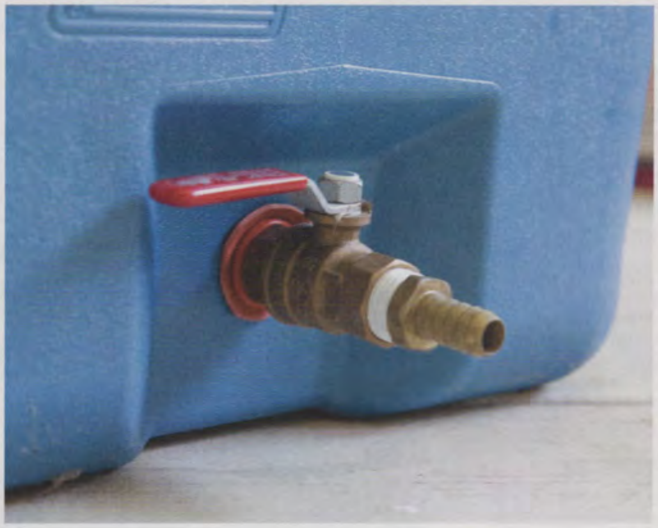
Parts and Tools

Hacksaw
Sandpaper
Pliers

For the ball valve:
A "cooler conversion kit" from your local homebrew shop
or
- ½-inch FPT pipe coupling, approximately 3 or 4 inches long
- ½-inch pipe nipple, approximately 3 inches long (this may vary based on cooler wall thickness)
- ½-inch FPT ball valve
- ½-inch MPT to ⅜-inch hose barb adapter
- Silicone (or other food grade material) gaskets to fit
- Pipe tape
- Optional: small rubber sheet for cutting custom gaskets/o-rings

For the manifold:
- Approximately 5 feet (1.5 m) of ½-inch hard copper pipe (type M or type L)
- (4) ½-inch 90-degree copper elbow fittings
- (3) ½-inch "T" copper fittings
- (1) ½-inch 45-degree copper street elbow fitting
- (1) ½-inch copper male pipe thread adapter

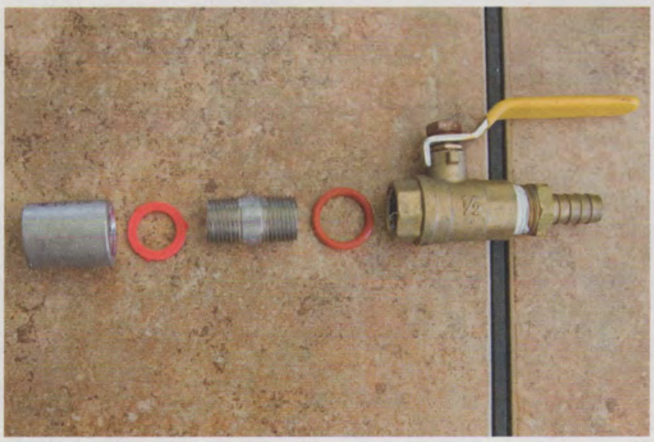
If you plan to build your project with metric pipe, you will need to choose your fittings appropriately.



1: CONVERTING THE COOLER

Once you've chosen a well-insulated cooler with an existing drain plug or spigot, it's time to install a ball valve. This is a major step in converting a mere cooler into an indispensable piece of homebrewing gear. For the sake of simplicity, I highly recommend purchasing a "cooler conversion kit" from your local homebrew shop or an online homebrew supplier. These kits are composed of two main parts: a bulkhead fitting and a ball valve. The bulkhead is further composed of gaskets and washers that fit together to form a water-tight seal through which your wort will flow when lautering and sparging. A hose barb is then added to the ball valve to allow the connection of tubing.

Follow the directions that come with whichever cooler conversion kit you purchase.



2: ASSEMBLE THE VALVE

If you choose to make your own ball valve, start by wrapping both threaded ends of the pipe nipple with pipe tape. Now attach the pipe nipple to the pipe coupling, apply a gasket to the exposed threads of the pipe nipple, and then slide it through the spigot hole from the inside of the cooler. Next, add a gasket over the threads of the pipe nipple on the outside of the cooler. Screw the hose barb adapter into the outlet threads of the ball valve, then screw the ball valve assembly onto the pipe nipple. Hand-tighten the whole assembly from the inside of the cooler by turning the bulkhead (this may require pliers to get a water-tight seal). If you find that you need extra padding around the bulkhead, you can cut your own flat gaskets from a small sheet of flexible rubber, which are available in most hardware stores — however, they are not foodsafe and should only be used on the exterior fittings that do not come into contact with the wort.

3: BUILDING THE MANIFOLD

The manifold is an array of systematically perforated piping that lays at the bottom of the mash tun and allows the wort to runoff while leaving the grains behind. The perforated side of the pipe faces downward, and gravity pulls the wort out of the grain and out through the open ball valve. The perforations are actually very thin cuts, which allows the flow of wort but prevents even small particles of crushed grain from entering the manifold. You can make a copper sparging manifold for about $15. And because there isn't significant pressure put on the pipes during mashing and lautering, there is no need to solder the joints together. Since it isn't soldered together, it can be broken down for cleaning and storage after each use.

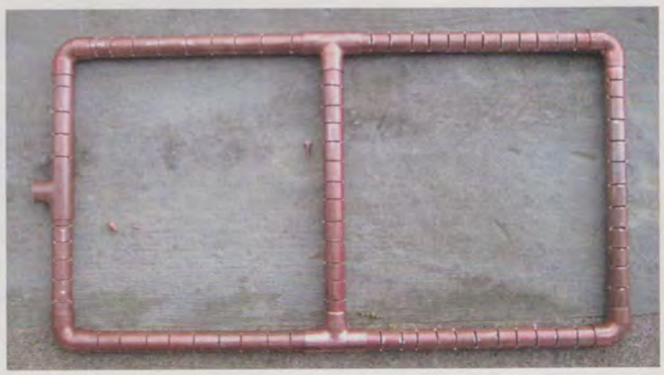
4: MANIFOLD FABRICATION

You should test the integrity of all the connections before your first brew day with your new mash tun. Put at least 2.5 gallons (9.5 L) of water in the cooler and let it sit for 30 to 45 minutes. If you notice a leak — even a slight one — you need to work backwards through the installation, retighten each connection and then test again.

The idea of the manifold is to run the pipe around all areas of the bottom of the mash tun to minimize "dead spots" (from which wort is difficult or impossible to collect), and also to reduce "channeling" of the grain. Channeling is mostly an issue in fly (continuous) sparging, since in batch sparging the grain is stirred, but pulling the wort from all areas of the mash tun simultaneously is never a bad thing.

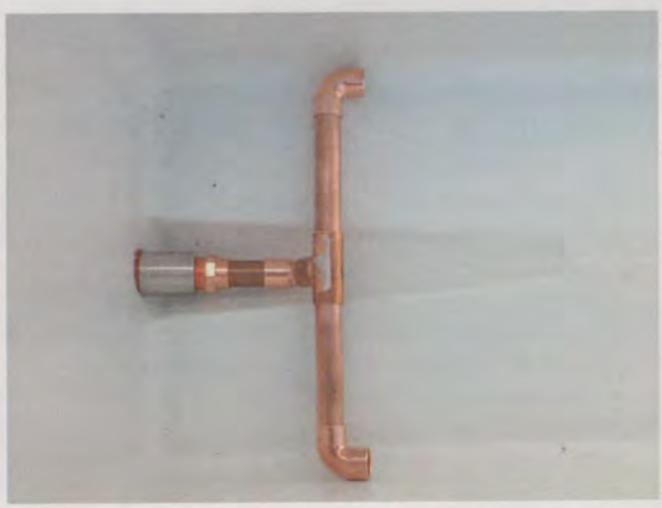
5: MANIFOLD ASSEMBLY

Cutting the copper pipe is fairly straightforward. A common hacksaw is probably the best tool for the job. Be sure to account for the length of pipe that is "lost" inside each pipe fitting, which on average is about half an inch. Since all of the pipe sections in the project will be attached to two pipe fittings, you should add approximately 1 inch (2.5 cm) to each length to be cut to compensate. It is important that the manifold sit flush with the bottom of the tun, or as close as you can get it. This is so that as much wort as possible is recovered, and also so that you won't hit the piping with your mash paddle while stirring the grain. Attach the 45-degree street elbow to the ½-inch male pipe thread adapter and screw that into the bulkhead fitting on your mash tun. This elevates the manifold above the trough level and makes it flush with the bottom of the cooler.



6: FINISHING THE JOB

All that's left now is to add some holes to allow the wort to flow through the pipes and out through the ball valve. You can use a drill with a small bit (⅛-inch is a good starting point), but I highly recommend going back to the hacksaw for this. Drilling is next to impossible on round tubing unless you center-punch at each drill spot. On each section of pipe (the straight pieces, not the elbows and other fittings), make a cut with the saw about every half an inch. Each cut should be no deeper than a little less than halfway through the pipe. Once all the cuts are made, wash all of the pipe sections and fittings in a mild detergent solution. Reassemble the manifold and it's ready for your next all-grain brew session. If you find that any of the joints don't fit snugly, or that they loosen over time and repeated use, you can manually crimp the loose fittings with pliers to tighten them up. You may also want to go over the cut sections with sandpaper to remove any burs. BYO



Continuous Sparging System

Story and photos by **Forrest Whitesides**

If you're looking to move from extract brewing to all-grain brewing, you'll need to become intimate with the details of sparging. In a nutshell, sparging is the process of rinsing the grain in order to extract as much sugar as possible while leaving behind grain husks and other particulate matter.

Continuous sparging, or "fly" sparging as it is often called, is a very common sparging method used by homebrewers. There are a number of commercially available products designed to aid in the process, most commonly in the form of sparge "arms" that distribute water to the grain bed via a gravity-fed rotating arm (not unlike a lawn sprinkler). But why pay for one when you can easily build your own?

Using PVC pipe and a four-way connector, we're going to make a simple four-armed fixture to suspend the shower arm and head above the grain in your mash tun. This project assumes that you are using a 5-gallon (19-L) round Igloo-style cooler as a mash tun, but it can easily be adapted for use with a square or rectangular tun.

The project design assumes that you already have a hot liquor tank (HLT) to hold the sparge water. If you do not have an HLT, you can pick up a 5 or 10-gallon (19 or 38 L) round cooler and a ball valve at the hardware store while you are collecting the rest of the parts for the project. Remove the cooler's plastic spigot and install the ball valve — now you've got an insulated HLT. You'll need a drill, a small hacksaw or coping saw and an adjustable wrench or pliers to do it.

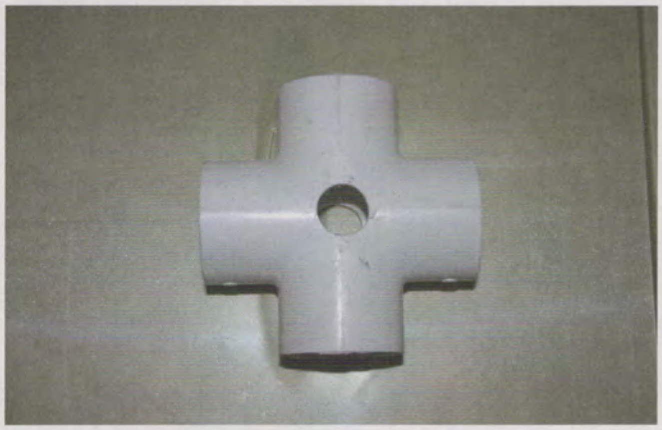
"There are a number of commercially available products designed to aid in the process, most commonly in the form of sparge 'arms' that distribute water to the grain bed via a gravity-fed rotating arm (not unlike a lawn sprinkler)."

Parts and Tools

- 1¼-inch PVC pipe (3 feet or ~1 meter)
- 1¼-inch PVC four-way pipe connector
- 1¼-inch PVC pipe caps (4)
- ½-inch FPT to ½-inch hose barb
- Standard 6-inch (15 cm) shower arm
- Low-flow (2.5 gpm or less) shower head with flow control valve
- ½-inch ID vinyl tubing (4–6 feet or ~120–180 cm)
- Teflon pipe tape (1 roll)
- Sand paper, medium grit (optional)
- 100% silicone caulk (optional)

1: DRILL HOLES

First, we're going to drill a ¾-inch hole in the center of both sides of the flat part of the PVC four-way pipe connector (see photo). Use a drill with a paddle bit or small hole saw to get the job done. Once you've got the two holes drilled, insert the shower arm through each hole to check for a firm fit. If the holes are two small (which is likely), you can widen them with either medium-grit sand paper (the slow way) or with a Dremel Tool with grinding/sanding drums (the fast way). The ideal hole size will be just big enough to allow the shower arm to be pushed through but will be tight enough to hold it snugly. If your holes are a bit too large, you can either start over with a fresh four-way connector (you did buy two just in case, didn't you?) or you can easily caulk the shower arm in place. Once you have the holes at the proper size, remove the shower arm and put it aside.



2: CUT THE PVC

Next, cut four 6-inch (15 cm) sections of PVC pipe (or use longer sections as needed for a rectangular mash tun). A hacksaw or coping saw will make quick work of the job (see photo). Insert the four sections into the four-way connector. Finish off by applying the end caps to the piping. Optionally, you can caulk all the connection points for a more permanent fixture, but provided that everything fits snug, this is not necessary. Not using an adhesive also allows the fixture to be taken apart for easier storage.

3: ASSEMBLY

Now it's time to bring everything together. Insert the shower arm through the holes in the center of the fixture, with the angled portion of the arm sticking out of the top. Apply a liberal amount of pipe tape to both threaded ends of the shower arm. Without the tape, it will be very difficult, if not impossible, to achieve leak-free operation.

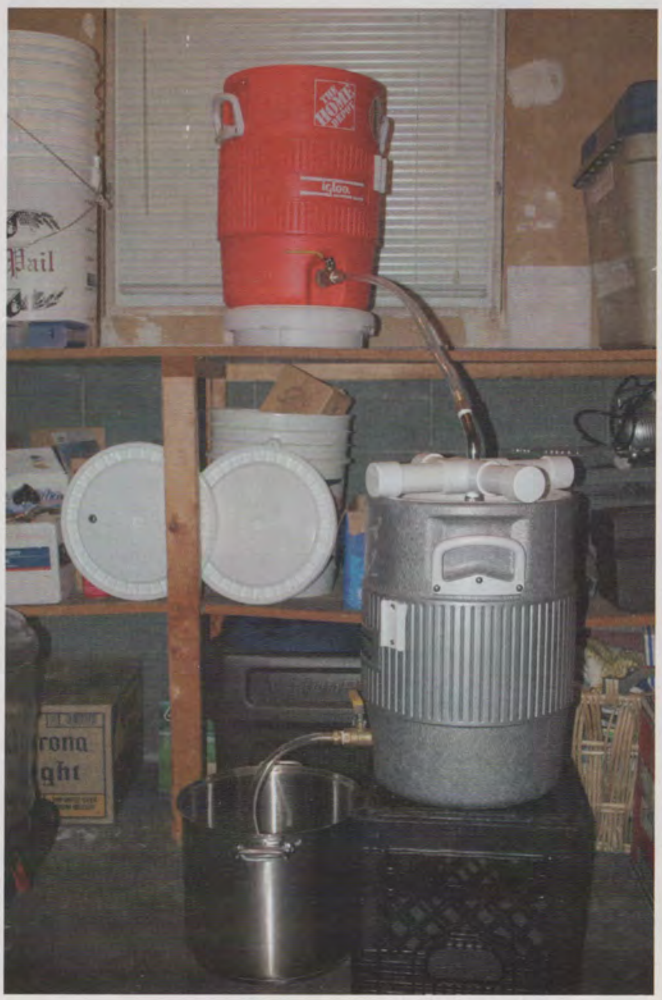
Screw the hose barb into the pipe thread on the angled end of the shower arm. Hand tightening will likely not be enough to get a good seal, so use an adjustable wrench or pliers to tighten. Next, screw the shower head into the pipe thread on the straight end of the shower arm. The shower head has a rubber gasket in its connector threading, so hand tightening should be enough to eliminate leakage (see photo).

4: CONNECT HLT

All that remains is to connect your HLT to the sparge fixture via a section of ½-inch vinyl tubing. If you prefer, you can use ⅜-inch high-temp tubing. With a little coaxing, it will fit snugly on the ½-inch hose barbs on both the HLT and sparge fixture.

Parts substitution

The parts list for this project on page 10 is almost infinitely configurable. You could use smaller diameter PVC pipe and fittings, for example. And you could easily spend half an hour at a big-box hardware store just sorting through your options for shower heads. Just make sure that the shower head you choose has a flow rate control valve. This will allow you to have maximum control over the sparge speed. For this project, I used the Europa Elite shower head, a commonly available and inexpensive model. You could even use some type of garden sprinkler head, so long as you make sure that it is safe for use with potable water and won't impart chemicals or metals.



5: A DECISION OF GRAVITY

Your new continuous sparging system operates solely with the help of gravity, so you'll need to position the HLT at least a foot or so above the mash tun. Putting the HLT higher above the mash tun will generate faster flow, but in continuous sparging, faster is certainly not better. Since you'll be collecting wort as you sparge, a three-tiered setup is ideal (i.e.: HLT at the top, mash tun in the middle, kettle on the bottom (see photo)). Experiment with the system to find the ideal set-up in your brewing space.

The goal in continuous sparging is to have an equilibrium of hot fresh water coming in the top of the mash tun and sugar-laden wort flowing out to the kettle. The fresh water added to the top of the grain slowly makes its way through the grain bed, picking up fermentable and non-fermentable sugars (and also flavors and color) on its way down and out through the mash tun to the kettle.

At all times during sparging, there should be about an inch of water sitting on the grain bed. By using an HLT with a ball valve and a sparge fixture with a flow control valve (on the shower head), you can fine-tune the flow going in to the mash tun to match the outflow. Sparging with too high of a flow rate will negatively impact extraction efficiency. A low-flow shower head has a theoretical maximum flow rate of 2.5 gallons per minute, but this is at 80 psi. Your gravity-fed system doesn't create near this pressure, so your flow rate will be fine.

It should take about an hour to get all the sparge water through the grain bed and into the kettle. Another reason to go slowly is that a higher flow rate is more likely to disturb the grain bed, which acts as its own filter during mashing and sparging. Too much disturbance will result in cloudy wort going into the kettle. BYO

Countertop All-Grain System

Story and photos by **Jeff Karpinski**

There is often a common progression in homebrewing. Brewers begin making extract beer in a pot on the stove. Next comes steeping grains to tweak the flavor of the beer. For many, this is followed by the lure of all-grain brewing.

My evolution in brewing was no different, and after a year of doing all-grain using nothing more than a 24-quart (23-L) 120V electric kettle I had built, a 5-gallon (19-L) cooler mash/lauter tun (MLT) and a small pot to heat strike water on the stove, I knew my ultimate brewing system would need to be special. I'm the only beer drinker in the house, so 5-gallon (19-L) batches too much for me. Three gallons (11 L) seemed to be my sweet spot. Still, I coveted the "big boy" systems. Then I saw Lonnie McAllister's "Brutus 20" system.

Many know Lonnie from his 10-gallon (38-L) Brutus 10 (the plans of which you can order at www.byo.com/store). Lonnie also has an unorthodox Brutus 20 experiment. He called it CRDFM (constant recirculation direct fired mash). Two pots, two pumps and two heat sources. It certainly was compact. What was obviously missing from the system

was the hot liquor tank (HLT). The Brutus 20 was essentially a two-vessel, no-sparge brewing system. After mashing in at a high liquor-to-grist ratio, wort is pumped from the mash/lauter tun (MLT) to the kettle, where it is heated and pumped back to the top of the grain bed. In this way, the mash temperature can be maintained or raised. When the mash is over, the wort is already clear from being recirculated. At that point, you need shut off the return flow to the grain bed and the kettle can be filled.

Parts and Tools

For the Kettle:
- (1) 24-qt aluminum kettle w/lid
- (2) ⅜-inch female barb
- (1) ⅜-inch close nipple
- (1) weldless thermometer sight gauge
- (1) ½-inch to ¼-inch NPT reducer
- (1) ½-inch weldless fitting set
- (1) ½-inch close nipple
- (1) 120V 2KW water heater element
- (1) water heater element nut
- (1) 14-gauge appliance cord
- (1) pvc end cap
- (1) 4-inch K type liquid safe thermocouple
- (1) roll self-stick duct insulation

For MLT:
- (1) 5-gal. (19-L) cooler
- (2) ⅜-inch female barb
- (2) ⅜-inch nipple
- (1) ⅜-inch ball valve
- (3) ⅜-inch male barb
- (1) ⅜-inch female tee
- (1) stainless braid

For Pump / CFC:
- (1) HD bucket w/ lid
- (1) march pump
- (1) ½-inch close nipple
- (1) ½-inch nut
- (1) ½-inch coupler
- (1) ½-inch female barb
- (1) ½-inch female to ⅜-inch barb
- (1) ⅜-inch female barb
- (1) ⅜-inch close nipple
- (1) ⅜-inch ball valve
- (1) ⅜-inch male barb
- (2) female garden hose end
- (1) male garden hose end
- 1 ft. ½-inch copper pipe
- (2) ½-inch copper tees
- (2) ½-inch to ¼-inch copper reducer
- 20 ft. ⅜-inch od soft copper tubing
- 50 ft. ⅝-inch id high-temp garden hose
- 4 ft. ½-inch high-temp silicone tubing
- 8 ft. ⅜-inch high-temp silicone tubing
- 1 set ½-inch QuickConnectors

For Controller:
- (1) 6x4 electric job box
- (1) 14 gauge appliance cord
- (1) 40A SSR
- (1) SSR heat sink
- (1) SYL-2362 PID
- (1) thermocouple panel mount
- (2) 120v switch / plug combo
- (2) switch cover plate

1: MATERIALS

The materials list (which can be viewed on page 13) covers everything used in the system except fender washers and hose clamps. Lots of both are needed. Just get a big bag each of stainless clamps for ⅜-inch and ⅝-inch. Fender washers are used to shim up various bits around the ⅜-inch nipples. Get a bunch of zinc ones and at least two stainless ones for the insides of the kettle and MLT lids. The 120V 2KW water heater element can be tricky to find. Lowe's and Home Depot near me carry only 1,500W ones, but Ace Hardware carries 2,000W in 120V. So, what's the bottom line on building a Countertop Brutus 20? As I built mine gradually over the winter and leveraged many parts from my scrap bins, I can't say exactly. A rough run of the numbers leads me to believe this system could be built from scratch for $400–500, worst case.

2: TWO VESSELS VERSUS THREE

During my first year of all-grain brewing, I beamed with pride at my frequent 90% mash efficiency, yet still had this nagging feeling my beers weren't all they could be. Then I read about and started tinkering with thin mashes — mashes with 2 qt./lb. (~4 L/kg) liquor-to-grist ratios and even higher. These thin mashes made for so much first-runnings that my sparge volume dropped to as little as a gallon (3.8 L). My mash efficiency dropped dramatically into the 75–80% range, but something strange happened — my beers became amazing. I finally realized what Lonnie knew all along, "This ain't a grain race here; it's about beer man!"

Whereas your efficiency will likely go down if you switch to no-sparge brewing, the tradeoff here is a brewing system with a smaller "footprint" — two vessels instead of three and one heat source (in the kettle) instead of two (for the kettle and hot liquor tank) or more. This may be more important to some brewers than a few extra percentage points of extract efficiency.

3: MLT

By the early fall of 2008, my mind was made up. I spent a good bit of time drawing sketches, thinking about the Brutus 20 and how to scale it down to 3–4 gallons (11–15 L) for indoor brewing. I quickly realized by leveraging gravity I could simplify the system further, eliminating one pump and burner. (Lonnie's Brutus 20 was a one-level system, using two pumps, and both vessels had burners.) So I was left with an electric kettle to heat the wort, a pump to push the heated wort to the top of the MLT and gravity to drain the MLT back into the kettle. CRDFM!

4: PID

Finally, a little automation can aid any brewing system in the temperature control department and this one is no different. Fortunately, the electronics used here are extremely simple - a PID controller, a thermocouple to read the kettle temperature, a solid state relay (SSR) to drive the kettle heating element and a couple combo switch/outlet plugs from the hardware store. Having good temperature control takes the stress out of brewing.

5: HOW IT WORKS

OK, enough theory, how does this thing actually work? It's probably easiest to describe both by stepping through a typical brew session.

In this photo, you can see the interior of the kettle. the heating element is installed and a ball valve drains the kettle. I also installed a PID controller, and a thermocouple monitors the temperature.

Fill the kettle with 4 gallons (15 L) or so of water and set the PID to strike temperature plus 2 °F (1 °C) to account for loss of heat to the CFC and a slight temperature overshoot in the MLT. Begin full system recirculation as PID set temperature approaches to pre-heat the mash/lauter tun (MLT). Once the PID set temp is reached, close the MLT valve and allow it to fill to the desired mash infusion volume. Shut pump off, add any water mineral adjustments and double-check strike temperature with a thermometer. Dough in once everything looks good.

6: CALCULATE VOLUME

Calculate the balance of water needed to meet the desired pre-boil volume. For example, if the mash infusion was 2.25 gallons (8.5 L) into 6 lbs. (2.7 kg) of grain, and I expect a loss of 0.1 gallon/lb. (0.83 L/kg) due to grain absorption, then there should already be 1.65 gallons (6.2 L) in the system. Assuming a desired pre-boil volume of 4.5 gallons (17 L), I should fill the kettle to 2.85 gallon (11 L). Set the PID to 170 °F (77 °C), the mash out temperature. worked well enough, but it was very hands-on. Could my ultimate brewing system have chilling integrated into it? I needed a housing for the pump and a way to lift the MLT above the kettle, so why not use a bucket? The pump fits well enough in the bottom of a bucket, but there's a lot of wasted space. Would a counterflow chiller (CFC) fit in there as well? Bingo! Plus, if I permanently plumbed the CFC onto the pump output, that would eliminate several plumbing changes during the brew session, reducing mess - always an important factor for brewing indoors.

7: RECIRCULATING

Once the mash is complete, begin recirculation by closing the CFC valve, opening MLT valve partially, and re-opening CFC valve to balance MLT inflow with outflow. This normally takes a couple minutes of fiddling and a re-check every 10 or so minutes during the recirculation. I've got a sight glass on the kettle to help monitor this. Recirculate for 30 minutes or until the full system recovers to 170 °F (77 °C), whichever takes longer.

8: BOIL

Shut the pump off and open all valves fully to allow wort to fall back to kettle. Switch the PID to manual mode, 100% output to begin the boil. Once the boil starts, you are done with MLT for now, so remove and clean it if you are so motivated. At boil end, the kettle element gets shut off, the kettle lid goes back on and the CFC output gets plumbed to the kettle lid. Turn the pump on to allow hot wort to circulate and sanitize the CFC and pump.

9: CHILL AND TRANSFER

While sanitizing, hook up CFC to a cold water source and dump lines to the sink. After 5–10 minutes, begin cool water flow through CFC.

After the wort is chilled, shut off the pump and momentarily raise the CFC bucket above kettle level to allow all the wort to flow back into kettle. Close kettle-out valve and it's now ready to dump into the fermenter.

From this point on, all that's left is clean-up. I rinse out the kettle and restore the system to a chill configuration so I can recirculate hot Oxyclean solution through the kettle and CFC for 10 minutes. I dump and repeat with rinse water and I'm done. Rolling the CFC bucket counter-clockwise above the sink about a dozen times drives out any remaining water in the coils and it's ready to put up. Beer time!

10: BUILDING THE BREWERY

Building this system really isn't too difficult and can be done in a weekend or two. The wiring is straightforward - particularly if you've done any household wiring like adding an outlet. The PID comes with great directions for its hookup. I used a drill and jigsaw for cutting out the component holes in the electronics box. Hole cutters sized for the ½-inch and ⅜-inch nipples as well as one large enough for the water heater element are needed, as well as a file to clean up rough edges on the holes.

11: CHILLER

Possibly the most challenging part of this project is sweating the copper fittings for the counterflow chiller. A propane torch, solder and flux are needed here. There's plenty of great plumbing how-to articles online if you've never messed with soldering copper before.

Lastly, be sure to have plenty of Teflon pipe tape on hand when assembling the weldless spigot and sight glass on the kettle. This will insure leak-free fittings.

12: GO SMALL!

I've now run roughly 20 brews through my system since completion and absolutely love it. I still learn little tricks and process improvements along the way, but I haven't changed the hardware one bit. Countertop small-batch all-grain brewing is here to stay — in my house at least! BYO

BOILING & KETTLE

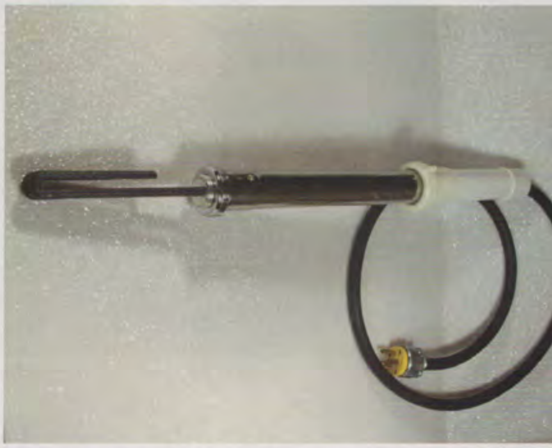
Build An Electric Heat Stick

Story and photos by **Tom Bardenwerper**

I've been an apartment brewer since 1987, so space has always been a problem. Then, in 2005, I purchased a 15-gallon (57-L) stainless steel conical fermenter and a 60-qt. (57-L) stainless steel brew kettle. With these two major upgrades came the inevitable step-up to brewing 10-gallon (38-L) batches. This increase created a number of problems, the first of which was heat: How was I going to boil 10 gallons (38 L) of wort in my small condo?

After surfing the Net for countless hours I came upon the solution: I saw an old "Bruheat" electric boiler on an English homebrewer's website and thought, "that's perfect, I could use an electric hot water heating element!" I did not want to permanently install a heating element into my kettle, however. Ideally, I wanted the heater to be portable, so I could apply heat where and when I needed it. The trick would be making something as safe as possible — electricity and water is a VERY DANGEROUS combination!

I decided to make it similar to a power tool; one with a straight han-



dle, a short power cord, and a heating element on the other end - a "heatstick!" After seeing all my parts options, I settled on the configuration I am still using today: a hot water tank heating element attached to a kitchen sink drain pipe that's attached to a plastic handle, with a power cord running through the middle. The hot water heating element electrical contacts are sealed water-tight from the inside with epoxy. Finally, by using a GFCI (Ground Fault Circuit Interrupter) protected wall outlet and a solid ground connection, I would have two layers of protection and be as safe from electrocution as possible if the heatstick were to develop a leak.

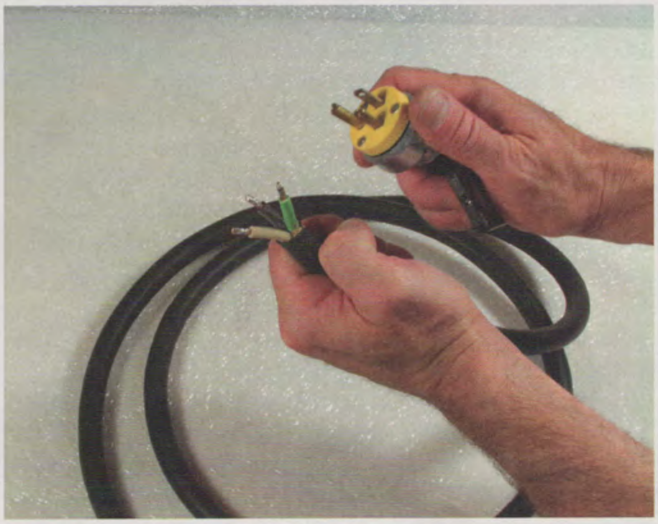
The primary thing I've learned from building this heat stick project is that the key to success is achieving a good seal around the electrical contacts of the heating element. To do that, I encapsulate or "pot" the electrical contacts in epoxy from inside the drain pipe. The heat sticks that I have now are all sealed with JB Weld epoxy, which has worked the best out of all the sealants I've tried, including: aquarium silicone, Alumalite casting resin and high-temp automotive RTV silicone gasket maker. JB Weld can withstand temperatures up to 450 °F (232 °C) and the epoxy never comes in contact with liquid so the heat stick is as food-safe as you can make it.

Parts and Tools

- GFCI (Ground Fault Circuit Interrupter) adapter or GFCI protected wall outlet
- Screw-in hot water heating element. (Choose based upon your home's electrical system and how much liquid you intend to heat. For this stick, I bought a 1500 watt, 120 volt, ultra-low-density element made by Camco. Part number 02853.)
- 12-gauge, 3-wire, rubber electrical cord
- Heavy-duty, armored, 20-amp, three-prong plug
- 12-inch x 1½-inch I.D. chrome plated, brass drain pipe
- 1½-inch x 1¼-inch slip joint nut
- 6-inch x 1½-inch I. D. plastic drain pipe extension tube with compression fitting nut and gasket
- ¾-inch PVC coupler
- 1-inch PVC end cap
- Small brass bolt, nut and washer for ground connection
- J-B Weld epoxy (not the fast curing type)

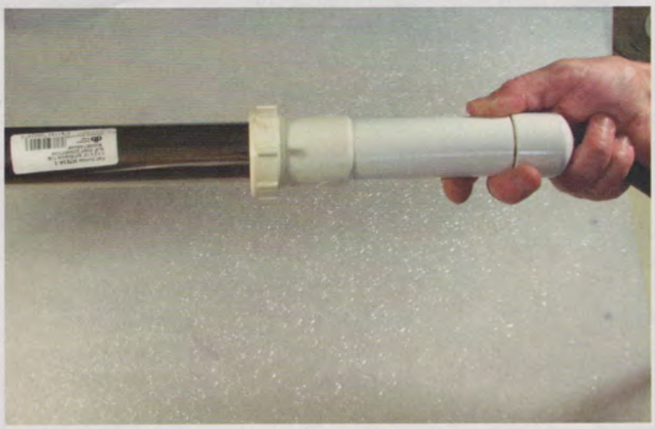
1: HEAT STICK SAFETY

- NEVER run a heatstick dry. The element MUST be fully submerged at all times or it will overheat and burnout very quickly, possibly causing personal injury, a fire, or worse!
- ALWAYS plug your heatstick into a functioning GFCI (Ground Fault Circuit Interrupt) protected outlet. If the heatstick ever leaks, the GFCI will instantly trip, shutting off power to the outlet.
- A heatstick draws a lot of power. Each stick must be on its own circuit or you'll likely blow a circuit breaker/fuse. Do not exceed 80% of your circuit's load capacity.
- A heatstick is a potentially VERY DANGEROUS tool! However, if built and used correctly, and you respect it as the potentially dangerous tool it is, you'll have years of safe, trouble-free brewing with it.
- Failure to follow these precautions could result in serious injury, fire or death! If in doubt about anything, stop and call a qualified electrician for assistance.



2: PLUG ASSEMBLY

Strip 1½ inches of the outer wiring insulation from the cord to expose the three wires and then strip about ½-inches of insulation from each wire. Solder the wire tips. Next, connect the wires to the plug, making absolutely sure the GREEN wire is attached to the GROUND plug. It does not matter which plug the black and white wires are attached to. Assemble the plug housing as necessary.

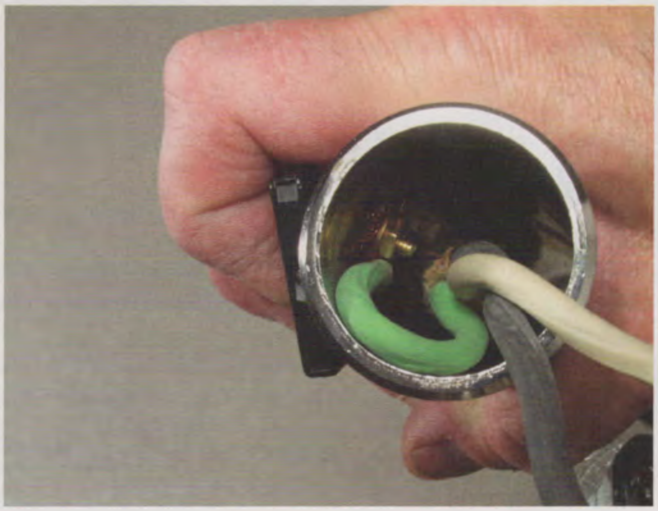


3: HANDLE ASSEMBLY

The plastic parts form the handle. Take the PVC end cap and, using a marker, mark the top-center with a dot. Using an appropriately sized drill bit for the diameter of the cord, drill a hole through the top of the PVC end cap and file the edges smooth. Attach the PVC coupler to the end cap and thread them onto the cord. Next, thread the cord through the center of the plastic drain pipe extension and slip the coupler on to the end of the pipe. Be sure the compression fitting nut and plastic gasket are screwed onto the plastic drain pipe and then run the cord through the metal drain pipe, but don't connect the pipes together yet; in the final step we need to pour epoxy inside.

4: GROUND NUT ASSEMBLY

Next, we need to mount the green ground wire to the metal drain pipe. If your GFCI should malfunction, the ground wire will blow the circuit breaker/fuse, giving you a second layer of protection from electrocution. Strip 4 inches (10 cm) of the outer wiring insulation from the other end of the cord to expose the three wires and then strip about 1 inch (2.5 cm) of insulation from each wire. Use a marker and place a dot about 2 inch (5 cm) up from the threaded end of the metal drain pipe. Make an indentation on your mark so the drill bit will not slide around. Next, use an appropriate sized drill bit for your ground nut and drill a hole at the mark you made, file the hole smooth and thread your ground nut through. From inside the pipe, put the washer on and screw the nut on loosely. Thread the stripped cord through the metal drain pipe and carefully attach the green ground wire to the ground nut on the inside - it's a bit tricky — a pair of pointy needle-nose pliers helps. Screw the wire down tightly.



5: ELEMENT ASSEMBLY AND SEALING

Attach the two remaining black and white wires to the end of the heating element. Screw the wires down tightly. Put the rubber gasket that came with the heating element over the base threads of the element. Take the slip joint nut (but not the gasket) and slide it over the element. The slip joint nut will slide past the element threads and screw on to the metal drain pipe end, forming a perfect fit with the heating element. While holding the element firmly so the wires inside don't twist, screw the slip joint nut down tight. Squeeze both full tubes of JB Weld into a disposable cup. Thin the epoxy with lacquer thinner or acetone to a consistency of house paint so you can pour it. With the stick standing element-end-down, pour the epoxy into the metal drain pipe so it completely covers and encapsulates the element and ground nut electrical contacts. Let the heatstick stand upright for 72 hours. When the epoxy has completely cured, couple the handle to the pipe.

6: WATER TESTING

Before brewing with your new heatstick, water test it. Fill your boil kettle to full depth and with the end cap uncoupled from the handle, immerse the stick — unplugged — into the water. Keep it submerged for at least 30 minutes. Take it out, dry off the outside and tap the stick upside down to see if any water comes out. Use a flashlight to double check for water on the inside. If you have water on the inside, you have a leak and will need to start over. When you're confident it's sealed well, re-connect the end cap, immerse the stick in the water again and plug it in to a GFCI protected outlet. If a leak is present, the GFCI should instantly trip, shutting off the outlet and heatstick. If the GFCI malfunctions, the short on the ground will blow your circuit breaker/fuse. BYO

Converting Brew Pot To Kettle

Story and photos by **Forrest Whitesides**

One of the great things about building your own homebrewing equipment is that you can convert a piece of equipment that you already have into something you find more useful — for example, if you have an extra brewpot, but you could actually use a kettle, you can follow a few simple steps and have the equipment you need, which is great if you don't want to spend money on something brand new.

Modifying an existing aluminum or stainless kettle by adding a valve, thermometer and hop/trub straining screen is not so difficult, and it's cheaper than buying a new kettle with the upgrades included. Plus it will make your brewing life easier. Just imagine feeding your counterflow chiller by simply opening a valve. No more siphoning boiling wort!

round, clean holes that are mostly free of burrs.

For this project, we'll be using weldless kettle fittings. This means we're going to need to drill some holes in the kettle. Drilling metal can be tricky, but it doesn't have to be difficult as long as you have a few essential tools and follow directions carefully. In fact, once you tackle this project, you can use your confidence in metal drilling skills to modify other equipment. For example, if you don't have a brewpot to convert, but perhaps have access to a (legally-obtained) used Sanke keg, you can convert the keg into a kettle as well. (Check out plans for that project on page 25).

The drilling can be difficult, but the fittings are very easy to install. For this project you'll need a Zymico Weldless Kettle Conversion Kit. There are several models available and all of them will work well for this project. You will also need a Blichmann Weldless Brewometer and a Zymico Bazooka Screen.

"Modifying an existing aluminum or stainless kettle by adding a valve, thermometer and hop/trub straining screen is not so difficult, and it's cheaper than buying a new kettle with the upgrades included. Plus it will make your brewing life easier."

I recommend using a step drill bit for this project, although a hole saw (for the ⅞-inch hole) and ½-inch twist bit will suffice. The step drill will be easier to use and makes perfectly

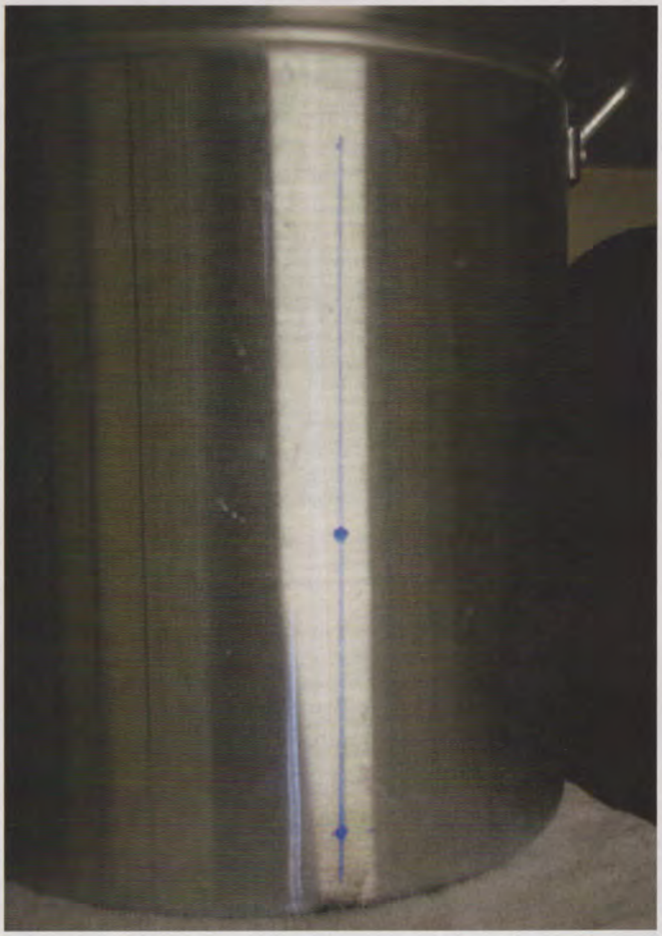
Parts and Tools

Weldless fittings
- Zymico Weldless Kettle Conversion Kit - there are several models available and all will work for this project
- Blichmann Weldless Brewmometer
- Zymico Bazooka Screen

Drilling needs
- A corded drill or a 14.4-V cordless drill
- ⅞-inch step drill bit and a 3/16-inch twist bit
- cutting oil or other lubricant like 3-in-1 Oil for drilling stainless, or liquid dish soap for drilling aluminum
- Metal file
- Adjustable wrench
- Teflon pipe tape
- Permanent marker or grease pencil

1: MEASURE TWICE, DRILL ONCE

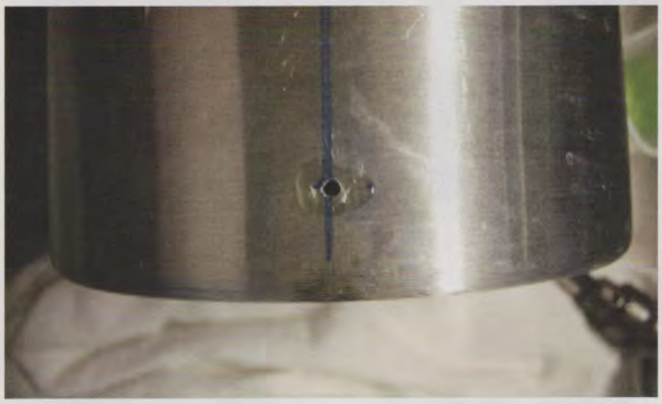
To have the valve and thermometer face 90 degrees from the handles, use a tape measure to find the distance between the kettle's two handles, divide by 2 to find the halfway point, and mark it with a Sharpie or grease pencil. Draw a line from the mark down to the bottom of the kettle. Make one mark on the line about 1.5 in. (3.8 cm) up from the bottom of the kettle and another about 7 in. (18 cm) or higher from the bottom (see photo). The top mark is for the thermometer, which, according to the manufacturer, should be at least 6 in. (15 cm) from the kettle bottom to protect it from the heat of propane burners.



2: DRILLING ALUMINUM

For aluminum, the easier of the two materials to work with (by far), common dish detergent is an excellent drill lubricant. Apply a small amount to the areas on the kettles marked for drilling. Also rub some detergent on the drill bits for good measure. It's a good idea to pre-drill a small pilot hole to get things started. The smallest hole size on the ⅞-inch step drill is 3⁄16 inch, so begin here for the pilot hole. Drill a pilot hole on both marks.

Next, use the step drill to widen the pilot holes to their proper sizes. The bottom hole for the valve should be ⅞ inch. The top hole for the thermometer should be a ½ inch, which is the fifth step on the step drill. Keep drilling until you feel the bit drop down five times. It's a good idea to check the diameter of the hole every couple of steps to make sure the hole doesn't get too big — there are no do-overs once you've drilled too far.



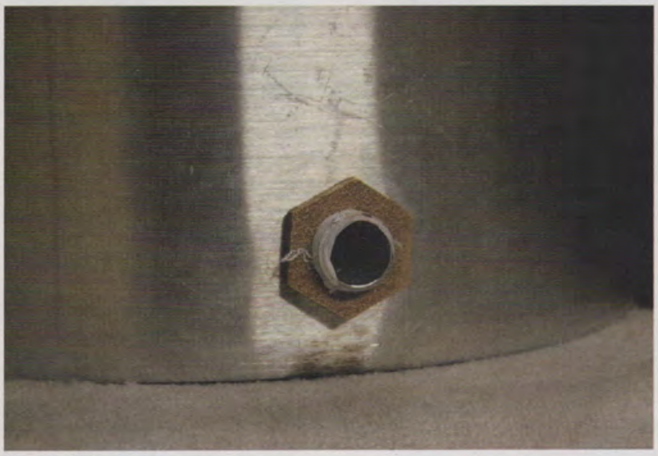
3: DRILLING STAINLESS STEEL

The general toughness of stainless steel makes it a superior material for a brew kettle. This also makes it difficult to drill. As with aluminum, lubricant is needed to facilitate the drilling process. In this case, use either a commercial cutting oil or something like 3-in-1 oil. It is critical not to get the metal too hot. If it gets too hot, the steel hardens and becomes virtually impossible to drill. Use the oil liberally, and reapply as necessary during the drilling process. When you see the oil evaporate in a small puff of white smoke it's time to apply more.

Keep the drill on medium or low speed and use lots of pressure. This, along with the lubricant, will help keep the steel at low temperature while drilling. Because stainless steel is so hard, start out with a really small pilot hole (1⁄16-inch or ⅛-inch) and work it up to 3⁄16-inch. Be aware that small-diameter bits will easily break under the pressure needed to drill through stainless steel. Go slow.

Once the pilot holes are 3⁄16-inch, lube up the step drill and start drilling. Again, use a medium speed and lots of pressure. Follow the same procedure as above for widening the pilot holes.

From here on out, the project steps are the same for either aluminum or stainless steel.

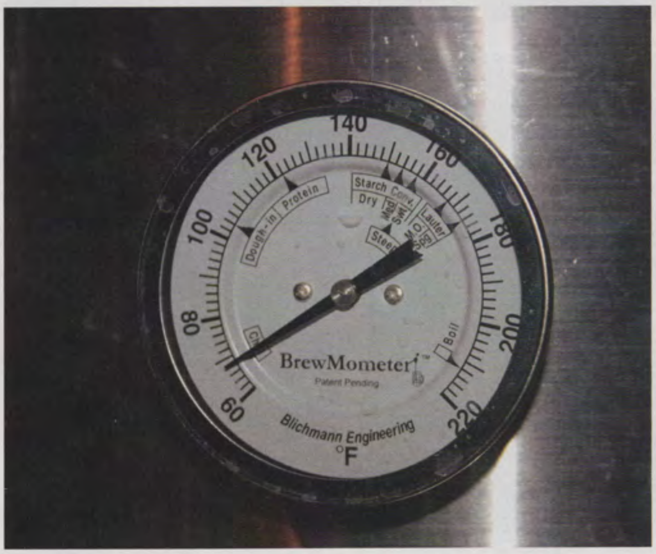


4: SMOOTH OPERATOR

Once both holes are the appropriate sizes, use a metal file to smooth the edges and remove any sharp burrs. A Dremel Tool with the appropriate metal grinding bit also works well. The holes should be smooth inside and out to prevent burrs from damaging the rubber gaskets used in the weldless fittings. Wash the kettle inside and out to remove any lubricant. Next you can move on to installing the ball valve.

5: INSTALLING THE BALL VALVE

Remove the brass nut and rubber gasket from the weldless bulkhead fitting. (Note: the bulkhead comes with two rubber gaskets, but only one is used in installation — the other is a spare). From the inside, put the bulkhead's threaded pipe nipple through the bottom hole. The metal washer should be on the inside. On the outside push the rubber gasket over the pipe nipple and then hand-tighten the brass nut until both it and the gasket are flush with the exterior kettle wall. Be sure that the milled-out side of the nut faces the gasket. Use an adjustable wrench to hold the nut steady and hand-tighten from the inside. Over-tightening can damage the gasket. Apply some Teflon pipe tape to the exposed threads on the outside and screw in the ball valve.



6: INSTALLING THE THERMOMETER

First, calibrate the thermometer following the manufacturer's instructions. The Blichmann Brewmometer dial reads from 60–220 °F (16–104 °C) with several important brewing temperatures marked, making it ideal for use for both boiling wort and mashing and sparging grain.

After calibrating, loosen and remove the thermometer nut. From the outside, put the thermometer stem through the hole. Make sure that the rubber o-ring is seated flush against the kettle wall, followed by the metal washer. Hand-tighten the nut on the inside of the kettle. Use an adjustable wrench on both sides of the thermometer simultaneously to tighten the fitting. Do not turn the dial to tighten. Over-tightening can damage the rubber o-ring. Finally, the Bazooka Screen screws simply into the bulkhead fitting. If the screen is too long, the end can be crimped. BYO

Converting Keg to Kettle

Story and photos by **Forrest Whitesides**

If you've been thinking of making the step up to 10-gallon (38-L) batches, you probably experienced sticker shock after shopping for high-volume brew kettles. A 15-gallon (57-L) stainless steel kettle with a ball valve will cost you upwards of $200, but you can make your own for about half that. You'll need a 15.5-gallon (half-barrel/59-L) Sankey-style keg, a weldless kettle fitting kit and some basic power tools. The end product is commonly referred to as a "keggle," since it is a keg-to-kettle conversion.

But first, a few words about used kegs. If you want a used keg (which I recommend, strictly on a cost-savings basis), the best place to start looking is at brew pubs or craft breweries in your local area, which may have kegs that are a little too dinged up to continue a useful life as pressurized beer containers. These will work fine. You can also order reconditioned or new kegs from vendors like Sabco.

What is NOT cool to do is take a keg from behind a restaurant or keep a keg from a party after paying the deposit. The restaurant or local liquor store is not the owner of the keg — the brewery who filled the keg is the owner. And the deposit does not generally cover the cost of replacing a keg. If you take a keg in either of those ways you're costing the brewery a lot of money and subsequently helping to drive up the cost of high-quality beer. It's also stealing. Get your kegs the right way.

> "If you want a used keg (which I recommend, strictly on a cost-savings basis), the best place to start looking is at brew pubs or craft breweries in your local area . . ."

Safety precautions

Protective eyewear is absolutely required. And given that there are flying, red-hot metal particles involved in this project, I highly recommend safety goggles instead of just glasses. Hearing protection is also recommended. Cutting and grinding metal is very loud and can cause hearing damage. Cheap earplugs will protect your hearing and make the project a lot more comfortable to complete.

Parts and Tools

- 15.5-gallon (half barrel/59-L) Sankey-style keg
- Weldless kettle fitting kit including a bulkhead and ball valve
- Plasma cutter, or an angle or die grinder, or a rotary tool, with metal cutting/grinding wheels
- Power drill with twist and step bits, or a hole saw
- Lubricant (3-in-1 oil)
- Coarse sand paper
- Permanent marker
- Protective goggles
- Ear protection

1: VENT THE KEG

Unless you bought your keg reconditioned, you must bleed off the interior pressure. Even empty kegs aren't really empty, in most cases. There will be a small amount of stale beer and a decent amount of pressure still inside. YOU MUST RELIEVE THE PRESSURE ON THE KEG BEFORE ANY CUTTING OR DRILLING. Failing to follow this guideline could result in serious injury.

My preferred method for safely depressurizing a keg is to lightly tap a small nail between the valve and the rubber bung (see photo). It is advisable to cover the top of the keg with an old towel to prevent a geyser of funky, stale beer from reigning down on you or shooting up in your face. You can also wedge the blade of a flat-head screwdriver between the valve and bung to bleed off the pressure. You can also hook a tap to the keg and just open it . . . that is if you have a tap.

2: MARKING AND CUTTING THE TOP

Use a permanent type marker (a Sharpie, for example) to mark the guideline for the cut. One easy way to do this is to tie one end of a string around the marker and the other end around the center valve on the keg. This low-tech method yields a very nice circle that is pretty close to perfect. If you've got a really steady hand, you can also just lean the marker against the inside edge of the outer rim and run it around the circumference of the keg. A common diameter for the opening on a keggle is about 12 inches (30.5 cm). This is totally a personal preference.

For doing the actual cutting, you have a few options. The most elegant choice is a plasma cutter. If you know someone who owns one of these, this is the best way to cut a super smooth opening with minimal fuss. If this isn't an option (which is the case for most of us), you can also use an angle or die grinder or various types of rotary tools. The smaller the diameter of the cutting/grinding wheel, the smoother a cut you can make. The tradeoff is that smaller wheels also take longer to do the cutting. In my tests the Dremel (with a 1.5-inch wheel) took about three to four times as long to cut the same distance as the RotoZip (with a 3.5-inch wheel), but the resulting edge was smoother and required less grinding and filing to make it safe for human contact. Either tool did an adequate job, however.

Expect to use two or three of the RotoZip wheels and six or more of the Dremel wheels to complete the cut. Buy double what you think you'll need, just in case.

3: REMOVING THE TOP

Once you've got the top out (see photo), you should smooth out the rough edges around the opening. Take extra care during this step, as the steel will be very sharp. I used an angle grinder as a first step to wear down the edge. I followed this up with a finer grinding stone attachment on my Dremel and some manual sanding with very coarse sand paper on a sanding block. My resulting edge in these photos, while not the prettiest in the world, is smooth to the touch and safe for general brewing use.

4: ADDING THE BALL VALVE

Now we're going to add a weldless bulkhead and ball valve to round out the keggle. If you plan to go with a welded connection, you can skip this section and consult with the welder. Most homebrewing gear uses ½-inch threaded fittings, so make sure you standardize on that when welding.

Several homebrew suppliers offer weldless kits that include the bulkhead and the ball valve. I opted to use Norther Brewer's bulkhead-only kit (catalog #7551) and a Blichmann 3-piece stainless steel ball valve (available from many suppliers). I chose this combination because all of the parts that touch the wort/beer are stainless steel, and the Blichmann valve can be broken down for cleaning. You can use any bulkhead setup or ball valve you like.

For a ½-inch bulkhead, you'll generally need a ⅞-inch hole. However, you should always follow the manufacturer's instructions, so if their guidelines give a size other than ⅞ of an inch, go with what is stated in the instructions.

Mark the spot for drilling a couple inches up from the bottom seam of the keg. The inside bottom of a keg is sloped, so the closer to the bottom you drill, the more of an angle your valve will sit at when attached. Each type and shape of keg varies as to the degree of slope, so make sure you don't drill the hole too low. In my experience, it's better to go a little too high than too low, because you can make up for a high valve with a dip tube.

5: DRILLING THE KEG

Drilling stainless steel can be frustrating sometimes, to say the least. The approach I take is to use a center punch to mark the initial hole, then use a ⅛-inch twist bit to make a pilot hole, and then widen the hole up to the proper diameter with a step bit (Figure 4). You can get inexpensive step bits from Harbor Freight and most big-box auto parts stores such as AutoZone.

The keys to drilling stainless steel are: use lubricant (3-in-1 oil works fine), drill at slow to medium speed, and use a lot of pressure. Lubricant is very important when drilling stainless steel, as it is critical not to get the metal too hot. If it gets too hot, the steel will harden and become virtually impossible to work with. Use the oil liberally, and reapply as necessary during the drilling process. You'll know it's time to apply more when you see the oil evaporate in a small puff of white smoke. At that point, stop drilling and apply more oil.

6: INSTALL THE BULKHEAD

Follow the manufacturer's instructions for installing the bulkhead fitting and then attach the ball valve. At this point, you could either add a hose barb fitting to the ball valve or connect more complex plumbing, depending on your brewery setup. Once you've done all the cutting, grinding, drilling, and filing, the inside of the keg is going to be nasty. Rinse it thoroughly with water to remove all of the drilling lubricant and metal filings. Follow up with an overnight soak in warm water and Powdered Brewery Wash (PBW). Rinse thoroughly, and you're ready to brew. BYO

BOTTLING & KEGGING

Counterpressure Bottle Filler

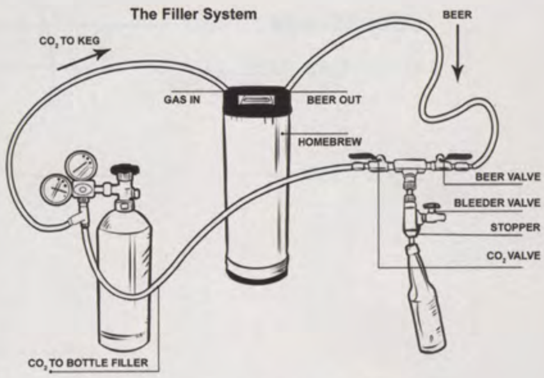
Story by **Tom Fuller** Illustrations by **Chris Champine**

Kegging is convenient. it eliminates the bottling process, and cuts out days of carbonating time. When you bring a keg to a friend's house, however, you're bringing a lot of beer. The more beer you bring, the more beer the friends drink. You may never get a full glass for yourself. These are the times that call for bottles.

You can try the tube in the faucet thing to fill a few bottles, but in a few hours it's just not the same beer. The mouthfeel is wrong, the head dissipates, and the carbonation is nil.

Using a counterpressure filler, you can achieve a perfect fill with no oxidation (wet cardboard flavor) and little or no loss of carbonation. This is a closed, keg-to-bottle filling system. With the right filler, you can eliminate oxidation and retain at least 80 percent of original carbonation.

The idea is to fill the bottle while keeping the carbon dioxide in solution. Filling straight from the faucet would cause foaming and result in CO_2 coming out of solution. Under pressure a controlled rate of flow can be achieved to eliminate or cause very little foaming, retaining much of the CO_2 in solution. The bottle is equalized to the pressure of the keg. This will not allow the beer to flow. You release this pressure slowly so the bottle will fill at a controlled rate. The bottle can also be purged of oxygen, thus reducing chance of oxidation.



Here are two easy fillers to construct: a two-handled model and a three-handed model. The two-handed model has no bleed valve. The purging of oxygen and release of CO_2 are achieved through squeezing the rubber stopper. This model is simpler to construct yet not quite as efficient as the three-handed, bleeder-valve model. With the bleeder-valve model you can achieve a much slower fill resulting in less foam and more CO_2 retained in solution.

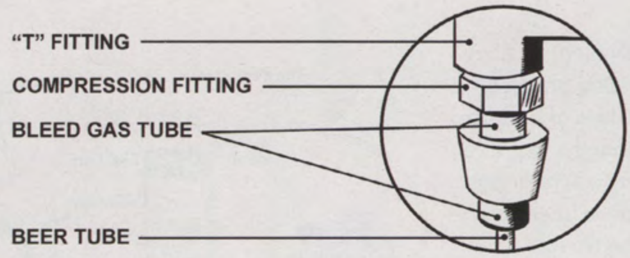
Parts and Tools

To build the two-handed model:

- (2) ¼-inch pipe-thread ball valves
- (1) ¼-inch pipe-thread female T
- (2) ¼-inch pipe-thread nipples
- (1) ⅜-inch compression fitting with ¼-inch male pipe thread
- (2) ¼-inch male pipe thread hose barbs (barb size to fit your tubing)
- (1) #2 rubber stopper
- (1) ⅜-inch brass tube (about 16 inches in length)
- (2) small hose clamps
- Teflon plumbers tape

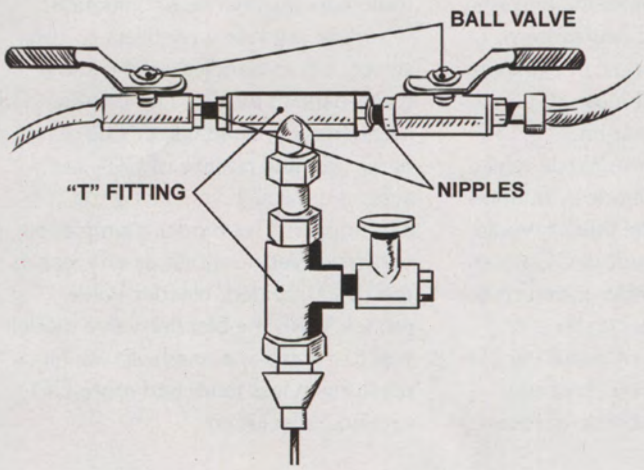
To build the three-handed model:

- (2) ¼-inch pipe-thread ball valves
- (1) ¼-inch pipe-thread needle valve
- (1) ¼-inch pipe-thread female T
- (3) pipe-thread nipples
- (1) ⅜-inch compression fitting with ¼-inch male pipe thread
- (2) ¼-inch compression fitting with ¼-inch male pipe thread
- (2) ¼-inch male pipe thread hose barbs (barb size to fit your tubing)
- (1) #2 rubber stopper
- (1) 4-inch length of ⅜-inch brass tubing
- (1) 16-inch length of ¼-inch brass tubing
- (2) small hose clamps
- Teflon plumbers tape



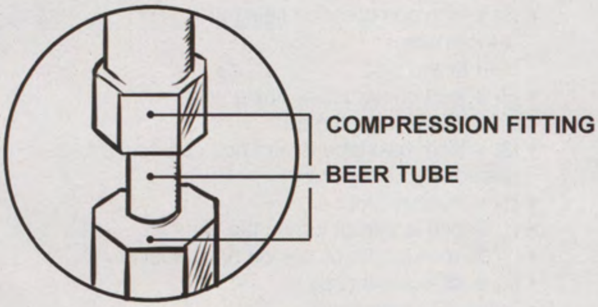
1: THE TWO-HANDED MODEL

Start by wrapping the nipples with a length of Teflon tape and thread into the T. You may set up the filler either with a valve on top and side or both sides (see diagram). It works well using the top and side with the top being the beer valve. That way the beer doesn't have to turn corners and this straight line of travel may create less foam.



2: THREADING

Thread the hose barbs onto the valve ends and the valves to the nipples, being sure to wrap Teflon tape on all threads. Put the brass tubing into the compression fitting and tighten down. Now, thread the compression fitting into the leftover opening on the T.



3: FINISH

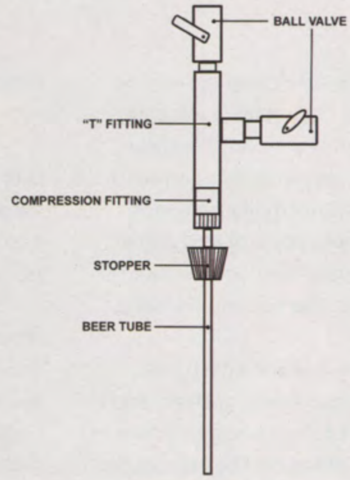
Slide on the rubber stopper and insert the filler into the largest bottle you plan to fill. For proper fill, the tube should be about ¼-inch from the bottom of the bottle. You may need to cut some length from the tubing to get the proper length. Finally, attach your plastic tubing to the hose barbs with the clamps and your filler is ready for CO_2 hookup and beer.

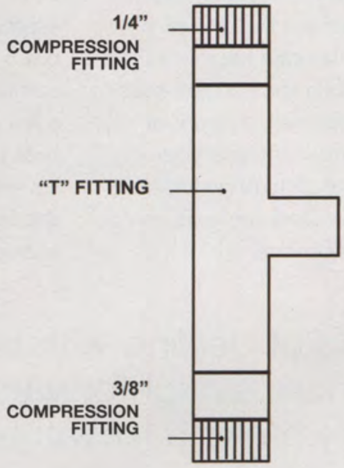
4: THE THREE-HANDED MODEL

Start by wrapping the nipples with a length of Teflon tape and thread into the T. You may set up the filler either with a valve on top and side or both sides (see T with valves diagram). Next, thread the valves onto the nipples, being sure to wrap Teflon tape on all nipple threads. Then thread the hose barbs onto the valve ends

Now, put the ¼-inch brass tubing into the ¼-inch compression fitting and tighten down. Thread the compression fitting into the leftover opening on the T. Then thread the ¼-inch compression fitting into one end of the T and the ⅜ fitting into the other end. The compression fitting should be on opposite ends so you can see through one out the other.

Two-Handed Model





5: BLEEDER ASSEMBLY

Thread the remaining nipple into the remaining opening on the T. Next, thread the needle valve onto the nipple. Insert the ⅜-inch tubing into the ⅜-inch compression fitting and tighten down. Slide this "bleeder assembly," ¼-inch compression fitting first, onto the ¼ tubing until it meets the other ¼-inch compression fitting. Tighten the fitting.

6: FINISH AND CONFIGURE

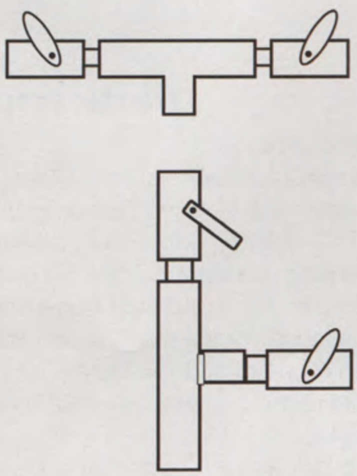
Slide the rubber stopper on the ⅜-inch tubing and insert the filler into the largest bottle you plan to fill. The tube for proper fill should be about a ¼-inch from the bottom of the bottling to get the proper length. You may also want to cut down the bleeder tube, as it only needs to extend about a ¼-inch beyond the stopper.

Now that you've got your filler, it's time to use it. The hook up is quite simple, requiring little or no extra parts depending upon your current kegging configuration. You will need a T fitting and beer-out quick disconnects, the size of which depends on your own setup.

What you do with these fillers (see the main diagram on page 29) is connect the gas-in directly to the CO_2 via the T on your regulator. The beer line goes to the keg-out. The setup is the same on both units.

(For more information about using a counterpressure bottle filler, go to www.byo.com/component/resource/article/509) BYO

T With Valves



Portable Kegerator

Story and photos by **Forrest Whitesides**

Adding a kegging system to your homebrew setup is often a welcome addition (and relief) to brewers. You can save time that would normally be spent bottling, precisely control and adjust carbonation levels, and you do not need to wait on the natural carbonation process.

The problem arises when you want to take your finely crafted draft beer on the road. You need to either use a counter-pressure filler to bottle from the kegs (see the previous project in this section), or you can simply fill a growler from the tap and then consume the beer quickly (the carbonation is hard to maintain for more than a few hours). While the counter-pressure filler is a great tool, it deprives you and those who consume your beer of the true draft experience and it requires the use (and subsequent cleaning) of glass bottles.

> "Instead of dealing with bottle fillers and irksome bottling tasks, a more straighforward approach to transporting draft beer is to simply make a miniature version of your kegerator . . ."

Instead of dealing with bottle fillers and irksome bottling tasks, a more straightforward approach to transporting draft beer is to simply make a miniature version of your kegerator and take it with you to picnics, camping trips, parties, etc.

I stayed with a single-keg setup, as this is simpler and less costly than a two-keg setup. The same principles apply, so just scale up if you want to go with multiple kegs.

Also, I built this project in two different sizes — the first with a 70-qt (66-L) rolling picnic cooler, and the second with a 5-gallon (19-L) round cooler. The larger version includes a draft tower. Any big temperature differential between dispensing hardware and beer will cause foaming, and this can happen with this cooler build, especially if the tower is warm. This is not a huge deal if you are using undercarbonated beer. However, if you're in a hot environment, the tower will heat up as it's not in contact with the ice in the cooler and all the metal that the beer comes in contact with will change the beer temperature, causing the CO_2 to come out of solution until the shank or faucet cools down. Therefore, it might take pouring up to two or three pints to settle down. Just keep that in mind.

Parts and Tools

- 3-gallon (11-L) keg
- Igloo Ice Cube Maxcold 70-qt. (66-L) roller picnic cooler or 5-gallon (19-L) round Gott or Igloo cooler
- 5-lb CO_2 cylinder, or one Genuine Innovations CO_2 charger
- Dispensing hardware (For the big cooler, I used a Perlick single-faucet draft tower. I used a 3-inch faucet shank from Northern Brewer and a cheap faucet for the round cooler. You can choose other hardware based on your needs and taste).
- 10 feet (3 m) food-safe beverage tubing
- Keg lube
- Power drill with a hole saw bit and a spade bit

1: KEG

The best keg size for this project is 3 gallons (11 L), although 2.5-gallon (9.5-L) kegs can work as well. Both sizes have the same diameter as their larger 5-gallon (19-L) cousins, but they are about 8 inches (20 cm) shorter. Because of the relatively small number of 3-gallon (11-L) kegs in circulation, buying new is generally only a few dollars more than buying used. The typical cost of a new 3-gallon (11-L) keg is around $100; used is around $85. For the extra $15 to $20, I'd recommend going with a new keg that you can be sure holds pressure and is clean.

I have two 3-gallon (11-L) kegs, one of which has the traditional hard rubber handles on the top, and the other which has no rubber on top and a single stainless steel handle. They are both the same height overall at the highest point (about 16.5 inches) but the one without the rubber handles is a bit easier to fit into small spaces, including the round cooler, because it is shorter and narrower around the outer top edges. The rubber-handle keg with the vinyl graphic Kegwrapz was graciously donated by Final Gravity Podcast (www.finalgravitypodcast.com).

2: COOLER, CO_2 SOURCE AND DISPENSING HARDWARE

For the CO_2 source, you have two options: a small cylinder or a mini "keg charger" that uses small CO_2 cartridges. The keg charger is cheaper and smaller, but it does not provide a way to monitor or regulate the pressure in the keg. For cylinders, you can choose a 2.5-pound or 5-pound cylinder.

For the dispensing hardware, there are two options as well: a through-wall faucet shank or a draft tower. The choice will come down to a combination of cost and space available in the cooler. Get your cooler first and then measure before you buy your dispensing hardware.

You will also need a set of disconnects (gas and liquid) for the keg. If you plan to use the keg charger to push the beer, you must make sure that the gas-in disconnect has the MFL-style tubing connector, as this is what the charger threads into directly. Do not get the barb-style gas disconnect.

3: INSTALLING THE TOWER

For installing the tower, mark off where you want it centered on the cooler lid and then drill the center hole for the beer line. Some towers have a short ⅞-inch shank at the end of metal tubing, while others have 3/16-inch ID tubing. A hole saw works great for the larger hole, while a spade bit is great for the smaller diameter. Fit the tower over the center hole and drop the beverage tubing through. Now mark the holes for the retaining/mounting bolts (the tower likely has four such holes), remove the tower, and drill the mounting bolt holes. My tower took #10–24 sheet metal screws, but yours may vary. I also added neoprene and metal washers on the inside, but this is almost certainly not necessary. The nuts alone will grip the semi-soft lid material adequately.

4: SHANK

If you want to go through the side of the cooler, use a $\frac{7}{8}$-inch hole saw to make an opening that's just the right size for a faucet shank. Before drilling, put the keg (and cylinder, if applicable) in the cooler and dry fit the shank to make sure it will clear the top of the keg. A short shank (3 inches/8 cm is a good length for the round cooler) will have enough clearance to allow inserting and removing the keg without having to first remove the shank.

5: CONNECT AND TEST

Now that the dispensing hardware is fitted, you can connect all the tubing and get ready for a test run. Put the keg and CO_2 source in the cooler and attach the disconnects. NOTE: If you are using the keg charger, thread it to the gas-in disconnect but make sure you do not have a cylinder in the chamber. You are just adjusting the position of the charger and you do not want to have the charger loaded for this. Now, connect the rest of the tubing to liquid-out and gas-in sides. Like any kegging system, the right amount of line resistance is required to keep the beer from foaming too much as it is dispensed. Shoot for around 8–10 feet (2–3 m) of beverage tubing and then adjust as necessary. Close the cooler lid and make sure it fully and securely closes. If it does not, rearrange the tubing or move the position of the keg and CO_2 source to help the lid close more securely. If you still can't get the lid closed all the way, you may need to cut out part of the lid (see photo).

6: FINISHING UP

The Ice Cube cooler has a ton of room inside, so spacing should not be an issue. Since there was space, I went ahead with a 5-lb CO_2 cylinder. There is still plenty of room for ice as well as bottled water, soda, or packaged food. I've also seen other homebrewers fit two 3-gallon (11-L) kegs in an Ice Cube cooler, so that is also an option. If you go with a single keg, you'll want to load the cooler with ice or cold packs to keep things from shifting. The round cooler makes for a more compact option, and if you go with a shank it is by far the cheaper of the two projects, but it does have drawbacks. Unless you mount a small cylinder outside the cooler, the only thing that will fit inside is the tiny keg charger, and there is not much room left for ice. Additionally, you will likely have to cut out a portion of the lid, which will reduce the insulating properties of the lid. This may require the addition of additional insulation material to prolong the life of the small amount of ice the cooler can hold. BYO

Rebuild A Keg, Build A Spunding Valve

by **Ralph Allison & Marc Martin**

Used Cornelius style kegs are widely available at reasonable prices. A considerable amount of money can be saved if you buy kegs that have not been worked on in any way and rebuild them yourself. This keg reconditioning process requires nothing but a little time, a limited amount of mechanical skills and most of the tools you need should be in every kegger's tool kit.

For those who either do not have the time, or do not want to go to the trouble, new Corny kegs are available. New kegs usually cost more than $100, but they are shiny, dent-free and their rubber gaskets and O-rings don't carry any off flavors or odors. Also, their poppet valves will not need to be replaced for some time. Reconditioned used kegs are also available, with typical prices starting around $35. When comparing prices between vendors, be sure to check on what has been done to the keg to recondition it. At a bare minimum, kegs should be pressure tested. Some sellers will also replace the O-rings and clean the keg. Others will additionally disassemble the keg, clean the dip tube and inspect and replace faulty poppet valves. In practical use, a fully reconditioned keg will work as well as a brand new one.

Optionally, you can also build a keg spunding valve for your rebuilt keg. The instructions for that project begin on page 37.

> "This keg reconditioning process requires nothing but a little time, a limited amount of mechanical skills and most of the tools you need should be in every kegger's tool kit."

Parts and Tools

For keg rebuilding:
- 5-gallon (19-L) used Cornelius keg
- Keg rebuilding kit that includes O-ring gaskets for Cornelius kegs
- 3/8-inch d rive ratchet wrench either an 11/16-inch or 7/8-inch-deep socket a small jeweler's type screwdriver
- Pressure gauge
- Powdered Brewery Wash (PBW) and/or Bar Keeper's Friend cleanser
- Small (about 1-inch) paintbrush, or a spray bottle
- Food grade lubricant
- Soft nylon cleaning pads or sponges (anything that will not scratch stainless steel)
- Star San, iodophor or similar sanitizer (no bleach)

For spunding valve:
- Brass Y adapter and brass coupler
- Pressure relief valve (the one I used is made by the Schrader Bellows Co. in Akron, Ohio. The part number is RV01A1N030SB)
- 0-30 PSI gauge

REBUILDING A KEG

1: CLEAN AND DISASSEMBLE THE KEG

Before you start, clean the exterior of the keg thoroughly with either Powdered Brewery Wash or Barkeeper's Friend with a scrub pad that will not scratch. Before starting disassembly, relieve any pressure in the keg by either lifting the relief valve or depressing the poppet valve on the top of the post with a small tool that will not damage the poppet.

Once the pressure is relieved, remove the keg cover by lifting the latching lever then lowering the cover into the opening and turning it slightly to align it. Remove and discard the lid O-ring. You will need a 3/8-inch drive ratchet wrench and either an 11/16-inch or 7/8-inch-deep socket to remove the posts. Some posts are eight sided and others twelve sided, so I suggest buying twelve point sockets in both sizes. Unless you are certain what type of socket you need for your keg, it is a good idea to bring the posts (or the whole keg) with you when you go to the hardware store. On one side of each of the handles on top of the keg on the "gas in" side, it will have "in" markings. Take a look at that post so you are sure to install it in the right place during re-assembly as there is a small difference in size.

2: REASSEMBLE

Once the posts have been removed, pry the O-rings high enough to be able to slip them off the posts and discard.

Next, remove the dip tubes. You will notice the gas-in dip tube is short, and the liquid-out is long. The liquid-out tube is either straight or curved. Stick your hand through the opening and push up on each tube. Once you have both tubes removed slip the O-rings off them and discard.

Next clean the inside of the keg with your cleanser and clean the cover, posts and dip tube. Then put the cover, posts and dip tubes in the keg. Turn the keg upside down and let it drain and dry. Now you will spread a small film of food-grade lubricant on each O-ring. First, lubricate and install the dip tube O-rings and insert the dip tubes in the proper holes. Next, install the posts and tighten. Lubricate the post O-rings, and install them in the post grooves. Lubricate the large O-ring and fit it onto the lid. Install the lid and latch it.

3: TEST FOR PRESSURE

Connect the "gas in" disconnect to the "gas in" port and pressurize the keg to 12 PSI. Add a couple of teaspoons of dishwashing detergent to some tap water. Use a small (about 1-inch) paintbrush, or a spray bottle, and liberally apply the detergent mixture to all of the gas fittings, connections and around the keg cover. If there are any leaks, you will see bubbles. If leaks are found, check the connections to make sure they are tight. When there are no leaks, pressurize the keg again to 12 PSI, and let it sit for a day. Use a pressure gauge attached to the "gas in" connector to monitor the pressure. If the keg maintained pressure, you are ready to sanitize it (with a non-chlorine-based sanitizer. Chlorine can cause pitting on stainless steel).

SPUNDING VALVE

With a spunding valve, you can retain the carbon dioxide of late fermentation to naturally carbonate your homebrew.

1: VALVE BUILD

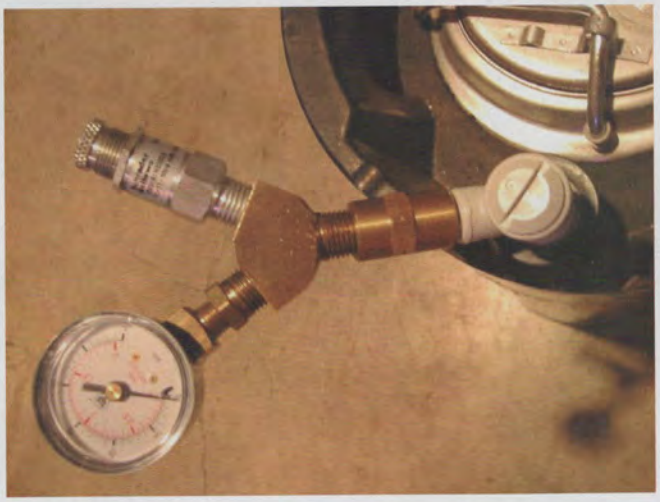
Having brewed on some large scale and pilot systems in breweries around the Portland, Oregon area, I have been able to pick up some tricks that can be readily adapted to homebrewing. One of these techniques is the capping of a bright tank for the retention of carbon dioxide (CO_2) produced late in fermentation. This produces naturally carbonated beer. For homebrewers, the most logical vessel for a sealed secondary fermenter is the Cornelius keg. The challenge becomes how to retain enough carbon dioxide pressure to provide for the right level of natural carbonation, but to vent any excess pressure.

Nine years ago, I sought to solve this problem. The best way I found was to build a version of the valve and gauge system, called a spunding valve, that is used in large commercial systems. An adjustable pressure relief valve and a 0–30 PSI gauge are the main two things needed. To connect these to the inlet side of a Corny keg, I used a brass Y adapter (one MPT "in" side and two FTP "out" sides), a standard ball lock fitting and a brass coupler (FTP on both ends) to connect the ball lock fitting to the Y adapter. All threads use plumbers pipe fitting tape to prevent leakage.

2: USING THE VALVE

To create your own naturally carbonated homebrew, simply transfer your beer into a sanitized Corny keg when your beer is 2-5 points above your estimated terminal gravity. For example, if your yeast is 80% attenuative and your starting gravity was 1.050, your target final gravity is 1.010. Thus, you should transfer your beer when a reading of about 1.015 is achieved. Place your pressure relief valve and gauge on the inlet tube side of your keg and keep the keg at normal fermentation temperatures. Check it daily and watch the pressure in the keg build.

To calibrate the adjustable pressure relief valve, you only need to monitor the pressure gauge. When it slightly exceeds your desired carbonation pressure (I generally shoot for 14 PSI), turn the top adjuster counter clockwise until pressure just starts to bleed off. Watch the gauge and when 14 PSI is indicated turn the adjuster back in (clockwise) until the pressure stops escaping.



3: MONITOR

After four or five days, turn the relief valve adjuster back in (clockwise) ½ turn and monitor the gauge for another day. If the pressure does not increase, you know that all secondary fermentation has ceased and the proper carbonation level has been retained.

An added bonus of using a spunding valve is that you need not transfer your beer again. It is well carbonated and ready to chill. Your secondary fermenter also doubles as your serving tank. BYO

CHILLING

Counterflow Wort Chiller

Story and photos by **Reg Pope**

Homebrewers all want to cool wort quickly after the boil. Wort needs to be cooled to a temperature at which the yeast can be safely pitched. Quick cooling also helps with cold break formation and - when some very light base malts are used — helps minimize the production of dimethyl sulfide (DMS). In addition, moving the wort quickly through the 160–120 °F (71–49 °C) range ensures that contaminating organisms have a smaller chance to gain a foothold at these temperatures that are favorable to their growth.

A clean and simple method is to use an immersion chiller. These devices are popular with homebrewers, but their capacity is a bit limited. The key consideration is volume.

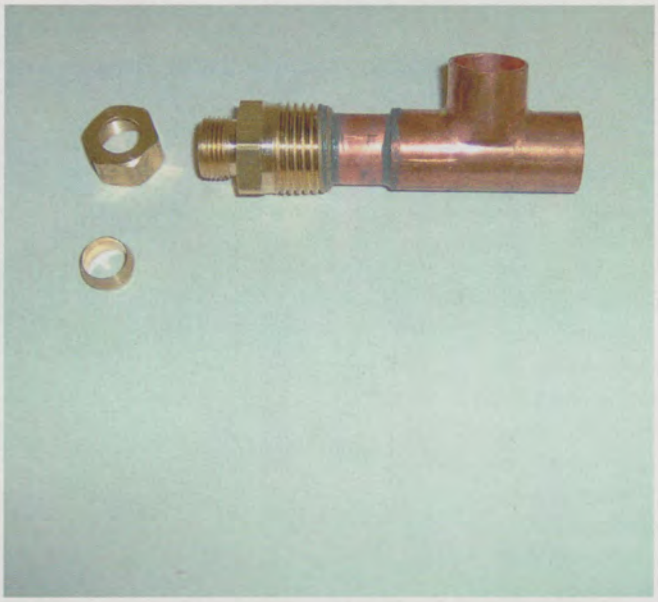
Using the algebraic formula (πr2h) for the volume of a cylinder — which is what a tube is, a long thin cylinder — a ⅜-inch (95 mm) x 25 foot (7.6 m) immersion coil has 32 cubic inches (537 cubic centimeters) of volume, equivalent to a little over a pint of liquid. That's the amount of wort the chiller displaces and the volume of cooling medium available to do work (move heat out of the wort) during chilling. So, the wort next to this "pint of coldness" is what's being chilled.

You can stir the wort, to get it flowing past the coils, but this takes hands-on effort during wort cooling. Also, opening the brew kettle to stir it with the chiller can allow airborne microorganisms to settle in your wort when it is in a temperature range favorable to their growth. And, if you are worried about aerating your wort while it's hot, you may shy away from swirling your immersion chiller.

What if you could take the volume of wort in contact with the chiller and turn it over at a constant rate? And what if you could take the water and replace it with fresh, cool water at a constant rate as well? This is the theory behind the counterflow chiller. The word "counterflow" describes the flow pattern of the water and wort relative to each other. The wort entry point is at the water exit and the water entry point is at the wort exit, so the two liquids move past each other in opposite directions. The warmest wort encounters the warmest water at the beginning of its residence in the chiller, and meets the coldest water at its lowest temperature as it exits. The hot wort encounters progressively cooler conditions and it travels through the chiller and continually transfers heat to the cooling water. The cooling water is common tap water and the water and wort never come in direct contact with each other. The wort touches only copper and remains enclosed inside a tube so there is no risk of the aeration or contamination.

Parts and Tools

- (2) ½-inch copper tee
- (2) ½-inch threaded x ⅜-inch compression fitting (6 inches or 15 cm)
- ½-inch rigid copper tubing
- (25 feet) ⅜-inch OD copper tubing
- (25 feet) ⅝-inch garden hose
- (4) ½-inch hose clamps
- Tubing cutter
- JB Weld
- Utility knife
- Screwdriver
- Drill and ⅜-inch drill bit



1: CONSTRUCTING THE COPPER TEES

The chiller is a basic "tube within a tube" design. The key to its function is the fitting that allows connection of the input and output hoses and tubes, and connects and seals all of the components of the wort reservoir and cooling jacket. Construction begins with the copper tees, the threaded/compression fittings and a small length of ½-inch (1.3-cm) rigid copper tubing to connect them.

When I purchased my supplies, the rigid tubing was available in a minimum length of 24 inches (61 cm), however only three inches is needed, two lengths of 1½-inch (3.8 cm). These were cut to length using the tubing cutter.

Dry fit the pieces in case any burrs or rough cuts prevent them from going together easily, and file them if necessary. Mix the JB Weld according to the manufacturer's directions. Assemble the fitting, using a generous amount of JB Weld to secure the parts. Once assembled, allow these fittings to dry and set overnight at a minimum.

2: THE TUBE WITHIN THE TUBE

The next step is to insert the copper tubing into the garden hose. Cut off the ends of the hose, taking the last six or eight inches of the hose and the fittings, and save them.

Lay out the hose in as straight a line as possible. Uncoil the ⅜-inch tubing and straighten it as much as possible as well. These items want to hold a curl and it will be impossible to get them completely straight. However, the straighter you can make them, the easier the next step will be (see photo at left).

3: INSERT THE TUBING

You will probably need some kind of lubricant to insert the copper tube into the hose, and dishwashing detergent works well. Squirt an ounce or so of dishwashing liquid into one end of the garden hose. (If the soap is really thick, add a little water as well.) Insert the end of the ⅜-inch copper tubing into the lubricated end of the garden hose and continue feeding it in until it extends out either end of the hose a few inches.

4: COILING YOUR CHILLER

The next step is to shape the cooler. I recommend taking the time to do it neatly. Commercial chillers are arranged in a nice, neat, stacked coil for a reason. First of all, it looks nicer. Second, it ensures a trouble free gravity drain. A sloppy coil will result in some parts of the tube being higher than others as the fluid travels around the loop. This will cause fluid to be trapped in the coil when the resistance of its weight exceeds the weight of the fluid behind it. In other words, it will stop draining before it's empty. It may be a small amount of fluid, but it is still a waste. In addition, there is the potential for contamination associated with poor drainage of wort and water when cleaning the unit.

An empty Cornelius keg is the perfect size to use as the form. Place it near one end of the hose and begin wrapping it around the keg in a spooling fashion. The curve of the keg is not so severe that it will readily cause kinking of the copper tubing, and the hose will act as a sort of protective sleeve during this step, but proceed with care just in case. Hold on to the end of the copper tube to keep it from sliding into the hose and out of reach. When finished, simply slide the keg out of the middle of the coil. There will inevitably be some movement of the tubing inside the hose during coiling, trim the hose and/or tubing so that there is 5 or 6 inches (13 or 15 cm) of tubing protruding from each end of the hose. (This step can be seen in the upper right hand corner of page 39.)

5: REAMING THE FITTING

The end fitting fabricated earlier is made up partially from a fitting that is designed to rest at the end of a length of ⅜-inch copper tubing and has a small lip of material that facilitates that by providing a "butting" surface. We need this fitting to "float" over our tubing, so that lip must be removed. This is accomplished by simply reaming out the fitting with a drill and ⅜-inch bit.

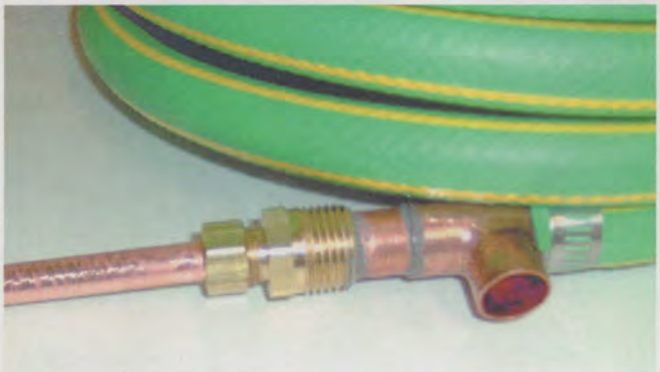
6: AFFIXING THE FITTINGS

Once this is done, the fittings can slide into place over the ends of the copper tubing and into the ends of the hose. Remove the end nut and the sealing bushing from the compression fitting — and don't forget to place the hose clamps on the hose before attaching the fitting.

A bit of liquid soap and some elbow grease will be required to get the end of the fitting (tee side) into the end of the hose. Once this is done, position and tighten the clamp (see photo).

Attach the reserved hose ends in the same manner and apply clamps to complete the assembly. Up until now there was no top or bottom to the unit. Be mindful of your flow pattern now as you attach the hose ends. The wort will flow via gravity from the top copper tubing access to the bottom one. The water must flow in the opposite direction. Thus the female hose fitting must be at the bottom and the male fitting at the top.

The assembly is now complete. The coil will hold its shape on its own but Zip ties can be used for this as well. BYO



Recirculating Wort Chiller

Story and photos by **Forrest Whitesides**

Given that there are so many places in the world where fresh, potable water is a scarcity, my personal philosophy is that the least we can do as enthusiasts of a water-intensive hobby is minimize water usage while brewing. One obvious place to start looking for water usage inefficiencies is the wort chilling process.

This chiller project, which turns a typical immersion chiller (the biggest offender in terms of waste water) into a water-recirculating chiller, can be a big help in warmer climates with warm ground water, and is also useful for reducing water usage.

I've been using a plate chiller for some time, which is efficient in terms of water consumption. However, I had growing concerns about properly sanitizing homebrew-sized plate chillers, and I started looking for an alternative. In my search, I admired a very clever pump-driven "whirlpool" chiller design by *BYO* contributor Jamil Zainasheff, but I didn't like the idea part of the design, which required pumping the wort around for 15 minutes while it's still hot. Instead, I considered recirculating the chilling water instead of the wort, a design change that would save a lot of water while using a cheap pump.

This project is a similar concept to using ice banks, which have been used in larger breweries for years. In these systems, cold water or glycol is frozen in large reservoir tanks. This allows the breweries to even out the cooling load and have much smaller compressors, saving money.

This recirculating chiller project is built on three main components: a submersible or in-line pump, a standard coiled-copper immersion chiller, and a cold water reservoir (a plastic bucket or cooler). The reservoir is filled with water and ice. The pump is submersed in the reservoir and the other end is attached to the input side of the immersion chiller (which sits in the kettle, as normal). The output side of the immersion chiller is connected via tubing back to the reservoir, completing the circuit. It is simple to use, efficiently chills — and is great for saving water!

"This project is a similar concept to using ice banks, which have been used in larger breweries for years. In these systems, cold water or glycol is frozen in large reservoir tanks."

Parts and Tools

- A standard coiled-copper immersion chiller
- A cold water reservoir (plastic bucket or cooler)
- Submersible pump, such as a March model 809 impeller pump
- 2 to 4 feet of ½-inch food-safe, heat resistant vinyl tubing
- ⅜-inch brass hose fittings (depending on your chiller), including a female NPT hose barb fitting

1: ASSEMBLE THE PARTS

Other than a decent pump, all you need for this project is an immersion chiller, either a bucket or cooler (5-gallon/19-L capacity works fine), some vinyl tubing, and a few brass plumbing fittings to help connect everything. The most common type of immersion chiller is made from ⅜-inch copper tubing, but ½-inch copper will work as well.

2: PUMP SELECTION

If you already have a March model 809 impeller pump (as many homebrewers do), you can skip to the next section.

You need a pump that has an operating head pressure rating that exceeds that of the total head pressure exerted by the recirculating system itself (read on for a method to estimate system head pressure). This rating is given in inches or feet of head pressure, which in the broadest sense is any resistance exerted on the pump, be it gravity or other flow impediments like small-diameter system tubing, also known as friction loss. Head pressure is not just how high the fluid must be pumped and includes several other factors (read on). Head pressure is just as important as flow rate when selecting a pump.

To arrive at the approximate operating head pressure of your system, use this formula: System Head Pressure = A + (B / 10) + (C / 2) + (D / 4), where "A" is the vertical height in feet between the water level in the reservoir and the input connection of the chiller, "B" is the total distance in feet of the system (vinyl tubing plus chiller coils), "C" is the number of 90-degree bends in the system, and "D" is the number of miscellaneous adapters and plumbing fittings. All of those things are a factor in how much resistance the pump must overcome to move the water.

Note: The above equation assumes the use of tubing that is in the general range diameter as would be found in typical homebrewing setups (see below for more on how diameter effects flow rate). It will be fairly accurate for tubing from about ⅜ inches to ¾ inches in diameter. Another assumption is that the tubing is smooth on the inside and not convoluted or corrugated.

3: COOLING RESERVOIR

To operate your chiller, get your bucket or cooler of chiller water ready. A bucket will work fine, but a cooler will help the water stay cold a bit longer as well as allow you to chill the water ahead of time and keep it cool until you're ready to use it.

For ice, you could just use a couple of bags of ice from a local store, but that's not the DIY spirit (and it costs more). As an alternative, you can fill about a dozen aluminum soda or beer cans and freeze them. I picked up this great trick from the Covert Hops Society brew club based in Atlanta, Georgia. You can also add salt to the ice water in the reservoir to drop the temperature a few more degrees. Why this works is outside the scope of this article, but Googling the term "freezing point depression" will give a good explanation.

CLEANING

Carboy Spray Wand

Story and photos by **Forrest Whitesides**

Probably every homebrewer's least favorite part of the hobby is the sometimes staggering amount of cleaning that is required to produce a sanitary, contaminant-free batch of beer. And one of the most stubborn things to clean can often be that thick, nasty-looking ring of dried kräusen gunk that is almost always present after a healthy fermentation. This is especially true for brewers who use blow-off tubing, as the kräusen travels all the way up the neck of the carboy.

You can soak the carboy overnight in a solution of water and a cleaning agent such as B-Brite and then use a carboy brush to get the stubborn cling-on gunk. Or, you could just use a high-pressure sprayer to blast away the left over kräusen.

There are two basic ways to build this carboy sprayer: either with soft copper tubing or with hard copper pipe. If you intend to use soft copper tubing, you'll need two compression fittings and a few adapters. I chose to use ⅜-inch OD copper tubing (to navigate the narrow neck of a glass carboy) along with ⅜-inch x ½-inch compression coupling (Watts part # A-118), a ⅜-inch x ¼-inch compression coupling (Watts part # A-116), a ¾-inch male hose thread x ½-inch male pipe thread adapter (Watts part # A-663), and a ⅛-inch hose barb x ¼-inch male pipe thread adapter (Watts part # A-85). These fittings work with my usual brewing setup, so feel free to make changes based on your equipment, whether it includes an outside garden hose or an indoor utility sink.

For those of you with PET carboys, or if you happen to have a glass carboy with a wider-than-normal mouth, hard copper pipe is a great alternative to copper tubing. It's less pliable than soft tubing, but far more sturdy over the long haul and there are several available fittings allowing for many different designs to accommodate a wide range of needs.

Going with hard copper pipe also means that you'll need to solder the joints and fittings together, as it is too rigid for regular compression fittings to work properly. If you've never soldered copper pipe before (referred to as "sweating" copper), don't let that stop you from giving this project a try. The process of soldering copper is very simple to learn (but difficult to master, of course), the equipment to do it is inexpensive (less than $20 for the basic gear), and it's a useful general home-improvement skill. Be sure to wear appropriate safety equipment and follow all precautions as directed.

Parts and Tools

Soft Copper Option

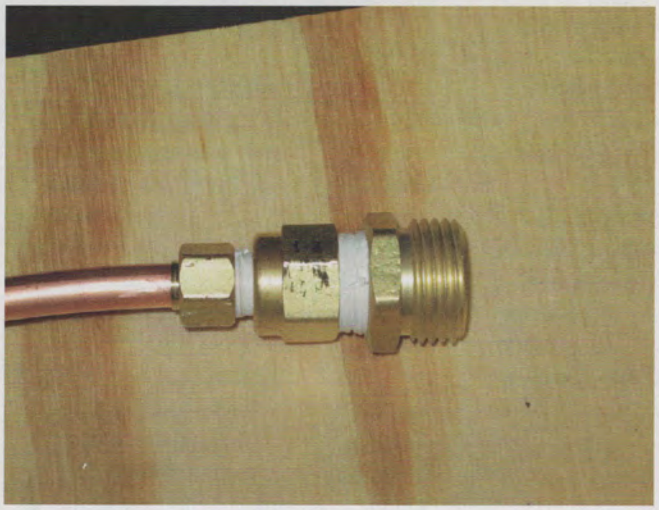
- 2-foot (or longer) piece of ⅜-inch OD soft copper tubing
- ⅜-inch x ½-inch compression coupling (Watts part # A-118)
- ⅜-inch x ¼-inch compression coupling (Watts part # A-116)
- ¾-inch male hose thread x ½-inch male pipe thread adapter (Watts part # A-663)
- ⅛-inch hose barb x ¼-inch male pipe thread adapter (Watts part # A-85).

Hard Copper Option

- 2-foot (or longer) piece of ½-inch OD copper pipe
- ¾-inch male garden hose adapter fitting
- 45-degree street elbow
- 90-degree street elbow
- end cap

1: SOFT TUBING OPTION

This photo shows what one end of your copper tubing should look like once you've attached the nut and flare fitting. To start, measure off a comfortable length of tubing and make your cut. A Dremel or other rotary tool with a cutoff wheel is an excellent way to cut the tubing. A coping or hack saw will also work, but take care not to apply too much pressure as the tubing is very easily deformed, and this can make it difficult or impossible to get a good seal with the compression fittings.



2: STEP TWO

Soft copper tubing is very pliable and can be bent and twisted to suit many cleaning applications. Try several different angles of bend to make sure you'll be able to fit the completed sprayer into your carboy. The next step is to wrap the threads of the two fittings with Teflon tape. Unscrew the nut from the ⅜-inch x ½-inch compression coupling and slide it approximately half an inch over one end of the tubing and then do the same with the flare fitting (which looks like a small brass ring). Now screw the rest of the compression coupling into the nut until hand tight.

3: STEP THREE

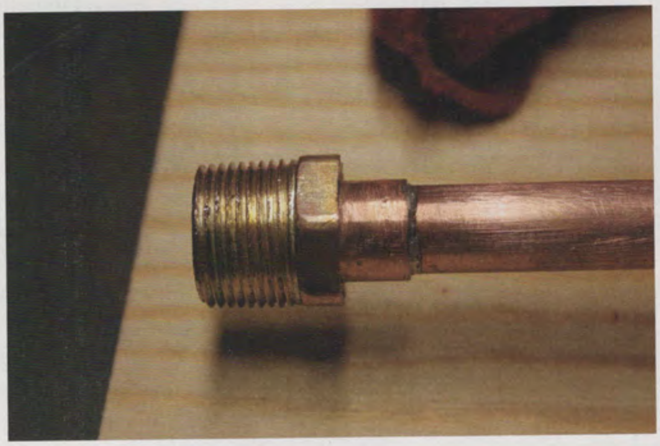
To tighten fully and insure a good seal, hold the main part of the coupling stationary while turning the nut with either pliers or a wrench. A vise is handy to hold the coupling steady, but it can also be done with a crescent wrench. Repeat the same procedure on the other end of the tubing with the smaller compression coupling. All that remains to be done is to wrap the threads of the two fittings with Teflon tape and screw them in to the compression fittings. Hook up your new sprayer to a garden hose or sink to test the integrity of the compression fittings. Tighten and readjust as needed. Once the fittings are wrapped, screw them into the compression fittings to look like they do in the photo.

4: HARD TUBING OPTION

For my hard copper sprayer, I chose a 2-foot section of ½-inch OD copper pipe, which is commonly available at hardware stores in short, pre-cut lengths that are perfect for this type of project. Fittings for this project include a ¾-inch male garden hose adapter, a 45-degree street elbow, a 90-degree street elbow, and an end cap. These are just suggestions, so feel free to shop around for different options to suit your needs. I highly recommend that you test fit the elbows before soldering to make sure the configuration will fit through the neck of your carboy. For example, I found that attaching the 45-degree elbow and then the 90-degree elbow - but not the other way around - fit fine into my carboy. To create a nozzle for your sprayer, cut a slit or drill a hole (or several small holes) in the end cap fitting (as pictured). I prefer the slit, as it creates a wide, high-powered fan of water, but your mileage may vary.

5: STEP TWO

Next, the ¾-inch male garden hose adapter to one end of the copper pipe, (as pictured) and solder the elbows together on the other end of the pipe followed by the end cap. By using "street" elbows instead of the regular variety, the elbows can be fit together directly. My local hardware store did not have 90-degree street elbows in stock, so I had to cut a short piece of pipe to use as a coupling between a normal 90-degree elbow and the end cap.



6: STEP THREE

Finally, solder the elbows together on the other end of the pipe followed by the end cap. Attach the sprayer to your garden hose and turn on the water to make sure your solder joints are fully seated and sealed. And now it's time for a homebrew! BYO

1: THE OXYGENATOR

Unlike some commercially-sold versions available to homebrewers, this DIY In-Line oxygenator is designed for easy breakdown by hand or with an adjustable wrench. This makes the task of cleaning it after use relatively simple. Remove the apparatus from the CFC, disassemble, rinse thoroughly, soak in your regular cleaner, rinse and air dry until the next time. Note: it's recommended that air stones are only handled by the shaft. There is a possibility that the oil in our skin can be transferred into the stone reducing performance (and increasing the chance of contamination).

2: PARTS AND ASSEMBLY (PART 1)

Start by working from left to right in this project (same as the flow of the wort). The first part is a ½-inch NPT Kleinhuis strain relief fitting. These nylon fittings can be easily found if you search the Internet for "liquid tight strain relief." This fitting's opening is matched to the copper tubing (wort out) from my CFC. Note: the screw down cap on this fitting needed a bit of additional clearance to fit over the CFC's tube so the hole was enlarged by filing to get a good fit. Hand tightening the cap is all it takes to get a leak proof seal. You will need to size this fitting accordingly to match your CFC or kettle. A compression fitting sized to your chiller or kettle out could be substituted. A brass ½-inch nut and a large O-ring are installed to achieve a tight seal to the SS Tee.

At the other end of the tee (on the outflow side) is a ½-inch NPT x ½-inch stainless steel barb fitting installed with Teflon tape. A vinyl length of hose is fit over the barb and leads to the fermenter for filling.

3: PARTS AND ASSEMBLY (PART 2)

In this photo you can see a closer look at the Kleinhuis strain relief fitting. At the center of the tee is a stainless steel ½-inch NPT Male x ⅜-inch barb with two small O-rings pushed inside. The air stone's barb is then pressed onto these O-rings to make a seal. I originally had difficulty getting this point to seal well. It took a few tries with differing O-rings to get a leak-free seal. This fitting with the air stone installed is screwed into the tee with a large ½-inch brass nut and O-ring making a liquid tight non-permanent connection to the tee. The air stone is now captured inside the body of the SS Tee fitting.

Keg And Carboy Cleaner

Story by **Bill-John Neidrich**

Here's a project that was inspired by Doc at The Brewing Network (check it out at www.thebrewingnetwork.com). In one of their first episodes Justin gushed about one of Doc's time and energy saving brewing gadgets. Doc kindly gave an explanation about how he used a submersible pump to recirculate cleaning solution through an overturned keg or carboy. He used a main spray head to clean the body of the vessel and also used auxiliary lines to feed cleaning solution through the gas in and beverage out dip tubes.

You will need:

- A submersible pump
- A bucket to put the pump and cleaning solution in
- A bucket lid or other type of support for on top of the bucket
- Various pipe fittings and adapters
- A ball valve
- Two hose barbs
- 3 feet (~1 m) of tubing

Just like any project, the equipment and materials you use can be swapped out based on availability, your preference or your budget. With that being said, the parts and equipment list below is what I used from bottom to top. I built this project using imperial copper pipe fittings. If you are interested in building this project in a country where metric pipe fittings are the norm, you will need to modify the parts list and build accordingly. Stainless steel tube and Swagelok-type fittings will resist erosion from strong alkaline and acidic cleaners, so using stainless is another good alternative to copper. Plus, if you use Swagelok you don't have to do any welding or soldering. Alternatively, you can use PVC pipe if you don't want to solder.

Since I initially built this project, I've added a heat stick (see how to build one on page 19) so I can heat the cleaning solution right in the pump bucket and I've added a rotating spray head. The cleaner could also be used for boil kettles and mash tuns (provided that they are rinsed of grain and other large particles).

Important: Water and electricity can cause serious electrical shock. The pump (and heater if you modify) must be plugged into an outlet with GFI protection.

Parts and Tools

- A large saucer
- A 5-gallon (19-L) bucket with lid
- A pump. The pump is really the heart of this beast. I used a ⅙ HP WaterAce R6S Utility Pump with a max flow of 25 GPM. I then wandered around with the pump in hand at the hardware store for what seemed like hours to find the right fittings to adapt it down to the ½-inch copper pipe.
- I used a monster copper female threaded fitting x 1-inch sweat
- One copper 1-inch to ¾-inch reducer bushing
- One short section of copper ¾-inch pipe
- One copper ¾-inch x ½ x ½ tee
- One copper ½-inch sweat to ½-inch mpt
- One brass ½-inch fpt ball valve
- One brass ½-inch mpt close nipple
- One brass ½-inch fpt tee
- Two nylon ½-inch mpt x 3⁄8" barb fittings
- Two sections of ⅜-inch vinyl tubing each 16-inch long
- Four small hose clamps
- Two 5⁄16-inch barb x ¼-inch flare swivel nuts
- One gas in keg quick disconnect (QD)
- One beverage out keg QD
- Some ½-inch copper pipe
- One bulbus copper "water hammer air chamber" for the spray wand

Note: You don't need to have the QDs dedicated to this cleaner but you probably want to have an extra set so you don't need to remove them from your draft system just to clean a keg.

1: THE BUILD

You'll want to dry fit everything together before any parts are soldered so you're sure to get the correct heights and lengths. You'll also want to find the location of any screwed in fittings when they are tight. Take your main threaded fitting and screw it into the pump. Then mark the direction that the ball valve needs to go. This mark will be used to align the fittings when they are soldered. Also make sure you design your cleaner so the ball valve is a few inches below the rim of the bucket.

2: THE BALL VALVE

Solder your parts up again making sure that your ball valve will be pointing in the correct direction when the unit is connected to the pump. Do not solder the pipe going up to the main spray head. You will want to leave it free so you can add different length pipes for your various cleaning applications.

3: PUT IT TOGETHER

Assemble all of the pieces that get attached to the pump. Thread on the ball valve, the nipple, the tee, and the hose barbs. Press one end of each section of tubing over the nylon hose barbs and clamp them in place with two hose clamps. Press the two $\frac{5}{16}$-inch barb by $\frac{1}{4}$-inch flare fittings into the open ends of the tubing and then clamp them in place with the two remaining hose clamps.

4: MODIFY THE BUCKET

You will need to modify your bucket lid by cutting a hole for the keg opening and the QDs. My cutout is an odd shape to accommodate both ball and pin lock kegs. You'll also need to cut a slot in the edge for the cord. I had to drill holes around the edge of the lid to allow liquid trapped in cavities to drain back into the bucket.

To support the weight of a carboy on top, I used a hole saw to cut a large hole capable of fitting the carboy's neck in a scrap piece of 2 x 6 (see figure 6). It adequately held the carboy but was awfully unstable so I used a jig saw to create a chamfer (a beveled edge connecting two surfaces) around the hole. This improved carboy stability tremendously. I have also seen people use milk crates and the like to hold the carboy.

5: MEASURE THE RISERS

You will want to solder the union on to the water hammer bulb. Once that's done you can start measuring out the lengths of copper pipe (risers) you need to get the spray head 4 to 6 inches (10 to 15 cm) from the top of your vessels. I use a shorter riser while cleaning carboys and a longer one when cleaning kegs. I put a slight bend in my risers in order to center the pipe in my bucket. Using a pair of pliers slightly deform each end of the riser so that it fits snugly into the fittings on the pump and the spray bulb. This will prevent the riser or bulb from separating due to water pressure. Using a 3/32-inch drill bit, drill as many holes as you can into the top of your spray head. You may need a number of bits, and use a vice or drill press if you can. Don't hold it while you're drilling. You may want to add dimples to the bulb with a punch prior to drilling to help keep the bit from wandering. To specifically target that stubborn kräusen line in your carboys, you can add a few holes along the sides of the bulb or your riser.

6: USING THE CLEANER

To clean carboys I shut the ball valve, place the wooden cradle over the spray head, and then slide the carboy over the spray bulb. When cleaning kegs I install the QDs on the lines, open the ball valve half way, and put the lid on the bucket. Then I place the keg over the spray bulb and connect the QDs. The keg rests right on the bucket lid (I may end up needing to reinforce the lid with something as I have cracked it). Everything should be good to go. I highly recommend using Powdered Brewery Wash (PBW), it foams far less than OxiClean and does not foam at all when heated over 100 °F (38 °C). If it's needed, foam control can also be used to prevent a foamy mess. Solution for cleaning carboys should not be heated over 100 °F (38 °C) to prevent the thermal shock from cracking the glass. Kegs can be cleaned with 150 °F (66 °C) solution, which will clean more effectively. BYO

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DRAFT DISPENSING

Tap Handles

Story and photos by **Ken Lenard**

Most of the homebrewers I know are very handy. They're tinkerers. They like to build, fix and improve things. I enjoy homebrewing very much, but I have to admit that I'm not very handy. So it is with great irony that I find myself writing an article about how to build something.

But even though I may not be handy, I also like the creativity that homebrewing allows. I like to formulate recipes, come up with catchy names for my beers (it helps me keep the various beers straight in my head) and create labels for my beers too. I don't really bottle much anymore, so I had a dilemma: where am I going to put a label? On a tap handle of course!

There are already many tap handles available for homebrewers to buy that will incorporate a label, but they seemed pricey to me. So, I set out to find a way for an unhandy person to make some homemade tap handles.

Rather than draw out the plans and then amass the materials for the project, the design for these handles came to me just from browsing around my local hardware store. I knew that I wanted to make some handles, but I wasn't sure exactly what I would need until I got there. Because they ended up being so simple to make, you can make these handles out of anything that you have laying around the house or anything that you happen to find at your local hardware or building supply store. Be creative and make modifications to suit your own home bar.

I had this particular design in mind because I wanted to showcase my labels, which are rectangular. I found some oval-shaped pieces of wood that looked very cool, but the design would have made it tricky to fasten to a stem and it didn't look like I would be able to place a label on each side. If you have a different shaped label, choose your materials accordingly. I've seen homebrewers use all kinds of things for tap handles. Last year my son's baseball team won a tournament and the kids and coaches both got trophies, so there were two in our house. The trophy featured a nice, 7-inch (18 cm) wooden baseball bat. My son's trophy was proudly displayed on a shelf in our basement, but I took mine apart and used it as a tap handle. Nothing like a Home Run Red Ale!

The result for these handles came out better than I originally envisioned. They are very sturdy due to a wooden dowel inside the handle (as well as some sturdy glue) and they do not flex at all when I pull on a tap to pour a beer. Now, whenever someone comes down to my basement bar, they'll know exactly what's on tap!

Parts and Tools

(to make eight 7-inch/18 cm-tall tap handles)

- 48 or more inches (122 cm) of 3.5-inch wide, 0.5-inch thick decorative wood trim
- 24 or more inches (61 cm) of 0.5-inch (1.25 cm) thick plain trim
- 64 inches (163 cm) of 3.5-inch (9 cm) wide, 0.5-inch thick plain wooden planks (for beer label mounting)
- 8 3/8-inch-16 faucet adapters
- 8 small drawer pulls (0.5-inch/1.25 cm across)
- Wooden dowels
- Wood glue
- Liquid Nails adhesive
- Mitre box
- Saw
- Drill with 15/64-inch drill bit
- Vice
- Metal snips
- Measuring tape
- Pencil
- Spray mount glue
- Spray paint

1: CHOOSE YOUR MATERIALS

As I mentioned, before I started this project I took a trip to my local mega-hardware store for inspiration. As I stood in the "decorative trim piece" section, it occurred to me that I needed to make a "stem" piece that would accept the faucet adapter and then I would create a separate, larger piece (the "face") which would display the label. I thought it would be nice to fashion the whole thing out of a single piece of wood, but this requires skills and tools that I do not possess.

2: THE DESIGN

The shape of the trim allowed me to place the pieces back to back to create a thick stem. The leafy pattern would show on both sides so that I could put a different label on each side of the handle so each handle I made could be used for two different beers. Just the two pieces of decorative trim together wasn't thick enough to accept the drilled hole for the faucet adapter, so I found another flat trim piece that I could sandwich between the leafy trim pieces to make the whole stem thicker. Next, I found some plain poplar planks that were 3 ½ inches (8.9 cm) wide, ½-inch (1.27 cm) thick and four feet (1.2 m) long. I cut these pieces in to 4-inch (10 cm) tall pieces to create the "face" of the handle. I envisioned the tap handle with the bottom of the stem drilled out to accept the faucet adapter, the top of the stem drilled out to accept a wooden dowel and the bottom of the face drilled out to accept the other end of the dowel. I considered. But they are pricey and when the handle was finished, it would look like a staircase spindle. I found some pieces of trim that had a leafy design on them. I immediately concluded that the manufacturer had a hop vine in mind when they made them. You can use any type of decorative design you would like, of course.

3: FIND THE HARDWARE

As I walked through the store, I found the kitchen hardware section and looked at the various drawer pulls. I was envisioning using them as a sort of finial that could be fastened to the top of the handle. The hardware came in a dizzying array of shapes and colors and I picked a few that looked good, so choose whatever you find appealing. I also found the faucet adapters in this department. The threads on the adapters are very coarse and there is usually a slot on one end so you can use a screwdriver to drive the adapter into the handle. The faucet adapters are readily available at many hardware stores and many homebrewers have screwed them into sawed-off table legs, antlers, lava rock and so on to serve as impromptu tap handles.

4: MAKE YOUR CUTS

I don't have a lot of room above my faucets (there is a TV there), so I knew I wanted the entire handle to be about 7 inches (18 cm) tall. Since the poplar planks I bought were 3 ½ inches (9 cm) wide, I printed out one my labels so it would be about 3 ¼ inches (9 cm) wide. If you want a larger label, be sure to get wider planks for the handle faces. Lay the label down on the plank and make a line with a pencil where the plank should be cut. The piece should be about 4 inches (10 cm) from top to bottom. Since the wood (I used poplar) is only ½-inch (1.27) thick and the stem was thicker, I cut two pieces of poplar and placed them back-to-back and glued them together. You can also use 1-inch-thick pieces. Next, cut the trim pieces into 3-inch (7.6) lengths. Place the pieces with the leaf pattern facing out and place a flat trim piece (which was the same width) between them and glue them together.

5: DRILL IT

When the glue is dry, drill a hole in the bottom of one of the poplar pieces. The hole is drilled to accept the wooden dowel so it is important to make the hole as straight as possible. When I built my taps, this is the step where some skill would have been handy. I placed the poplar face into a vice and carefully drilled the hole and then another one in the top of one of the stems. I fitted the dowel in place and assembled the two pieces. Then I placed the stem into my vice so I could drill out the $\frac{15}{64}$-inch hole for the faucet adapter. I did this with the trim piece in a vice and me standing over it with a corded drill. I drilled the hole and grabbed one of the adapters. I placed it into the hole and started to turn it. It went in crooked. I took it out and started again. It was a little better but now I saw that my three glued-together trim pieces were starting to break apart. I took a big slug of my beer. I drilled the hole out a little wider and tried again. Success! Have a slightly larger drill bit on hand in case this happens to you.

6: FINISHING TOUCHES

I took the handle down to my faucets and tried it out. It wobbled a little so I readjusted the adapter until the handle spun like a top. Then I placed some glue into that hole to keep the adapter where I wanted it. This part takes some practice and the threads of the adapter make it tricky, but once you get one done, it becomes easier. Once you have it working as you would like, take the dowel out, place some glue into both holes and replace the dowel. Put the entire handle together, straighten it and lay it to the side to dry. The final step is drilling a hole in the top of one of the handles for the "finial." Choose a drill bit that fits the size of the drawerpulls you choose. Once the hole is drilled, cut the head off the screw with a pair of snips and then place the cut end of the screw into the centered hole. Then screw the finial onto the top. Finally, I primed all of the handles and then painted them in various colors. When the paint was dry, I glued the finial screws into the holes and attached the hardware. BYO

Home Kegerator

Story and photos by **Forrest Whitesides**

In this project, I'll outline how to build a basic, two-tap kegerator. It's not a cheap project, but the benefits are tremendous and well worth the money.

Before you can get started buying all of the needed hardware, you need to decide if your kegerator is going to be housed in a refrigerator or chest freezer. Using a refrigerator is generally less expensive overall and requires less equipment, but a decent-sized chest freezer can usually accommodate more kegs (and thus taps). Also, used refrigerators can be had for very little money — and in some cases are free if you can pick them up yourself. Be aware, however, that old refrigerators consume a lot of power. Although the upfront cost may be right, a newer refrigerator may end up saving you money in the long run.

I lucked into a model-clearance sale and got it really cheap. It's an "apartment-sized" refrigerator/freezer combo, which looks just like a normal fridge, but it's about 12 cubic feet (0.34 cubic meters) inside instead of the normal 18 cubic feet (0.51 cubic meter) or larger. It's perfect for a two-, three- or even four-tap setup.

To figure out how many kegs a given fridge or freezer will hold, trace around the bottom of a Cornelius keg on a piece of cardboard, cut it out and take that with you when you go to look at your options. If you don't have a keg yet, you can just draw an 8-inch diameter circle instead of tracing the bottom. Also, be sure to measure the fridge or freezer for vertical clearance. A typical ball-lock keg with the disconnects attached is about 26-inches (66-cm) high. Vertical clearance isn't usually an issue with full-size refrigerators or chest freezers, but it's good to know the height of the kegs when trying to squeeze just one more into a tight space in the back of the fridge.

"Using a refrigerator is generally less expensive overall and requires less equipment, but a decent-sized chest freezer can usually accomodate more kegs (and thus taps)."

I opted to go with a refrigerator because it fit my brewing needs (and available space), required minimal hardware and was less expensive overall than going with a chest freezer. I ended up buying a new unit because

Parts and Tools

- 1 refrigerator
- Drip tray
- 2 Cornelius kegs
- 2 shanks
- 2 forward-sealing faucets
- 2 tap handles
- 2 10-ft (3-m) lengths of beer line (3⁄16 ID)
- 4 hose clamps (for beer line)
- 1 CO_2 tank
- 1 dual-gauge regulator
- 3 feet (1 m) air line hose (¼-inch diameter)
- 1 "Y" splitter (for air line hose)
- 6 hose clamps (for air line)
- 2 beer "out" disconnects *
- 2 gas "IN" disconnects *
- caulk
- keg lube
- elelctric drill
- ⅞-inch hole saw
- screwdriver
- Tap handles. (Make your own tap handles, as shown in the project on page 55 of this special issue.)

*(Be sure to match your disconnects to the type of kegs you have: either ball lock or pin lock.)

1: CHOOSE YOUR SHANKS AND FAUCETS

For a refrigerator-based kegerator, you'll need a shank and a faucet head to make each tap. The shank fits through a hole drilled in the refrigerator door, and, via beverage tubing, connects the keg to the dispensing faucet. Some shanks have a permanently attached hose barb, while others use a tail piece and wing nut to attach the barb. Either type will work just fine. The other end of the shank has a threaded collar that mates with the faucet. This is a great system, as it allows any faucet to be used with any shank. This comes in handy if you want to upgrade your faucets at a later date.

There are many faucets available on the market right now, ranging from cheap brass units to high-end stainless with a brushed nickel finish. If you have the money, I highly recommend the forward-sealing style faucets. In a forward-sealing faucet, the flow of beer is stopped near the front of the faucet, not the back as in most faucets. This means that, when you pour a beer, it does not flow through a tap that has beer residue in it that has been exposed to oxygen. They're easier to keep clean (and they look really cool). But any faucet will work, so there's no need to spend a lot on faucets right away.

2: CO_2 - HIT THE GAS

The heart of any kegerator is the gas that pushes the beer. In the vast majority of cases, this will be carbon dioxide (CO_2), but could also be a nitrogen/CO_2 mix (turn to page 61 for more about building a nitrogen system). Gas cylinders most commonly come in 5-lb., 10-lb., and 20-lb. sizes, but both smaller and larger sizes are available.

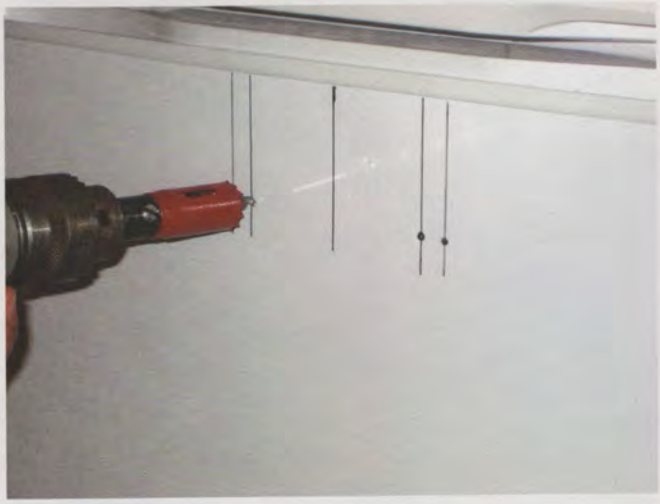
A gas regulator is required as well. It attaches to the cylinder and allows you to set the pressure of the gas imposed on the keg, which is how you set and adjust the carbonation level in the beer. Dual-gauge regulators also show how much pressure is remaining in the cylinder.

If you plan on having several beers on tap, you'll also need some way to push the gas to each keg. This is typically done with a manifold that splits the line from a single gas cylinder into many output connections. For splitting off to just two kegs, you can use an inexpensive "Y" adapter that screws into the regulator. If you plan on serving beers that require different carbonation levels, this will require either a separate CO_2 cylinder and regulator or a double regulator attached to just one cylinder. For starting out, however, a simple dual-gauge regulator is more than adequate.

3: CONVERT THE FRIDGE

This is actually the easiest part of the whole project. All you need is a drill and a ⅞-inch hole saw. Just drill a hole through the refrigerator door for each tap you intend to have. That's about all there is to it.

Before you drill, you'll want to measure and mark the door. First take a look at the inside of the refrigerator door to verify the locations of shelving supports. It is best not to drill through these supports, as you may want to keep the shelves for holding bottled homebrew or odds and ends related to brewing. Now you can mark off your center points for drilling (as shown in this photo).



4: INSTALL THE SHANKS

The holes you drilled should be a tight fit for the shanks. Work them through the hole and tighten the nuts on the inside of the kegerator (which is what your fridge now is, officially). For a little extra thermal security, you can seal the edges of the holes with a little silicone caulk before you tighten down the nut. I have not found this to be necessary, but if your shank holes aren't quite clean and neat, it might not be a bad idea. It can't hurt either way.

Once the retaining nuts are tightened down on the shanks, screw the faucets into the shank collars and you're ready to hook up the kegs and gas. You can also attach your drip tray now. For attaching to a refrigerator door, you'll need one that has a mounting bracket (as opposed to drip trays that just lay flat under vertically mounted taps). Instead of screwing mine into the door, I glued some felt-backed magnets to the tray. This makes it easier to remove the tray for cleaning, moving the kegerator, etc.

5: TESTING, TESTING

Attach the regulator to the cylinder, and make sure the connection is tight (but do not over-tighten). Slip one end of a length of gas tubing over the hose barb on the regulator's shut-off valve and secure it tightly with a hose clamp.

The other end of the gas tubing goes on the gas quick disconnect fitting (which is usually grey and plastic) and should also be secured with a hose clamp (pictured).

Attach the grey gas disconnect to the "IN" post (also called a plug) on a keg filled with tap water (or sanitizer if you prefer). Set the regulator to about 8 to 10 PSI and open the valve on the cylinder. You'll hear the gas enter the keg. Now take a spray bottle filled with either soapy water or a standard strength solution of Star San sanitizer and spray the connections on the regulator and the disconnect. Watch closely for bubbles, as this is a sign that CO_2 is leaking. If you see bubbles, turn off the gas and retighten the connection nearest to where the bubbles occurred. Keep doing this procedure until you don't see any bubbles. Even a very tiny leak will leave you with an empty cylinder in a very short time.

6: ATTACH THE TUBING

Now attach the beverage tubing to the hose barb on the liquid disconnect (usually black plastic) and the hose barb on the shank and secure both connections with a hose clamp (as shown in the photo). As a starting point, use about 10 feet (3.0 m) of beverage tubing. Attach the liquid disconnect to the "OUT" post on the keg, turn the gas back on, put some kind of container under the tap, and pull the handle toward you to open it. The water in the keg will now flow out through the faucet. Watch the beverage "out" side for liquid leaks. Tighten and reseat connections that show any leakage at all. If you think you're having trouble with the keg seals, apply a thin coat of food-grade lubricant to all rubber parts (seals and gaskets). This is commonly available at homebrew suppliers and is often simply called "keg lube." BYO

Nitro Kegerator

Story and photos by **Forrest Whitesides**

So you've got a kegerator, and you're loving life now that you don't have to bottle every batch of homebrew anymore. You also are the envy of family and friends because you serve finely crafted beer on draft in the comfort of your own home. But something is still missing: the ability to serve stouts, porters and pub ales with that same full mouthfeel, thick head, and gorgeous cascading bubble effect that your favorite brewpub or tavern offers with their fancy draft setup. With very little time and about $200 (if you are frugal, that is), you can serve up "nitro" beers at home without having to do any permanent modifications to your kegerator.

How does it work?

So where does that creamy mouthfeel, thick head and shimmering/cascading visual effect in a nitro beer come from? It's a combination of two critical elements: a specially designed faucet and a special mixture of gas.

The faucet, which is often called a "stout" or "Guinness" faucet, sports an elongated vertical design and at its core has a restrictor plate that both slows down the speed of the pour and also agitates the beer as it is poured (which helps to create that big head). The restrictor plate, or "sparkler" as it is sometimes called, functions very similar to the aerator disc in a kitchen or bathroom sink faucet. It can also be removed from the faucet for a standard pour in cases where the faucet must serve double duty as both a stout and standard tap.

The other half of the equation is the gas pushing the beer, which is referred to as "beer gas," "Guinness gas," or even "beverage gas," depending on the supplier. Nitrogen and CO_2 blends are sold in a few different ways and it's critical that you get the right blend for the below procedures to work. The blend you'll want will have 70–75% N_2 and 25–30% CO_2. Avoid the common high pressure draft system 60/40 blend, which is actually 60% CO_2 and 40% Nitrogen. Nitrogen does not dissolve very well in beer, and much of it comes out of solution almost immediately after pouring. This is a big part of what causes the visual cascading effect (the other part being the agitation from the restrictor plate in the faucet). Additionally, nitrogen tends to form smaller bubbles than CO_2, and this is why a nitro-poured stout or pub ale has a dense, persistent head.

Once the pour is complete and the undissolved nitrogen has escaped, what's left is a beer that's approximately one-third as carbonated as a typical draft beer. It's similar to a cask ale but without the concerns of flavor degradation (oxidation) from pumping air into the keg. The lower carbonation also gives the beer a fuller mouthfeel as compared to beers served at higher carbonation levels.

Parts and Tools

- Kegerator
- Nitrogen/CO_2 blend gas tank (10–75% N2/25-30% CO_2)
- Stout faucet
- Cylinder connector (most N_2 tanks are female, unlike CO_2 tanks which have male connections)
- Gas regulator that meets the safety standards of your N_2 tank (will be printed on the tank. A regular CO_2 regulator may not be safe.)

1: SOURCING BEER GAS

Your current supplier of CO_2 likely carries the nitrogen/CO_2 gas mixture as well. If they do not, check with local bars and restaurants to find out where they get their gas. For various reasons, commercial draft systems frequently use a nitrogen/CO_2 mixture to push all of the beers on tap-so if there is a place near you that serves draft beer, they're getting the gas from somewhere. A polite inquiry with the manager will likely lead to a good supplier of beer gas. Also be aware that beer gas is sold in cubic feet and not in pounds as CO_2 is sold.

2: GET THE GEAR

Luckily, stout faucets use the same fittings as any other faucet, so there is no need for you to buy any additional shanks or draft tower fittings (unless, of course, you're adding the stout faucet as an additional, permanent tap in your lineup). Stout faucets cost anywhere from about $75 up to about $150. I bought one of the cheaper models from www.beveragefactory.com, and it looks great and performs superbly. Most vendors that carry general kegging equipment will also stock stout faucets, so they should be easy to find.

3: ADAPT YOUR TAP

As mentioned earlier, the restrictor plate can be removed, allowing you to use the stout faucet as a standard faucet. This makes things easier if you don't plan to have a nitro-appropriate beer on tap at all times. Swapping out faucets when you switch kegs isn't that big of a deal, but it's one more thing to do and one more piece of gear to clean and put away. I had initially planned to change my faucet heads as I changed beers, but I've found that it's much less of a hassle to just remove or reinsert the restrictor plate as needed.

4: NITROGEN GAS SAFETY

Nitrogen is stored at a much higher pressure than CO_2 and requires a different type of cylinder. In most cases it also has a female threaded connection, as opposed to a CO_2 cylinder's male connection. Check with your supplier as to the type of connection their cylinders have. Because of the higher pressure and different connection, you'll also need a different regulator for the beer gas cylinder. An exception to this is if you already have a CO_2 regulator that is rated up to the max PSI of the gas in your cylinder (generally about 3000 PSI), in which case you can use an inexpensive adapter to convert the gender of the regulator's connection fitting. If you are not 100% certain about the regulator's safety rating, buy a new regulator that meets the safety specs (which are usually stamped into the cylinder). You cannot make assumptions here. It's not worth the risk of serious injury and/or major property damage to save a few bucks.

If you plan to house the beer gas cylinder outside of your kegerator, it is imperative that you secure it with rope, chain, or bungee cables. A failed cylinder valve or regulator could create a serious problem that could injure bystanders and would almost certainly cause extensive damage.

5: DISPENSING WITH BEER GAS

The most traditional way to go about serving your nitro brew is the traditional all-beer-gas method. This procedure works by simply taking your finished beer and hooking up the beer gas at about 30–35 PSI and lettting it carbonate for 7 to 14 days before serving. This is the same basic procedure you'd follow for carbonating with CO_2. In order to pour a creamy pint with a thick and rich head it is very important to have less than 1.5 volumes of carbon dioxide in the beer and roughly 20 mg/L of dissolved nitrogen. In order to have that little carbon dioxide and that much nitrogen you must gas with mixed gas at a relatively high pressure. Too little nitrogen and you don't have the nice foam and too much carbon dioxide and you end up with crazy beer when it is poured through a stout tap. This is a point of contention with even the experts, however.

Because nitrogen does not liquefy at the pressures commonly seen in gas cylinders, it cannot be as densely packed as CO_2 (which does liquefy at lower pressures). Therefore, even very large beer gas cylinders will generally be depleted far quicker than much smaller CO_2 cylinders. And given that beer gas is more expensive than CO_2, you'll be making more trips to the gas supplier and spending more money if you decide to use this traditional method of carbonating your nitro brews.

Note: If you do this and you are going to use any CO_2 parts, keep in mind that you won't be able to pour regular beers as well unless you buy another CO_2 regulator. BYO

FERMENTATION

Glycol Fermenter

Story and photos by **Marty Cornelius**

Professional brewers control the temperatures of each of their individual fermentation vessels. To accomplish this, homebrewers are typically stuck using multiple chest freezers or refrigerators to control fermentation temperatures. I wanted to have temperature control over each of my fermenters like the pros, to store them within the confined space of my garage, and also still use my garage for its intended use . . . to park cars. So with a little research, welding, design and patience I built this temperature controlled fermenter.

This project does not require a lot of space to build or store. I built it in my garage and store it along one side next to my brewing system. All of the materials can be easily obtained and the whole thing can be built for about $2,000. You can ferment a lager in one vessel and an ale in the other; raise the temperature for a diacetyl rest and even crash cool to near freezing before kegging to help clear your beer.

I am a makeshift welder, and I've always wanted to learn how to weld stainless and aluminum. My solution was to take a TIG (tungsten and inert gas) welding course at the local vocational school. This is where I actually came up with the idea of a jacketing

system for my Sabco fermenters. You may choose to do this as well or, armed with a six-pack of your favorite homebrew, you can find an experienced welder that will weld this part of the project for you. With a good understanding of how the chiller is going to work and look, this project will come together in a snap.

I used a 5000 BTU window air conditioner and a standard size ice chest for the chiller unit. The air conditioner's evaporator coil is immersed in a glycol bath to cool the glycol. A small fountain pump is used to constantly circulate the glycol solution inside the cooler. Two slightly larger fountain pumps are used to circulate glycol through copper tubing that is wrapped around each fermenter underneath an insulated jacket. These larger pumps are switched on and off by a temperature switch that is monitoring the temperature inside each fermenter.

The Ultimate Chiller provides great temperature control. I set the glycol temperature to 30 °F (-1 °C) during primary fermentation, which allows adequate cooling so I can set the fermentation vessels at either lager or ale temperatures. After primary fermentation is complete you can raise the temperature for a diacetyl rest then lower to near freezing to help settle the yeast and clarify the beer before racking.

Parts and Tools

Description	Part Number	Vender	Quantity
Fermenters	PR731	Sabco	2
Aluminumm Strap	8975K17	McMaster-Carr	5
Aluminum Channel	4592T11	McMaster-Carr	2
Aluminum Roll	112540	Lowe's	1
Copper Tubing	⅜" x 60'	Lowe's	2
Copper Wire	12-ga ground wire	Lowe's	130
Armaflex Insulation	½" x 48" x 48"	Allied Insulation	2
Shelving	18" x 48" x 38"		1
Temperature Control	TS-13010	Cole-Palmer	3
AC Unit	68868	Lowe's	1
Fountain Pump	FT-160	fountainmountain.com	2
Fountain Pump	FT-70-0	fountainmountain.com	1
PVC Tubing	60702	usplastic.com	10
Tubing Insulation	21374	Lowe's	4
Gylcol	60703	micromatic.com	2
Cooler	6½ gallon		1

1: COOLING JACKET

I used 60 feet (18 m) of ⅜-inch copper tubing for the cooling loop on each fermenter. I used a 12-gauge copper wire in between the copper tubing loops as they wrap around. This wire has two functions. First, it will increase the surface area contact between the copper tubing and the stainless vessel. This helps to transfer the temperature of the cold glycol to the fermenting beer. Secondly, the copper wire also provides a way to pull the copper tubing tight and hold it in place on the fermenter.

2: WRAP THE COPPER TUBING

Each fermenter uses 60 feet (18 m) of copper tubing and 65 feet (20 m) of 12-gauge copper wire. Roll out the tubing and the wire in a straight line. With some help from a friend, and a lot of patience, wrap the copper tubing and the wire around the vessel at the same time. Use a tubing bender to bend the end of the tubing so it faces outward from the vessel. I used a ratchet strap hooked on this bent part of the tubing to hold the first wrap in place until I got all of the tubing and wire wrapped around. Slowly work your way around until all of the tubing and wire are wrapped around and in place. I used some stainless steel picture hanging wire to keep the copper tubing pulled together, with the copper wire in between to hold it in place. At the top, bend the tubing out again and use another ratchet strap to pull the copper tubing tight. With everything in place you can use the same 12-gauge wire to attach the ends of the tubing and pull them tight. Just wrap the wire around the end at the top. Wrap it all the way around one time and attach the other end to the tubing at the bottom and twist the wire tight.

3: INSULATED JACKET

The aluminum bands that I built in my welding class are used to house the insulation and provide something ridged to attach the outside aluminum jacket to. Start by rolling the 1-inch x ⅛-inch (2.5 x 0.32 cm) aluminum strap around a bucket or empty keg to make a circle that is about 18 inches (470 cm) in diameter. Cut the first strap about 55 inches (1.4 m) long; this is a rough length but when you finish the first strap you can use it for a pattern to build the others.

4: CUT THE STANDOFFS

For the standoffs, cut a ½-inch x ½-inch (1.3 x 1.3 cm) aluminum channel into 1-inch (2.5 cm) pieces. You will need a total of 108 (2 x 9 x 6 = 108) pieces for the six bands. The standoffs are made by welding two pieces of the ½-inch (1.3 cm) aluminum channel together. It takes nine of these for each of the six bands. Weld each of the standoffs in place, evenly spaced along the inside circumference of the strap. Before welding the last standoff to the end, check the length of the strap by putting it on the vessel and marking the correct length, about 1 inch (2.5 cm) shorter. All of the other straps can be cut to this same length.

My straps are 54 ¾ inches (139 cm) long. This allows for a 1-inch (2.5 cm) space between the two end standoffs. Drill a 3/16-inch hole in both of the two end standoffs. Use a #10 x 2 ½-inch machine screw and nut through the 3/16-inch holes to draw the bands tight and hold them in place on the vessel.

5: INSTALL INSULATION

Before installing the standoff bands, cut the Armaflex insulation to fit around the vessel on top of the copper tubing. The insulation can be held in place and firm using nylon string. With the insulation in place, install each standoff ring securely in place. Just slice a small opening in the insulation at each place the standoffs need to contact the vessel. Also, and this is important, cut small pieces of insulation and stuff in the openings formed by the aluminum channel on each standoff. The outside of the fermenter will sweat any place that is not properly insulated!

6: INSTALL THE OUTSIDE SKIN

Now attach the aluminum sheet metal to the outside of the bands using ⅛-inch x 3/16-inch pop rivets. Rough cut the sheet metal about 1-inch (2.5 cm) longer then the actual outside circumference of the bands. Attach one end at the inlet and outlet of the copper tubing and work your way around. You can make the final cut at the end to fit perfectly using a good pair of scissors or tin snips. I just lined the bottom up evenly as I attached the sheet metal then trimmed the top to fit along the top band after all of the riveting was finished. These made a nice even-looking finish around the top and bottom. The next step is to build the glycol chiller.

7: GLYCOL CHILLER

The glycol chiller is made using a 5000 BTU window air conditioner and a 6½ gallon (25 L) ice chest. Take the outside housing off of the AC unit and remove any screws holding the evaporator coil. The evaporator coil should have enough freon tubing so it can be bent to position the coil inside of the ice chest. Be careful not to kink the tubing as you position the coil. Using a jigsaw, cut a notch at the top of the cooler for the freon lines to go through. The fan that blows air across the evaporator coil is no longer needed. Remove the fan blade and cut the motor shaft off with a hacksaw. Now trim the outside housing with tin snips and reinstall it.

8: HARVEST THE AC UNIT

The temperature control thermostat on the AC unit can be removed and the two wires to it twisted together with a wire nut. This will cause the unit to run any time it has power. The glycol temperature will be controlled using one of the Love temperature switches by monitoring the temperature of the glycol bath. I made a thermal well out of a piece of ⅜-inch copper tubing to support the Love switch temperature probe in the side of the cooler.

I drilled a ⅜-inch hole in the side of the AC unit housing and reinstalled the high/low switch there. The power to the AC unit will be switched on and off with temperature switch. As the glycol warms up the AC unit will come on; when the glycol cools to your set temperature, the AC unit will kick off. That is cool! (Be sure to keep pets and children away from the glycol; it tastes sweet but is toxic.)

9: TEMPERATURE CONTROL

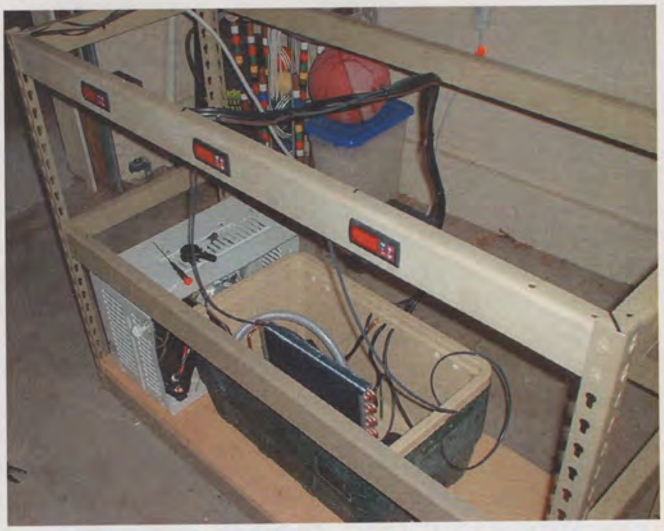
The Love Digital Temperature Switch comes complete with a temperature probe and is pretty much ready to use right out of the box. If you have never used this type of control, you may spend a little time learning the basics, but the instructions provided with the controller have all of the information you need.

I mounted the three temperature controllers across the front panel of my shelving unit. The center control has its temperature probe in a homemade thermal well inside of the ice chest. The other two controllers turn the large fountain pumps on and off, as each of the two fermenters requires cooling. Their temperature probes are mounted inside the thermal well on the Sabco fermenters. I had to drill the factory thermal well out slightly on the Sabco fermenters so the probe would fit inside. Use a 9⁄32-inch bit and be careful, stainless steel can be very hard to drill (read about drilling stainless steel in the project on page 25).

10: ASSEMBLE THE SYSTEM AND PUMPS

Three fountain pumps control fluid movement through the system. The smaller pump has a short hose connected to the outlet and simply circulates glycol around the coil inside the ice chest. This smaller pump runs continuously. The other two larger pumps have their outlet connected to a section of ⅜-inch PVC hose. The other end of the pump outlet hose is connected to the top copper tubing on the fermenter. The bottom copper tubing on the fermenter is connected to another ⅜-inch hose that dumps the glycol back into the ice chest. I drilled ⅝-inch holes in the side of the ice chest, above the liquid level, for the lines to go through. Plastic wire ties hold the lines securely in place.

The Love temperature switch provides power for the large pumps. The probe for the temperature control monitors the temperature inside the fermentation vessel. If the vessel needs cooling, the pump comes on and circulates glycol around the vessel until the set temperature is reached, at which point the pump kicks off.



12: WIRING

If you are not comfortable working with electricity, get a professional to help you wire this project. I used the Ground Fault Interrupter (GFI) plug that came with the air conditioning unit to power everything. The GFI has a 20-amp circuit breaker built in. I use Test and Reset buttons to switch everything off and on manually when I am not using the system. Each of the larger fountain pumps is controlled off and on by their own Love temperature switch. The probe for this switch is inserted into the thermal well on the fermenter. As the fermenter requires cooling, the temperature probe will signal the switch to turn on the pump. When the fermenter temperature reaches the set point on the Love switch, the pump turns off.

The air conditioning unit is connected to it's own Love temperature switch. The probe for this switch is in a thermal well inside the ice chest. As the glycol heats up, from being circulated around the fermenters, the switch tells the AC unit to come on. When the glycol in the ice chest reaches the set point on the Love switch, the AC unit turns off.

13: Test Run

Use water in the cooler for testing the system, but don't set the temperature to go below about 35 °F (2 °C) with water or everything will freeze solid. After everything tests out, replace the water with a glycol mixture. I use a 40/60 mixture of pure propylene glycol and water. This mixture will provide a freeze protection to about -10°F (-23 °C). You will need this much protection because the actual temperature of the fluid directly in contact with the cooling coil in the ice chest is most likely well below freezing temperatures. I run my chiller at 30 °F (-1 °C) during primary fermentation, then I lower it to 20 °F (-7 °C) to crash cool before racking. If you don't run enough glycol in solution you risk the mixture becoming thick and slushy at lower temperatures. BYO

Inline Aerator

Story and photos by **Tony Profera**

As homebrewers, we have control over many of the physical processes used to make our beer. It's been known for some time that after boiling (and then chilling the wort) it is highly beneficial for the yeast to be pitched to a well aerated/oxygenated media. The fermentation life cycle (and ultimately the beer quality) will benefit from reduced total fermentation time, shorter lag time (the time it takes for fermentation to start), better attenuation and improved yeast life cycle.

There are several common methods homebrewers use to aerate the wort. Most of us are familiar with the rock-and-roll method of vigorously shaking the fermenter to add air. This has the advantage of requiring no additional equipment. Although a plastic bucket is safer, there are concerns with repetitively rocking a full glass carboy.

There are various adapters (both commercially sold and others that can be built) that when installed on the end of a hose leading into the fermenter will "splash" the wort to aid in aeration. Another method makes use of an aquarium air pump and air stone. These assorted air introduction methods work to varying degrees. The downside to these methods is the air we breathe is mostly nitrogen and only 20.9 % oxygen. Also, air may contain contaminants if not properly filtered. If higher O_2 saturation levels are beneficial to the fermentation it makes sense to use pure O_2 for this purpose.

At the top of the performance list is direct injection of the wort from a 100% oxygen source. Although over oxygenation is a concern, the general consensus is that there is little possibility of this occurring in homebrewed beer as homebrewers do not achieve commercial-level brewing temperatures and pressures. Typically a small O_2 canister and screw on regulator with a hose and air stone are used. The regulator is turned on low and the air stone is submerged into the fermenter containing the wort creating a steady stream of tiny O_2 bubbles. This infusion of pure O_2 raises the dissolved oxygen level to assist the yeast in their all-important work of fermentation.

A potential downside to this "dunk in fermenter" method is the stream of bubbles may not be equally dispersed throughout the fermenter and might not permit other areas of the fermenter to be oxygenated to the same concentration. Additionally, this method adds extra time to the brew session as it's performed after the wort is already in the fermenter.

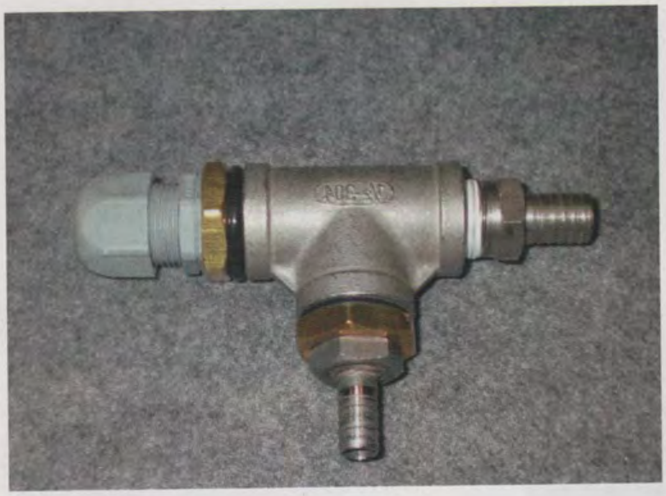
In an effort to improve on this method (and because I am a gadget guy) I built a DIY in-line oxygenator. It is installed on the "out" side of the counter flow chiller (CFC). It injects oxygen into the wort as it moves from the counterflow chiller and into the fermenter. Adding oxygen to the wort as it moves to the fermenter ensures that a more even adsorption of oxygen is made, and saves a bit of time as well.

Parts and Tools

- (1) Kleinhuis Liquid Strain relief fitting NPT ½-inch (fit to outflow of counter flow chiller or kettle)
- (2) large brass nuts (to fit ½-inch NPT)
- (2) large O-rings sized to fit ½-inch NPT
- (1) ½-inch NPT stainless steel tee
- (1) stainless steel ½-inch NPT Male x ½-inch barb fitting
- (1) 0.5 micron barbed (or shaft) stain less steel air stone
- (2) small O-rings (R04) sized to barb of air stone (+ extras)
- (1) ½-inch NPT male x ⅜-inch stainless steel barb fitting
- Teflon tape

1: THE OXYGENATOR

Unlike some commercially-sold versions available to homebrewers, this DIY In-Line oxygenator is designed for easy breakdown by hand or with an adjustable wrench. This makes the task of cleaning it after use relatively simple. Remove the apparatus from the CFC, disassemble, rinse thoroughly, soak in your regular cleaner, rinse and air dry until the next time. Note: it's recommended that air stones are only handled by the shaft. There is a possibility that the oil in our skin can be transferred into the stone reducing performance (and increasing the chance of contamination).



2: PARTS AND ASSEMBLY (PART 1)

Start by working from left to right in this project (same as the flow of the wort). The first part is a ½-inch NPT Kleinhuis strain relief fitting. These nylon fittings can be easily found if you search the Internet for "liquid tight strain relief." This fitting's opening is matched to the copper tubing (wort out) from my CFC. Note: the screw down cap on this fitting needed a bit of additional clearance to fit over the CFC's tube so the hole was enlarged by filing to get a good fit. Hand tightening the cap is all it takes to get a leak proof seal. You will need to size this fitting accordingly to match your CFC or kettle. A compression fitting sized to your chiller or kettle out could be substituted. A brass ½-inch nut and a large O-ring are installed to achieve a tight seal to the SS Tee.

At the other end of the tee (on the outflow side) is a ½-inch NPT x ½-inch stainless steel barb fitting installed with Teflon tape. A vinyl length of hose is fit over the barb and leads to the fermenter for filling.

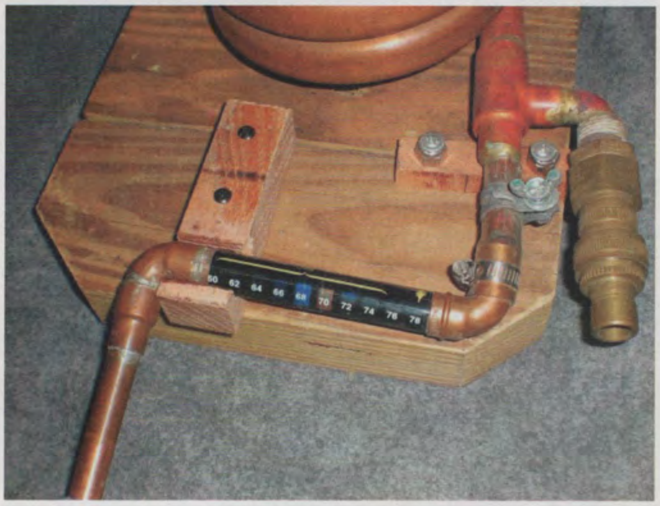
3: PARTS AND ASSEMBLY (PART 2)

In this photo you can see a closer look at the Kleinhuis strain relief fitting. At the center of the tee is a stainless steel ½-inch NPT Male x ⅜-inch barb with two small O-rings pushed inside. The air stone's barb is then pressed onto these O-rings to make a seal. I originally had difficulty getting this point to seal well. It took a few tries with differing O-rings to get a leak-free seal. This fitting with the air stone installed is screwed into the tee with a large ½-inch brass nut and O-ring making a liquid tight non-permanent connection to the tee. The air stone is now captured inside the body of the SS Tee fitting.

4: PARTS AND ASSEMBLY (PART 3)

Attached to the barb is a flexible hose leading to a sanitary air filter. To the other side of the air filter is a hose that leads to the O_2 regulator. As these hoses are a larger diameter than the air filter barbs, a small ½-inch length of rigid polyethylene hose was installed on the filter barbs to take up the gap and allow a gas tight press fit.

Boiling the air stone for 15 minutes prior to use ensures it is sanitary and no bacteria remains alive to adversely affect the brew. The rest of the parts are soaked in Iodophor or Star San and then reassembled for use.



5: UPGRADES

If you want to upgrade this build, some of the changes I am considering include removing the two small O-rings and silver soldering the air stone barb into the ½-inch stainless steel fitting. This will ensure there are never any leaks from this point. Caution: if you decide to do this be sure that the air stone itself does not get heated or the barb may become unsoldered/brazed from the stone and can pull out! Wrapping the stone with a small length of wet cloth should keep the stone cool enough to prevent this. I plan to replace the brass nuts for stainless steel. You can also consider replacing the "stick on" temperature gauge (see photo) with a small digital temperature gauge.

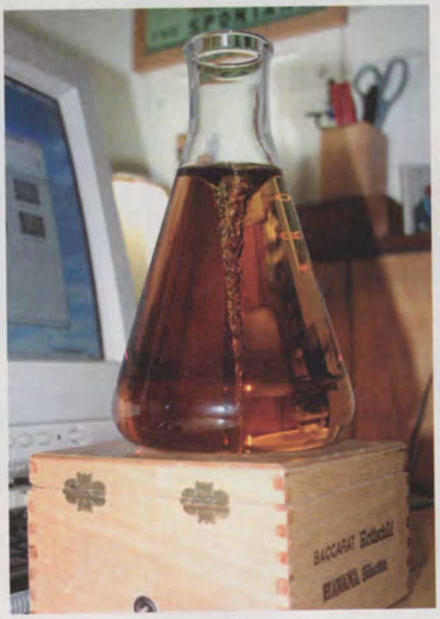
6: FINISHING AND SAFETY

All fittings should be thoroughly degreased and cleaned prior to assembly. Any grease that remains that comes in contact with oxygen can cause a fire, and any grease or residue won't help your beer either. Additionally, any ignition source in the presence of pure O_2 is hazardous! Be certain all flames are out prior to using pure oxygen.

Once you've got all the pieces in place, you can attach it and give a go! BYO

Yeast Stir Plate

Story and photos by **Forrest Whitesides**



If you ask experienced brewers for advice on improving your beer, one of the things they are most likely to say is, "Make a yeast starter!" One easy way to improve your yeast starter is to use a magnetic stir plate and stir bar during the fermentation of your starter. A constantly-stirred yeast starter will yield a higher cell count than an unstirred starter. Commercially available stir plates start out at about $80 for a small unit and go up from there. But, with a little ingenuity and some spare parts, you can make one yourself for much less.

The heart of the project is a strong neodymium magnet (more commonly known as a rare earth magnet) affixed to an 80mm 12-volt DC fan typically used in desktop computers. You'll also need some type of power supply, some nuts and bolts and washers and a suitable enclosure to house the whole project. For this article, I used a wooden cigar box, but you can modify that design (I have also built a stir plate with an old external hard drive case). You'll also need a flask and a magnetic stir bar.

> "Commercially available stir plates start out at about $80 for a small unit and go up from there. But, with a little ingenuity and some spare parts, you make make one yourself for much less."

Parts and Tools

- Power drill
- Felt tip pen
- Wooden cigar box
- 80mm 12-volt DC fan
- 12-volt AC/DC wall adapter
- Rare earth magnet
- #6-32 x 2-inch machine screws
- #6-32 machine screw nuts
- #6 metal washers
- ¼-inch flat neoprene washers
- ¼-inch inside-diameter rubber grommet
- Plastic wire connectors

Sourcing Magnets

There are many places you can get an appropriate magnet for this project, including taking them from old or broken hard drives or ordering them from scientific supply shops.

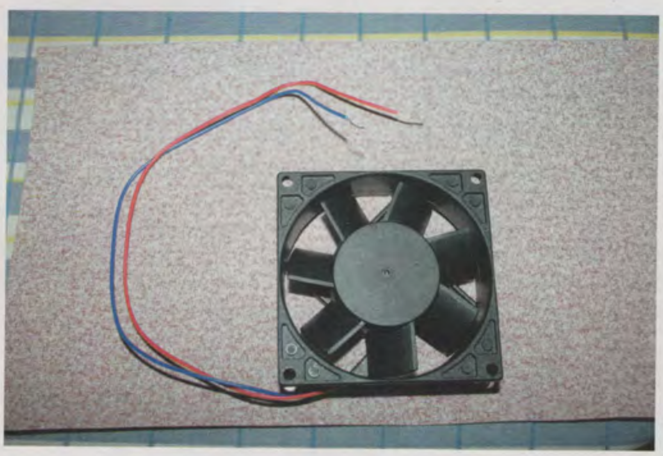
The balance of the stir plate is very important. One of the advantages of using common PC case fans, however, is that they have relatively low torque. Your stir plate may wobble a fair bit with nothing on top of it (especially a light-weight cigar box), but test it with a full flask before you start worrying. Consider that the liquid in a full 1-L flask weighs 1.0 kg (2.2 lbs.) and a 2-L flask would be, obviously, double that (plus the weight of the flask itself). In my tests, a two thirds full 1-L flask is sufficient to dampen all vibration and wobbling.

1: CHOOSING A FAN

An inexpensive PC case fan from your local electronics retailer will work just fine for this project, as will any case fan you can pull out of any old PC. Garage sales are an excellent source for old PCs, and one PC will provide you with multiple fans and a hard drive from which you can pull a great magnet for use in this project.

Any 12-volt DC fan will work, but some offer more features than others. Radio Shack, for instance, sells a barebones fan with just a lead wire and ground wire. This type of configuration is very easy to work with, but offers no rotational speed control. On the other end of the spectrum, computer parts maker Antec offers a nice case fan with an integrated three-speed selector switch, giving you a no-fuss method of controlling the rotational speed. It also has built-in colored LED lights (which doesn't help your yeast, but does look cool). Of course, you can always wire in a potentiometer for fine-grained control of the more simple fans, or you can use a multi-voltage power supply.

The stir plate described in this project uses an 80-mm fan and is ideal for 1-L flasks. If you plan to use a 2-L or larger flask for your starters, consider using a 92-mm fan and a larger enclosure, although 80-mm will still work.



2: PREPARING THE FAN

To prepare the fan for use as a stir plate motor, center the magnet on the fan's hub (the central round surface to which the fan blades are attached). The magnet will be attracted to the metal coils inside the fan housing, which will hold it in place temporarily.

Holding the fan in your hand, give it a spin with your finger to check how well the magnet is balanced. If you feel some wobble, adjust the position of the magnet on the hub. When you have the magnet positioned properly, mark the edges with a felt pen and remove the magnet.

Now apply a small amount of multi-surface adhesive - I recommend Gorilla Glue — to the fan hub and reposition the magnet as marked. Allow the glue to dry as per the manufacturer's instructions, usually 12 to 24 hours, before installing it in your enclosure.

3: POWER SUPPLY

You will need to power your fan with a 12-volt wall-adapter type power supply. You may very well already have one or more of these devices around the house as they are common sources of power for lots of small electronic devices. A 9-volt power supply will also work, although it will make the fan spin slower than a 12-volt adapter.

You can also use a multi-voltage power supply sold as a universal model to power many types of devices. These cost a bit more, but they allow for stepped control of fan rotation speed via selectable output voltage.

Whatever model you choose, you will cut off the round adapter plug (the end that plugs into an electronic device) and strip back the wire an inch or so in preparation for splicing it to the fan's lead and ground wires. If you are not comfortable wiring electricity, ask a professional for help.

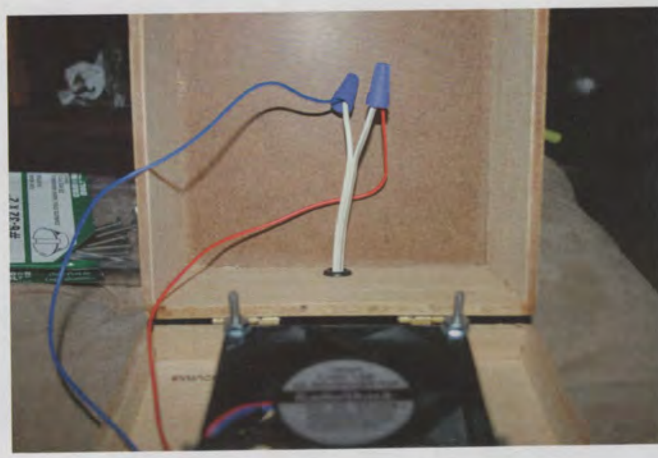
4: ASSEMBLY (PART 1)

Line up your fan flat in the center of the top of the cigar box lid and use a felt-tip pen to mark a dot for each of the four holes in the fan casing. If you can't find a pen small enough to get through the hole, you can also ink the end of a cotton swab and use that to make the four dots. Now drill four $\frac{13}{64}$-inch holes on the dots. Since the sheet metal screws have a tapered head, countersink the four holes with a $\frac{7}{32}$-inch bit to allow the screws to sit perfectly flush in the lid. Also drill a $\frac{1}{4}$-inch hole near the bottom of the rear panel and fit the hole with a rubber grommet. You may also want to drill some holes in the enclosure to allow the motor to have some fresh air, so that the mechanical heat from the fan motor can be dissipated.

Open the lid, fit four screws through the holes and put a neoprene washer (to help with vibration dampening) and then a metal washer over each screw. Guide the four holes in the fan casing onto the screws and push the fan flush against the washers. Give the blades a spin with your finger to make sure the magnet clears the lid and the fan can spin freely. If it does not spin freely, remove the fan from the screws and add additional washers to put more space between the lid and the fan. Add a final metal washer after the fan and finish off with a nut for each screw.

5: ASSEMBLY (PART 2)

Make sure that the power supply is unplugged before proceeding. Now pull the wires of the power supply through the grommeted hole in the back of the cigar box. Use a pair of wire connectors to splice together the two lead wires and two ground wires. (You can use a voltmeter to differentiate lead from ground, or you can just use trial and error). Plug the power supply into the wall to verify that the wiring is correct. As an additional touch, you can cut a piece of plexiglass to fit the lid of the cigar box to protect the wood and electronics from liquids.



6: FINE TUNING

Magnetic stir bars can often be finicky. Even with commercial-grade stir plates, it is sometimes difficult to get them to spin properly. One of the easiest ways to get your stir plate operating smoothly is to use either a multi-voltage power supply or a fan with built-in speed selector (see photo). (The fancy fan is a much cheaper than the fancy power supply.) Start the stir bar off at a lower speed and then increase the speed when it is smoothly spinning. Starting off at too high or too low rotational speed often makes the bar jitter and dance, but not spin. The more options you have on regulating the speed of the rotation of the fan and magnet, the easier it will be to get good results from your starter. BYO

HELPFUL GEAR

In-Line Thermometer

Story and photos by **Forrest Whitesides**

So, if you followed the instructions on page 39, you've got a great new counterflow chiller to knock down your boiling wort to yeast pitching temperatures. But now you aren't sure how high of a cooling water flow rate you need to do the job. What you need an in-line thermometer to give you hands-free and real time feedback on the temperature of the wort as it leaves the chiller.

This type of thermometer is positioned after the "wort out" connection on a counterflow chiller and is connected on either end by vinyl tubing. The wort flows out of the chiller, through the in-line thermometer and then into a fermentation vessel (carboy, bucket, etc). The in-line thermometer shows you temperature changes in the wort as it happens. This allows you to adjust the flow rate of cooling water going into the chiller to get the target pitching temperature you need for whatever type of yeast you might be using.

If you have cool or cold ground water, using such a thermometer will also help you save money by allowing you to reduce excess water usage during cooling. Brewing is a water-intensive process, and if you can dial in the exact flow rate you need, you can potentially save several gallons of water per brew session. In addition to the cost savings, cutting your water usage is also environmentally friendly.

There are two materials options for this project: metal or clear PVC. Metal conducts heat better than plastic and allows the thermometer to adjust to temperature changes quickly. Clear PVC is lighter and cheaper and allows you to see the wort as it flows through.

Parts and Tools

For the metal thermometer, you'll need the following parts:

- ½-inch x 3-inch pipe nipple, brass
- Two ½-inch FPT to ½-inch hose barb fitting, brass
- LCD self-adhesive aquarium thermometer, small vertical style
- Teflon pipe tape
- Clear plastic packing tape

If you want to go the clear plastic route, here's what you'll need:

- ½-inch x 4-inch* pipe nipple, clear PVC [Fig. 6]
- Two ½-inch FPT to ½-inch hose barb, PVC or polypropylene
- LCD self-adhesive aquarium thermometer, small vertical style
- Teflon pipe tape
- Clear plastic packing tape

* You may have difficulty finding clear PVC at your local hardware store. If so, you can order it online from U.S. Plastics (www.usplastics.com) using part number 34349.

*Note: The 3-inch clear PVC pipe nipple that U.S. Plastics stocks has less non-threaded surface than the equivalent brass part, so I recommend that you get the 4-inch part. For the hose barb fittings, you can use any available plastic material that is safe for potable water.

1: PRE ASSEMBLY

Before assembling this project, the brass parts should be washed with warm water and mild soap to remove any dirt and oil and then dried. The first step is to give the threads on both ends of the pipe nipple a liberal wrapping of teflon tape. It is very difficult to get a good seal with threaded metal fittings without using pipe tape. Now screw in the hose barb connections to either end of the pipe nipple. Hand-tightening may be enough to get a good seal, but you should give each connection a little extra torque with a wrench just to be safe. Even the smallest leak in your thermometer will give you a headache on brew day by adding to overall cleanup time. (Over time, temperature fluctuations can cause the metal to expand and contract, which can loosen the fittings. You should check the tightness of the fittings after every third or fourth usage).

2: AFFIX THE THERMOMETER

Now that all the fittings are snugly connected, affix the LCD thermometer to the pipe nipple. The small vertical LCD thermometers commonly available in pet stores are generally about three inches high, which is a tight fit on our 3-inch pipe nipple. You may have to trim a little off the bottom of the thermometer strip. When I assembled this project, I needed to trim off the name of the manufacturer in order to get it to fit on the pipe nipple. Trimming will not in any way impair the operation of the thermometer, so don't be shy about customizing it to fit your project. Since they retail for about $2 at most pet stores, go ahead and buy two of them in case you trim a little too much.

3: COVER THE THERMOMETER

To finish off the in-line thermometer, give the pipe nipple a turn or two of plastic packing tape. The stick-on strip thermometer was designed to be used on flat glass rather than concave metal, so the clear tape will help keep it in place long after the adhesive backing wears out.

4: GOING PLASTIC

Putting together a see-through thermometer is nearly identical to the steps involved with the metal version: Wrap the threads with pipe tape, screw in the hose barb fittings, and affix the LCD thermometer strip and wrap it with packing tape.

5: METAL VERSUS PVC

The strip thermometer used in this project reacts to temperature changes surprisingly fast considering its low price. I tested both a metal and clear PVC version of this project to get a rough idea of how it would perform in a situation of quickly changing flow temperatures. Starting off with warm tap water (approximately 90 °F or 32 °C) flowing through the thermometer, I quickly shifted to much cooler water (approximately 60 °F or 16 °C) and noted how long it took the thermometer to register the change. The metal thermometer took about eight seconds to adjust to the change, while the PVC thermometer took about 15 seconds. I did not test under "laboratory conditions," so take the above results as rough estimates of performance.

6: VARIATIONS ON A THEME

The above parts and methods are merely suggestions. Feel free to substitute larger or smaller fittings to suit your individual brewing setup or use stainless steel instead of brass. Above all, don't be afraid to be creative. BYO

Pumped Up Toolbox

Story and photos by **Ryan R. Lockard**

About three years ago, I decided the time had come to upgrade to a pump, but without a dedicated brewing structure, I needed to design a portable solution. Since there was also an ongoing need to organize many of the smaller brewday items, this design for a brewing toolbox seemed to solve multiple needs at once.

When I first developed this piece of equipment I had doubts about the pump heat displacement and the durability of the build. This configuration has been used for dozens of brew sessions, usually with the lid closed in both the heat of summer and ice of winter. I have run the pump nonstop for up to 45 minutes during a large lager batch chilling recirculation (I typically begin recirculation with 15 minutes remaining in the boil to sanitize the pump, lines and chiller). Over time, there has been no visible or noticeable impact to the pump performance — and more importantly to the quality of the beer. These pumps can sometimes shut down if they overheat. Often if you let them cool down they will start again, however, you can modify your design to include a basic thermometer probe to measure the air temperature in the box to avoid overheating.

My system uses a hodgepodge of brass and stainless fittings. Ideally, just use all stainless steel fittings. With the exception of the March pump, all the components of this build can be found at any local home improvement store, although stainless fittings may have to be sourced online.

Important: if you do not have access to a GFCI (ground fault circuit interruptor) outlet during your brew day, you **MUST** modify this plan to incorporate an inline GFCI breaker, otherwise do not take on this project. You can find an inline GFCI breaker at most homebrew stores. Liquid and electricity can seriously hurt or kill you. Do not attempt any electrical wiring if you aren't experienced. Find an electrician to do the work for you.

Parts and Tools

Optional Parts:
- March 809 pump
- Misc fittings
- Plastic toolbox (Home Depot Workforce 17182281 A625-768)
- Inline GFCI breaker
- Grounded extension cord

Switch Box Tools and Parts:
- Electric switch
- 1-inch hole Saw
- (2) coat hook
- Drill
- Scrap 2x4
- Screw drivers (phillips and slotted)
- 6-inch worm clamp
- Utility knife
- ½-inch street elbow fitting
- Wire clamps
- Wire nuts
- Wire stripper
- (8) Size 10 machine screws
- Marker
- (8) Size 10 machine nuts

1: PREPARE THE PUMP

To start, remove the four screws securing the pump head to the pump motor, and remove the pump head. Affix the pump motor to the 2x4 scrap using the worm clamp. Ensure the wire box on the pump motor is accessible for later use.

Next, dry fit the pump and 2x4 inside the toolbox, and mark where the pump shaft meets the toolbox wall, mark this point with a marker. Using a drill, make a pilot hole at the point you marked inside the box.

Using a hole saw centered on your pilot hole, drill through the toolbox wall. The hole should be large enough for the shaft to easily fit through the wall. Remove any burrs with a knife. Your pump should now easily fit inside the toolbox and the shaft should fit through the wall.

Now cut a 1-inch (2.5 cm) hole in the middle center of the back of the toolbox for the power supply cord.

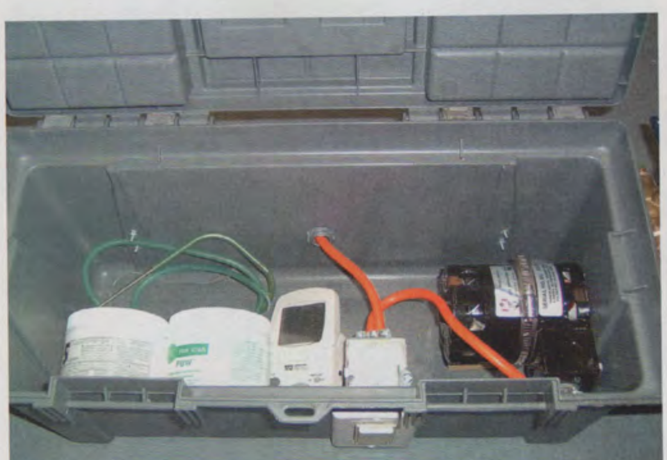
2: WIRING

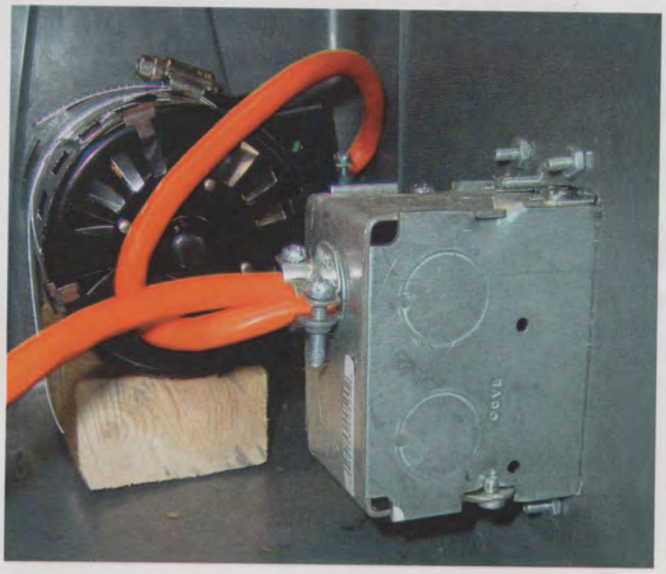
Cut the female end off the extension cord. Cut a 12–15 inch (~30–38 cm) section of cord, and set aside. Feed the cut end of the longer cord through a wire clamp and the hole drilled in step 4. Remove the insulation and strip the three wires (green, white and black) from the longer section of cord. Tighten the wire clamp with about 12–15 inches (~30–38 cm) of spare wire inside the toolbox.

Strip the insulation from both ends of the shorter cord, and strip the insulation from the three interior wires at both ends. Remove the cover plate from the pump motor to expose the pump wiring. Match the colors to one end of the small section of extension cord and secure with wire nuts. Re-attach the wiring cover plate.

3: INSTALL THE SWITCH BOX

Measure the outside dimensions of your light box and mark the dimensions on the front of the toolbox. Cut out the marked dimensions with a knife. The switch box should dry fit into the new hole. Punch out one wire hole in the switch box and feed in the remaining end of the shorter cord and the remaining end of the longer section (leave a minimum of 5 inches/13 cm of cord inside of switch box, excess can always be trimmed later). Secure both cords with a wire clamp. Secure the switch box to the toolbox with screws and nuts as shown.





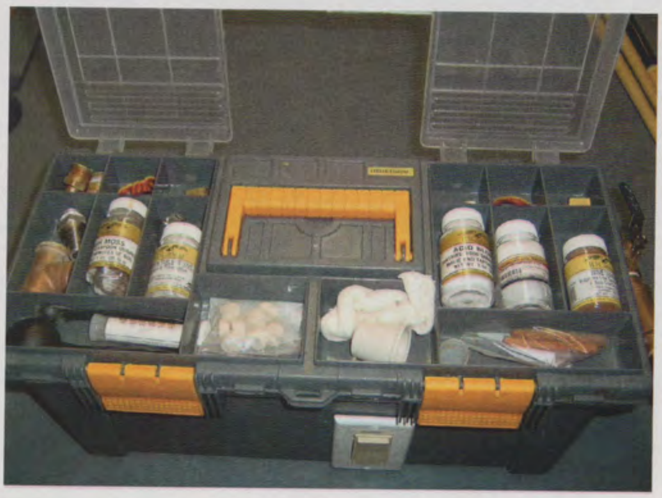
4: ATTACH THE WIRING

Mark the non-stripped section of cord (this is your source wire). Strip the insulation and interior wires from the longer section of cord. Feed both the shorter and longer cords through the wire clamp and the back of the switch box. Wire the switch using the two black exposed wires. Ensure the ground (green) and current (white) wires are secured with wire nuts, and attach the switch to the switch box. Attach the switch plate. Tighten the wire clamp (see photo).

5: INSTALL THE PUMP

Dry fit the pump head to the outside of the toolbox on pump motor shaft with the inlet at the 6 o'clock position and the outlet at the 12 o'clock position. Using a marker, mark the location of the six pump head screws and remove the head and move the motor so the drill does not cause it damage. Using a ⅛-inch bit, drill pilot holes for the four marked screw holes. Refit the motor and head and secure the head to the motor using the manufacturer's screws. The pump should be secure to the toolbox now. Add the street elbow fitting to the inlet port of the pump head. The street elbow will allow for easy tubing connection later.

Screw the two coat hooks to the back of the toolbox as shown in this photo. Wrap the exterior cord around the hooks.



6: PRIME THE PUMP

Fill the toolbox with your brewing items. At the risk of sounding obvious, you should think about where you place your items. The pieces you may need in a pinch or have easy access to should be either in lid compartments, or the inner tray so you do not have to rummage.

One of the largest issues with first time pump users is priming the pump. Without proper priming the pump will not create a vacuum and not perform properly. Because of the inlet/outlet orientation, the vacuum can be created fairly effortlessly. When using the pump, position the toolbox lower than the vessel, open the valve on your vessel and allow the liquid to flow into the pump head. This will force the air out of the pump head. After a minute or two, switch on the pump and you should be flowing issue free. BYO

Water Filter

Story and photos by **Forrest Whitesides**

If your tap water isn't quite up to muster for use as brewing water because of heavy chlorine or other off odors and tastes, you are pretty much limited to two options: buy bottled water for brewing or filter what comes out of the tap.

Buying water from your local grocery store or big-box club store is relatively painless, but it does require a trip to the store and hauling the water home, and then you have to dispose of the plastic containers.

Filtration can be quite expensive initially. Whole-home systems can cost more than $1,000. And while countertop filters can be found for starting at about $60, replacement filters cost from $20 each and need to be replaced every 300 gallons or so, on average. Considering the cost of the filter unit and the first filter cartridge, a countertop filter delivers good brewing water for about 30 cents per gallon. Pitcher-based filters, like the popular Brita models, deliver fantastic results as well but are unbearably slow for filtering in quantities needed for brewing, and the cartridges require frequent replacement. So why not build your own filter?

The filter used in this project is rated to operate effectively at flow rates up to 2.5 gallons per minute (which is the federally mandated maximum flow rate for showerheads and faucets, established by the Energy Policy Act of 1992). Depending on your water pressure, you may have to run water through the filter at less than the maximum rate possible in order to get adequate filtration. If it takes more than 24 seconds to filter one gallon, your flow rate is within the operating standard. If it takes less than 24 seconds, you need to lower your flow rate for optimal results.

Parts and Tools

- Culligan WHR-140 in-line filter
- (1) 2-inch 90-degree elbow joint, PVC
- (2) 2-inch x ½-inch bushing adapter PVC
- (1) 2-inch x 3-inch coupling, PVC
- (1) ½-inch male thread x ⅝-inch hose barb (I used brass, but use stainless or plastic)
- (1) ½-inch male thread x ½-inch hose barb, (stainless or plastic)
- (1) Universal dishwasher snap adapter for sink, (chrome)
- ⅝-inch vinyl tubing, cut to fit
- Optional: ½-inch ball valve, brass (instead of ½-inch hose barb)

Note: This project is designed to be used with a kitchen sink, but can easily be adapted for use with garden hose fittings. If you'd rather use the filter with your garden hose hookup, you can simply substitute a ¾-inch garden hose adapter in place of the ½-inch male thread x ⅝-inch hose barb on the water-in side. Then just attach the filter to your garden hose connector. You can also get a garden hose adapter for your sink and use a washing machine water hose if you don't want to fuss with the vinyl tubing and barbs. Also, you can (and in some states have to) substitute nylon hose barbs in place of the brass barbs for a cleaner look and an all-plastic configuration.

1: THE FILTER

The core of our system is, of course, a water filter. I specifically chose a Culligan WHR-140 in-line filter because of its long life and compact size. The WHR-140 is an in-line filter used in Culligan showerheads. It is available most places that sell filtered showerheads, such as Bed Bath & Beyond and other home stores, and it costs about $15. It is also available online. It uses a filter media made by KDF Fluid Treatment Inc., which, according to the manufacturer, removes 99% of free chlorine, reduces water-soluble heavy metals and also eliminates sulfur odor. The performance life of this filter is rated at 10,000 gallons (38,000 L) before replacement is necessary. For technical information on the filter media itself, see the manufacturer's website at www.kdfft.com.

Considering a total project cost of around $40, the cost-per-gallon for this filter is about one-half of one cent per gallon. For all-grain brewers, this translates to approximately 1,000 batches worth of brewing water, assuming approximately 10 gallons (38 L) total used to arrive at a final volume of 5 gallons (19 L). This depends, of course, on mash thickness, how long you boil and several other factors. Like anything else, your mileage may vary.

2: SLIDE FILTER INTO ELBOW

Before you get started assembling the filter, wash all the parts (PVC and brass) in warm water with a mild soap. The PVC will likely be dirty from sitting on a shelf in the store and the brass connectors have a thin sheen of oil on them to protect from corrosion. You'll want to wash all that off before you use the filter to clean up your tap water.

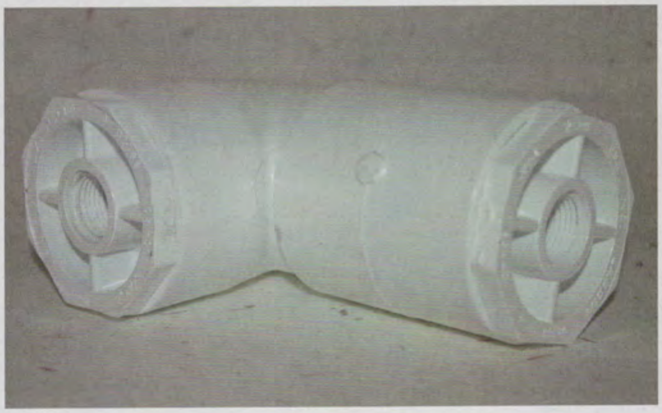
First, slide the filter unit into the smaller-diameter end of the PVC elbow joint until the rubber gasket on the filter is snug against the elbow opening (see photo).

3: SLIDE ON COUPLING

Now slide the coupling over the end of the elbow where the filter sticks out. On both ends of the joint, insert the bushing adapters (see photo step 4). Now we're ready to screw in the water in/out connections. Liberally apply pipe tape to the threads of the ⅝-inch hose barb and screw it in to the bushing attached to the coupling piece. Repeat the same procedure with the ½-inch hose barb and screw it in to the other bushing (see photo step 5). As an alternative, you can "kick it up a notch" by using a ½-inch ball valve in place of the ½-inch hose barb. I chose a ball valve with a spigot bib because it has an angled head, which makes it ideal for countertop use (see photo step 6).

4: BUSHING ADAPTERS

Unscrew the standard aerating faucet insert from your sink and screw in the dishwasher snap adapter. Attach one end of a length of ⅝-inch vinyl tubing to the faucet and the other end to the ⅝-inch hose barb on the water filter. All that remains is to turn on the water at your faucet and collect the filtered water in a hot liquor tank, bucket or kettle. If you opted to use a ball valve for the water out connection, be sure the valve is in the open position when you turn on the water from your sink. Otherwise, the pressure buildup will cause the PVC parts to fly apart rapidly and possibly violently. (I discovered this the hard way!) Be very careful.



5: HOSE BARBS

Allow a few gallons to run through the filter before collecting any water for brewing. This will allow for any filter media dust to be expelled, and give you a chance to verify the integrity of the various connections. If you notice leaks around the in/out connections, reapply pipe tape and re-tighten the connection. Leaks at the PVC joints indicate that the parts do not fit snugly. Disassemble the unit, reconnect everything, and test again. If you still get leaks, you can use plastic pipe cement to seal each connection. Just make sure that whatever you choose is safe for use with potable water.

6: FILTER MAINTENANCE

If after time, the flow rate of the filter slows down noticeably, it is likely that there is a buildup of sediment partially blocking the filter. To remedy this, connect your sink faucet to the water-out hose barb or valve and let the water run for a few minutes. This will back-flush the filter and eject the sediment. BYO

HOPS

Randall-Style Hop Filter

Story and photos by **Christian Lavender**

Most of the homebrewers I know that own kegerators rarely bottle their homebrew anymore. But some of the most hopped homebrews I've tasted lately seem to come in bottle form. As a kegerator homebrewer, I asked myself, "How can I make my draft homebrew hoppier?"

I use kegs as my secondary and tertiary fermenting vessels when brewing, and with the right timing, this allows my brew to self-carbonate with the malt sugars left over from the main fermentation. With this process of fermenting, conditioning and dispensing within a closed keg system there never seems to be a good opportunity to introduce any additional bittering/flavoring/hop aroma to my draft homebrew. Filtering hops within the system seemed like an answer.

I had read about the original Randall the Enamel Animal, a Dogfish Head invention, and many other different types of hop filter builds online and from friends, but I wanted to build a hop filter that was going to be kegerator-friendly, easy to detach and clean and cost effective. So, I decided to introduce a hop filter to my home kegerator system.

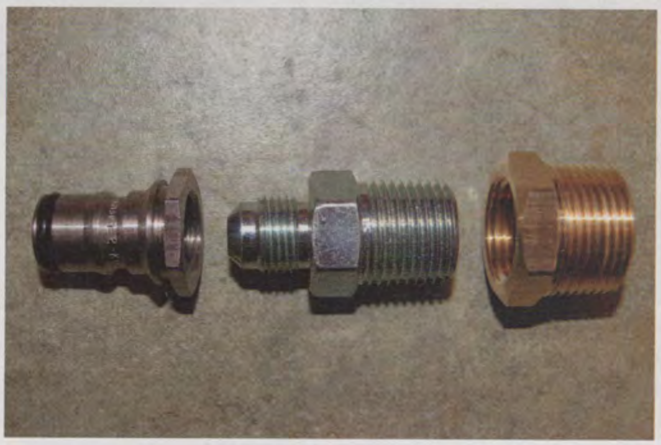
After assembling the hop filter, getting it installed and pouring my first homebrew, I have to say I could really taste a difference in the hop profile of the beer. One small addition to the kegerator has made an already smooth operator into a smooth hoperator!

Parts and Tools

- GE Household Pre-Filtration System. Model # GXWH20S
- Brewer's Edge® KettleScreen™ with ½-inch thread and 12 inches long
- ½-inch Male pipe thread to ⅜-inch male barb connector
- 4 small ⅜-inch O-rings
- 3 clamps
- ½-inch female pipe thread to ½-inch female pipe thread coupling
- 2 Firestone liquid posts with ⅜-inch female pipe thread
- 2 ⅜-inch Male pipe thread to ½-inch male pipe thread reducers
- 2 ¾-inch Male pipe thread to ½-inch female pipe thread bushings
- 2 Quick disconnect fittings for ball lock kegs with ¼-inch MFL (threaded)
- 2 ¼-inch swivel nut to ¼-inch barbed end sets
- 4 ft. of 3/16-inch inner dimension PVC tubing
- Teflon tape
- Filter wrench
- Adjustable wrench
- Flat head screwdriver
- Metal snips
- Measuring tape
- Bolt cutters

1: GATHER YOUR SUPPLIES

I have a mountain of spare homebrew parts scattered around my home, as most homebrewers I know do, and was able to track down most of the fittings including the clamp, coupler, reducers and bushings. Before I got started on the assembly, I needed to take inventory of my tools and supplies to make sure I could finish what I started and, low and behold, I was missing a vital piece that sent me back to the homebrew shop. I had overlooked getting a second quick disconnect fitting to connect the "out" on the hop filter to the "in" on my tap tower. It's always a good rule of thumb to lay down the game plan before you get started with any project. When I returned home my good buddy Brew (my Golden Retriever) had taken it upon himself to play tug-o-war with the beer line I had purchased to connect the hop filter and tap tower together. So yep, you guessed it, back in the car and back to the homebrew shop. This time I bought a bushel of beer line.



2: ASSEMBLE THE FITTINGS

Before you get started assembling the fittings for the quick disconnects, make sure to clean and sanitize all the parts. You will need to lay out the three parts (¾-inch male pipe thread to ½-inch female pipe thread bushings, ⅜-inch male pipe thread to ½-inch male pipe thread reducers, Firestone liquid posts with ⅜-inch female pipe thread) for each side and wrap the male threads of each fitting with the Teflon tape. (I used a mixture of brass and stainless steel fittings, but I suggest using all stainless steel fittings when possible.) After you get all of the fittings tightly screwed together you can insert the ¾-inch male pipe thread of the bushing into the ¾-inch female pipe thread on the filter housing. Repeat this on the other side of the filter housing to finish assembling the quick disconnect liquid posts for use with the quick disconnect fittings for ball lock kegs.

3: KETTLE SCREEN MODIFICATION

Measure 7 inches up from the crimped end of the Brewer's Edge® KettleScreen™ and cut with your metal snips. Make sure to reshape the snipped tube back to its original shape with a pair of pliers. On the half with the threaded fitting use your bolt cutters to cut off the permanent clamp and remove the fitting. Remove the ½-inch threaded fitting and insert it into the end of your newly cut 7-inch screen. Slip on a stainless steel adjustable clamp and tighten. Next, screw on your ½-inch x ½-inch female pipe thread coupling and then screw in the ½-inch x ⅜-inch male barb connector into that. Slip on the 4 small ⅜-inch O-rings until they are about midway down the barb. When you have completed these steps you should have something that looks like the modified screen in the picture.

4: INSTALLING THE SCREEN

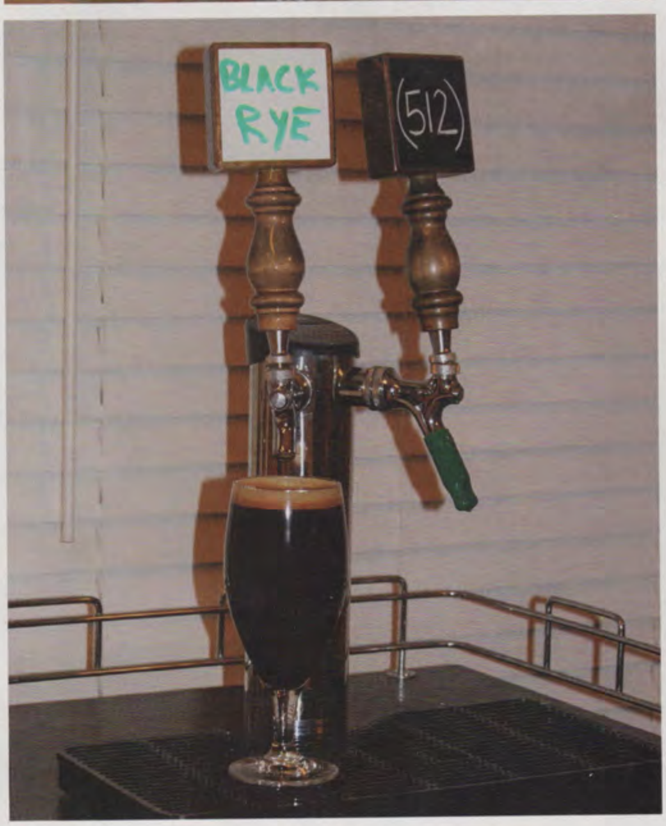
Slowly twist the screen assembly into the opening on the inside of the filter assembly cap. The O-rings you used on your barb fitting should twist in and be quite snug. The purpose of this design is for making cleaning of the hop filter as easy as possible. When ready to clean the filter you will just slowly twist out the filter assembly from the filter cap. During dispensing, the PSI in the filter housing will force the screen up and create a natural pressure seal. These filters are designed to withstand up to 125 PSI, so you do not have to worry about its pressure capability because most beers are dispensed between 5 and 12 PSI. Tightly secure the clear filter closure to the filter cap with the included filter wrench.

5: COMPLETE THE ASSEMBLY

Once the filter is assembled we will now be ready to attach it to the rest of the kegerator dispensing system right? Wrong. Make sure you clean, clean, clean this filter. The last thing needed at this point is for your beer to be contaminated by an unclean "filter." Use regular brewing sanitizer and baptize your new hop filter. After you have cleaned you are ready to add the filter to the system. The beer should flow from your keg like this: KEG ->HOP FILTER ->TAP TOWER. Assemble your beer line jumper out of the two quick disconnect fittings, ¼-inch swivel nut x ¼-inch barbs, clamps and the PVC beer line. Connect the beer line jumper from the keg's beer line "out" to the hop filter's line "in" liquid post. Then connect the tap tower quick disconnect to the hop filter's line "out" liquid post. You now have completed the connection and have another important step at this point. What kind of hops to use?

6: TEST DRIVE

I used Centennial whole leaf hops for the first run through the filter. My homebrew on tap at the time was a Black Rye brewed with Columbus and Centennial and then dry hopped with Amarillo and Centennial. I turned on the CO_2, set it to around 8 PSI and watched the hop filter fill with beer. As the beer traveled down and then back up through the screen I watched for leaks around all of my fittings. Success! No leaks and the beer made it all the way out and up to the tap tower dispenser. I closed the kegerator door and let the temperature come back down to 38 °F (3 °C) before dispensing to minimize foaming. The first beer was foamy, but quickly settled and I could see some particulate had made its way through the filter. After a few beers the particulate matter cleared and I was left with a noticeably hoppier brew. BYO



French Press Hopback

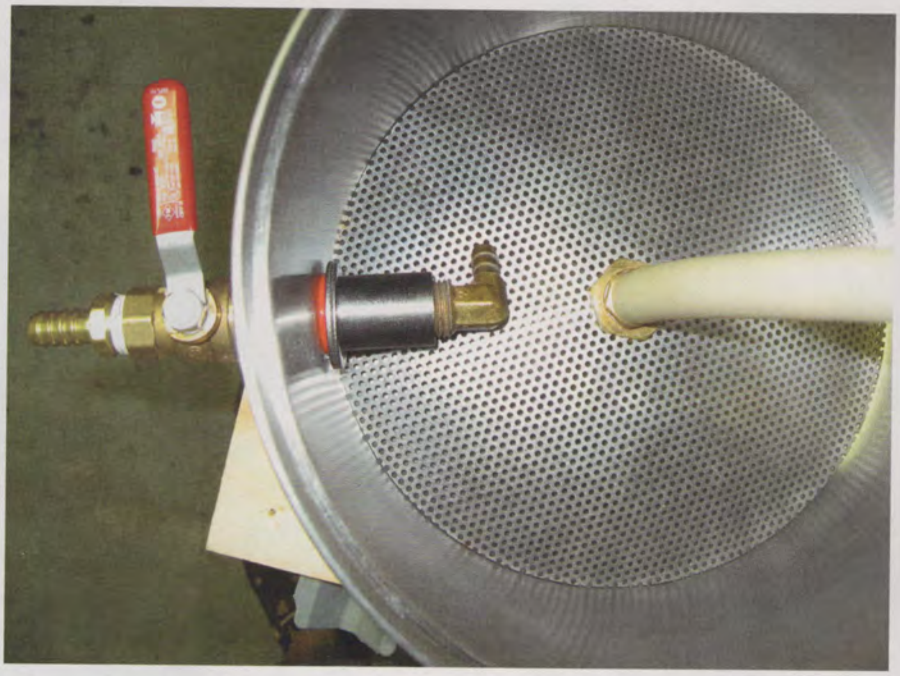
Story and photos by **Forrest Whitesides**

The concept of a hopback — a device containing hops through which you pump your still-hot wort before it is chilled — is certainly nothing new. It's a technique both pros and homebrewers have been using for years. In professional brewing applications, a hopback (also sometimes called a hopjack or simply a hop separator) has traditionally been used to remove cone hops from the wort post-boil. The process of loading the hopback with fresh hops — as a means to add flavor and aroma to the wort as it is pumped to the chiller — was a subsequent innovation in commercial settings. But homebrewers can use the basic concepts behind a hopback to add a new dimension of hop kick to their beers.

While the designs for hopbacks are as varied as the brewers who use them, this hopback project resembles the operation of a French press coffee maker. It offers superior filtering and maximum wort-to-hops contact surface area. For this hopback (and most other hopbacks I've seen) to work properly, you should use whole hops instead of pellets. Hop pellets break down into particles too fine to be strained out and thus are not suitable for hopback use.

A lot of hopbacks are made from a CPVC or metal cylinder and often use a pump to push the wort through. The wort goes into one end of the cylinder, which is loaded with fresh leaf hops, and then flows through the other end into a counterflow chiller.

Instead of that setup, we're going to gravity-flow (or optionally pump) hot wort into a small pot with hops held under a false bottom and then let the beer flow up through the hops and out of a ball valve into a counterflow or plate chiller.



> "While the designs for hopbacks are as varied as the brewers who use them, this hopack project resembles the operation of a French press coffee maker."

Parts and Tools

- 8-quart (7.6 L) or larger cooking pot
- False bottom that fits into the pot
- Ball valve with bulkhead fitting
- ½-inch male NPT-threaded hose barb
- High-temperature, food-safe tubing

1: DESIGN AND POT SELECTION

The design for this hopback project is built from three main critical components: an 8-quart (7.5-L) (or larger, depending on your needs) common cooking pot, (see photo) a false bottom and a ball valve with bulkhead fitting. You'll also need a ½-inch male NPT-threaded hose barb and some high-temperature, food-safe tubing.

2: FALSE BOTTOM AND BALL VALVE

The most important thing in selecting a pot is to make sure the diameter is very close to the diameter of the false bottom you're going to use. I chose a Northern Brewer 9-inch (22.5 cm) diameter false bottom commonly used in lautering, but you can also go with a 10-inch (23-cm) or 12-inch (30.5-cm) false bottom. Whatever you choose, make sure that it fits the pot you intend to use and that it is safe for use with near-boiling liquid. (Hint: I took my false bottom into a department store and tested the fit in several pots before making a purchase. You might get a few funny looks, but it'll save you a big headache down the road.) Either stainless steel or aluminum pots are fine for this, but I recommend stainless. There are many inexpensive and widely available stainless pots in this smaller size.

I recommend a ½-inch ball valve to allow for an outflow that will be close to matching the inflow from the kettle. I used a spare weldless kettle conversion kit from Zymico from another project, but you don't necessarily need something that fancy — choose a part that suits your budget and needs.

3: DRILLING THE POT

This is probably the trickiest part of the project, and the one step you want to get right the first time. There are no do-overs when drilling a hole. For an in-depth look at proper drilling techniques for both stainless steel and aluminum, see page 22 of this special issue. I recommend using a step-drill bit for drilling, especially for stainless steel. With aluminum, you can get the job done with a spade/paddle bit.

Drill a ⅞-inch hole approximately 1.5 inches (4 cm) up from the bottom of your pot. What is critical here is to put the hole high enough so that when the ball valve and bulkhead are installed there is enough clearance for the false bottom to be easily inserted and removed. I highly recommend doing a few test placements of the bulkhead - before you drill - to make sure it's high enough (you'll need an extra set of hands to help you do this). The horizontal placement of the hole is up to you, but I personally prefer to have it about 90 degrees from the handles.

4: INSTALLING THE VALVE AND FALSE BOTTOM

Install the bulkhead portion of the valve and then screw on the ball valve itself. Do not over-tighten, as you could possibly damage the gaskets.

The false bottom comes with a 90-degree barbed elbow fitted in the center of the screen. Unscrew the top nut holding in the elbow and remove the fitting. In its place, screw in a ½-inch male NPT-threaded hose barb and replace the top nut to secure it.

Now simply slide the false bottom in under the bulkhead fitting and you're done. If you used a Zymico weldless bulkhead (or made your own with similar parts), you can use the barbed elbow that you removed from the false bottom as a pickup tube to minimize the wort lost to the dead space in the hopback. Just screw it into the bulkhead and push the barb down against the false bottom.

5: USING THE HOPBACK

The operation of this hopback is fairly straightforward:

• Put some hops in the bottom of the hopback
• Slide in the false bottom (above the hops)
• connect the hopback's hose barb to your kettle's ball valve via high-temp tubing
• open the outlet valve on the hopback, and then
• open the valve on your kettle.

The hopback's outlet valve, of course, will be connected to the "wort in" side of your counterflow chiller, also with high-temperature tubing.

6: SOME THINGS TO CONSIDER

If you use the barbed elbow as a dip tube, be aware that it will somewhat restrict the outlet flow of your wort. In this case, your kettle valve should only be opened between half and two-thirds of maximum flow to make sure the hopback valve can keep up with the inflow of wort.

Also, because of the nature of the design, if you intend to use a pump with this hopback, be sure you can restrict the flow rate enough to avoid an overflow of the hopback reservoir (the pot).

Another consideration is that since the flow into your chiller will likely be at a lower rate than you are used to, you should adjust your cooling water flow rate accordingly.

With the hopback pictured (9-in./23 cm false bottom in a 8-quart/7.6 L pot), I find that 1–3 ounces (28–85 g) of whole leaf hops works best. More than three ounces (28 g) is a tight fit once the hops are fully hydrated, but it can be done. If you're going to try to cram a whole lot of hops in there, I recommend not breaking up the hops after taking them out of their vacuum-packed bags. Using too much, however, may cause the false bottom to lift up and allow hops to get pulled into the valve and into your chiller (possibly causing a frustrating clog). Using a larger false bottom will more easily accommodate larger quantities of hops. Stepping up the size of the false bottom and pot may be a good option if you plan to brew 10-gallon (38-L) batches. BYO

Hop Dryer

Story and photos by **Forrest Whitesides**

Historically, hops were dried in two- and three-story round brick buildings called oasts, which made their first appearance in England in the 16th century. You can recreate a similar basic convection-driven drying effect at home on a scale to match your own homebrew-sized hop harvest.

What we're really building is a dehydrator that uses active convection (driven by a small fan) as the main means of dehydration. The hops are suspended on a drying rack and the fan pulls a constant flow of air over the hops, which carries the moisture away.

The following build guide is just one of many ways to put together your own oast. The size, shape, look, and general construction of the hop dryer can be almost anything you want to match your needs and budget (or whatever you can manage to bang together, as in my case). What is critical to the design is that there is an adequate flow of air across the hops. Everything else is negotiable.

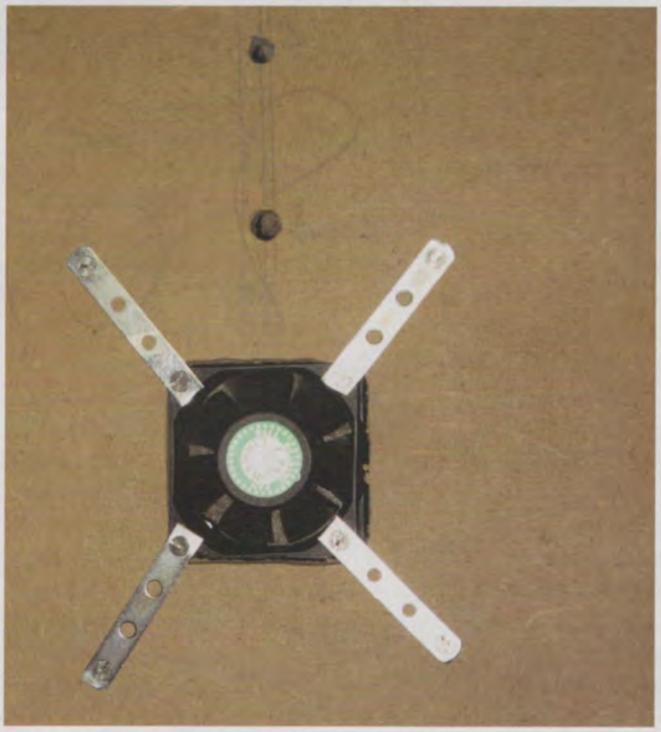
I built my hop dryer primarily from ½-inch medium-density fiberboard because it is an easy material to cut, it takes glue very well, and it is economical. I used inexpensive 1½-inch by ¾-inch pine stock to make the drying rack frame and the interior rack supports. I used vinyl-coated fiberglass screen to finish the drying rack but you could also use stainless steel screen. I used two small utility hinges to create a "front door" for the oast. To keep the door closed, I used a sash lock — the type of lock that is commonly used to latch windows.

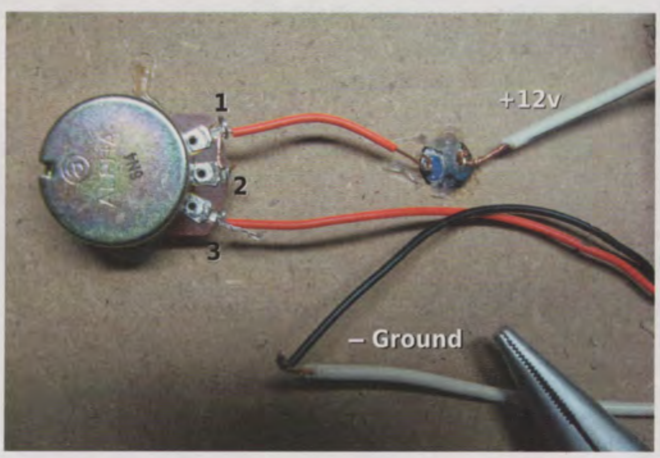
Because it was easier for me to visualize in my head, I built my oast as a cube (my wife affectionately calls it the "big box 'o hops"). Each side is roughly 24-inches (61 cm) because the fiberboard I bought came in 48-inch x 24-inch sheets, so going with that size saved me a few cuts at the beginning. You can build yours in any size or shape that fits your brewing space. So long as the air is flowing inside, the shape of your oast is irrelevant. A true oast traditionally uses heat in the design, but this project (for safety and simplicity) does not.

Parts and Tools

- 3 48-inch x 24-inch sheets of ½-inch medium-density fiberboard
- 1 ½-inch by ¾-inch pine stock
- 1 65-mm (2.5-inch) or 80 mm (3.125-inch) 12-Volt DC fan
- DC power supply (to run the fan)
- 500-ohm linear potentiometer fan speed controller
- 1 on/off power switch
- 2 small utility hinges
- #6–32 machine screws (along with the corresponding washers and nuts)
- 4 flat pre-drilled brackets
- Stainless steel or vinyl-coated fiberglass screen
- Miter box
- Back saw
- Hand saw
- Keyhole saw
- Sanding block
- Power drill
- Staple gun
- Wood glue

(If you have power tool equivalents to these hand tools, use them at your discretion.)





1: GENERAL BUILD GUIDE

Cut six sections of fiberboard or plywood to size (24-inches/61 cm). For simplicity, I chose to use common butt joints, but I reinforced each joint with dowels for added strength. Join the sides and rear sections with the bottom section first, and attach the top and front for the last part of the build. Before gluing, drill a few ½-inch holes near the bottom of the left, right, and rear sections of the box. These holes serve as intake vents from which the fan can pull air up through the oast. Also drill a ¼-inch hole at the top of the back section for the power supply wires.

Now apply glue to the sections, fit and clamp them and let the glue fully cure (which takes about 24 hours) before taking the clamps off.

2: MOUNT THE FAN

With the bottom and sides clamped and drying, now is a good time to mount and wire the fan and electronic controls to the top section of the soon-to-be oast. Lay the fan flat on the board where you want to mount it (I recommend close to the center for more even airflow) and trace the outline with a pencil or pen.

For my oast, I decided to mount my fan flush with the board, but you can also mount it directly on top of the board. This is much easier than flush mounting, and the overall performance is practically identical.

For flush mounting, cut around the fan outline you traced on the board. You can use a rotary tool (Dremel, RotoZip, etc), jigsaw, or keyhole saw to cut the hole. The fan should just fit inside the hole. To secure the fan, use eight #6–32 machine screws with washers and nuts along with four flat brackets. I made brackets from #4 mirror hanging eyes.

For top mounting, come in about a ¼ of an inch from each side of the fan trace and cut the hole. Use four of the #6–32 machines screws, washers, and nuts to secure the fan. Once your fan is mounted, choose a spot for the controls, drill a 5/16-inch hole for the potentiometer shaft to fit through, and also drill a hole for the power switch (the size of which will depend on the switch you choose). Postition the controls near the fan, as this makes for a cleaner, shorter wiring run. Most potentiometers and switches were not designed to be mounted to materials thicker than about a ¼ of an inch, so you'll need to glue them in place.

3: WIRING THE FAN

Connect the positive wire from the power supply to one of the lugs on the SPST switch (it doesn't matter which one), and use a short piece of shielded wire to connect the other lug on the switch to lug 3 of the potentiometer. Connect lugs 2 and 3 of potentiometer to each other. Connect the red (positive) wire from the fan to lug 1 of the potentiometer. Finally, connect the black (ground) wire from the fan to the ground wire of the power supply. The complete wiring, (unsoldered) is shown in the photo on the left. Solder all connections except for the ground wires, which can be spliced together with a small wire cap connector.

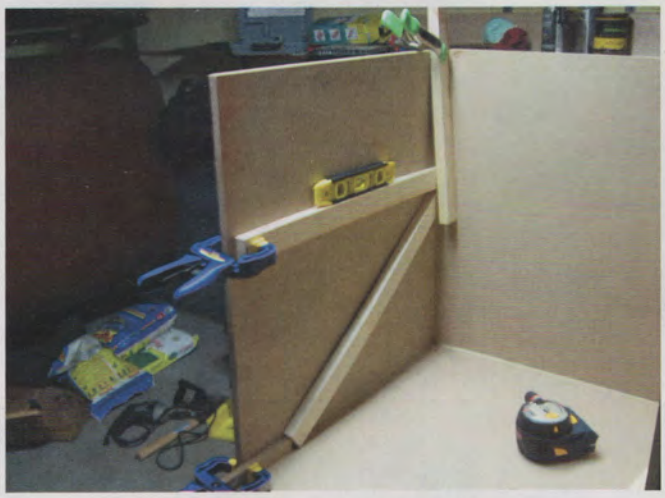
4: DRYING RACK

Now that the wiring is finished, and the glue is *still* curing, let's move on to the hop-drying rack. Cut four pieces of wood stock for the rack's frame. The lengths for these should be about a ¼-shorter than the interior width of your oast, and at least an inch shorter in depth, but this will vary some depending on how you join them. As with the oast box itself, I used butt joints to join the rack and reinforced the joints with staples. Corner clamps make this job very easy, but they aren't required.

When the glue is dry, cut a piece of vinyl screening about an inch wider on each side than the frame itself. Staple the screen to the frame along the side edges (see photo), and also add a row of staples along the bottom side edges (I don't recommend using staples smaller or thinner than the T50). Make as many racks as you need for your hop harvest.

5: INTERIOR SUPPORTS

By now, the glue securing the oast joints will be dry, so you can add the interior supports that the rack will sit on. I'd suggest using at least ½-inch (0.23 cm) thick stock for these. Cut two pieces (per rack) about 2-inch (5 cm) shorter than the interior depth of your oast. I glued the supports to the oast using clamps and scrap stock to secure it and used a bubble level to get it even.



6: FINAL ASSEMBLY

When the rack supports are cured and dry, glue the top section to the rest of the oast. Now all that remains is to attach the front section to the oast with hinges. I chose to have the front open forward like an oven, but you could also have it open from the side like a cabinet or refrigerator. I chose to have the front open forward like an oven, but you could also have it open from the side like a cabinet or refrigerator. To keep the door closed, you'll need some type of latching mechanism. I used a window-style sash lock. BYO