

# How to Open a Brewery



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# The Craft Beer Industry 2018

*An American craft brewer is small, independent and traditional.*

- **Small**

- Annual production of 6 million barrels of beer or less (approximately 3 percent of U.S. annual sales). Beer production is attributed to the rules of alternating proprietorships.

- **Independent**

- Less than 25 percent of the craft brewery is owned or controlled (or equivalent economic interest) by an alcohol industry member that is not itself a craft brewer.

- **Traditional**

- A brewer that has a majority of its total beverage alcohol volume in beers whose flavor derives from traditional or innovative brewing ingredients and their fermentation. Flavored malt beverages (FMBs) are not considered beers.



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# The Craft Beer Industry 2019

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- **Brewer**

- Has a TTB Brewer's notice and makes beer



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# U.S. BEER SALES VOLUME 2020

OVERALL  
BEER  
**-2.9%**

186,058,000 BBLS

**-9.3%**  
CRAFT

22,815,258 BBLS

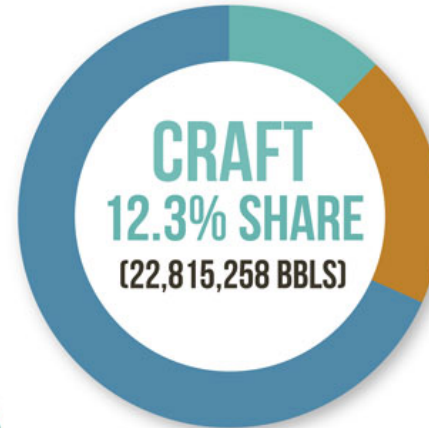
**0.6%**  
IMPORT  
BEER

36,328,497 BBLS

OVERALL BEER MARKET  
**\$94.1 BILLION**

CRAFT BEER MARKET  
**\$22.2 BILLION**

22% DOLLAR SALES LOSS



IMPORT  
**19.5% SHARE**  
(36,328,497 BBLS)

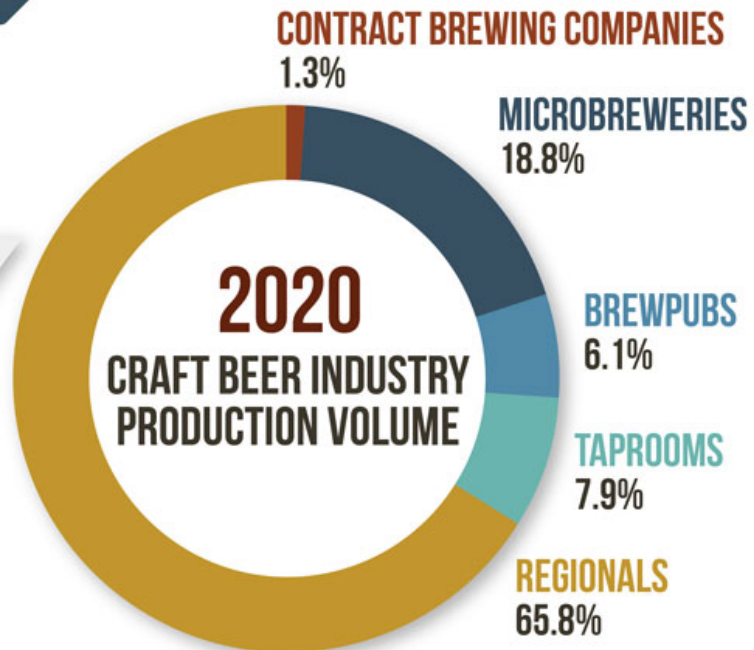
OTHER DOMESTIC  
**68.2% SHARE**  
(126,913,774 BBLS)

SOURCE: BREWERS ASSOCIATION

# U.S. BEER PRODUCTION VOLUME 2020

OVERALL  
BEER  
-2.9%

-9.2%  
CRAFT\*



\*DIFFERENT THAN SALES VOLUME FIGURE BECAUSE OF CRAFT EXPORTS

SOURCE: BREWERS ASSOCIATION

# U.S. Brewery Count

	2015	2016	2017	2018	2019	2020	2019 to 2020 % Change
<b>Craft</b>	<b>4,803</b>	<b>5,713</b>	<b>6,661</b>	<b>7,618</b>	<b>8,391</b>	<b>8,764</b>	<b>4.4%</b>
Regional Craft Breweries	178	186	202	230	240	220	-8.3%
Microbreweries	2,684	3,319	3,956	4,518	1,821	1,854	1.8%
Taprooms					3,159	3,471	9.9%
Brewpubs	1,941	2,208	2,503	2,870	3,171	3,219	1.5%
Large/Non-Craft	44	67	106	104	111	120	8.1%
<b>Total U.S. Breweries</b>	<b>4,847</b>	<b>5,780</b>	<b>6,767</b>	<b>7,722</b>	<b>8,502</b>	<b>8,884</b>	<b>4.5%</b>



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# April 2021 Brewers Association Report

- 8764 active breweries
- 1854 microbreweries
- 3,219 brewpubs
- 3471 taproom breweries
- 220 regional craft

716 opened

346 closed



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# Threats

## Increased competition:

- Within the segment, breweries open at a rate of 2 per day.
- Large brewers, buying craft breweries, ingredient suppliers, and rating sites. Using their financial muscle to influence market share.
- Wholesalers focus is being diluted through brand proliferation.
- FMB, new wine and liquor products, cider
- Legalized cannabis
- “Healthier” products (hard seltzer, kombucha non alcoholics, low calorie)



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# Commitment

- Are you the right person for this?
- Hope is not a strategy



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# Are you the right person

- Mission and vision
- Professional Help Options
- Your People
- Business Plan Realistic?
- Building a brewery or building a company.



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# Mission Statement

mis·sion state·ment     *noun*

noun: **mission statement**; plural noun: **mission statements**

*a formal summary of the aims and values of a company, organization, or individual.*



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# Mission Statement

- What do we do?
- Why do we do it?
- Who are we who are doing it?
- Who are we doing it for?

Ari Weinzweig – Zingerman's deli



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# Mission Statements

- “Be Amazing.” Stone Brewing
- TO PROFITABLY DELIVER THE FINEST BEERS IN THE WORLD AND CULTIVATE EXTRAORDINARY EXPERIENCES Core Values - Honor Our Customers, Deliver Quality, Work as a Team, Do Our Best and Next Time Do It Better, Build a Healthier Society, Celebrate the Culture of Beer, Own It Deschutes Brewery
- Our **mission** at Quest Brewing Company is to produce unique, quality beers that are second to none. We operate in ethical and environmentally friendly standards while hand-crafting our products.
- The mission of The Bruery is to enjoy crafting unique beer for the enjoyment of our supporters.



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# Vision Statement

A vision statement is a company's road map, indicating both what the company wants to become and guiding transformational initiatives by setting a defined direction for the company's growth.

Wikipedia



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# Vision Statement

- What will things look like when you successfully arrive at where you are going and when things are working really well?
- What will success look like?
- What will you be known for?
- What will the community think of you?
- What will the media be reporting about you?
- How will your employees be dealing with each other?

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# Vision Statement

- The vision for Quest Brewing Company is to become a premium craft beer brand in the Southeast.

## List of values Devil's Backbone

- Adventure – Expanding horizons thru approachable food drink and experiences
- Beer Positive – Great beer is, great beer whether we made it or not
- Passion – Relentless devotion to our beer, our people, and our community
- Integrity – Work hard, be honest, and set the example
- Family – With each other through the good and bad
- Humility – Striving to be the best, without exclamation
- Stewardship – Leaving it better than we found it



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# Professional Help

Expertise in areas of

- Federal and State Alcohol regulations
- Business structures
- Franchise Laws
- Trademark Laws
- Human Resources
- Lease negotiations
- Development and Review Boards



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# Your People

Do they have complimentary skills?

Are they?

- A brewer
- A chef
- A restaurant manager
- A real estate broker
- An architect
- An attorney
- A marketing professional
- A multi millionaire



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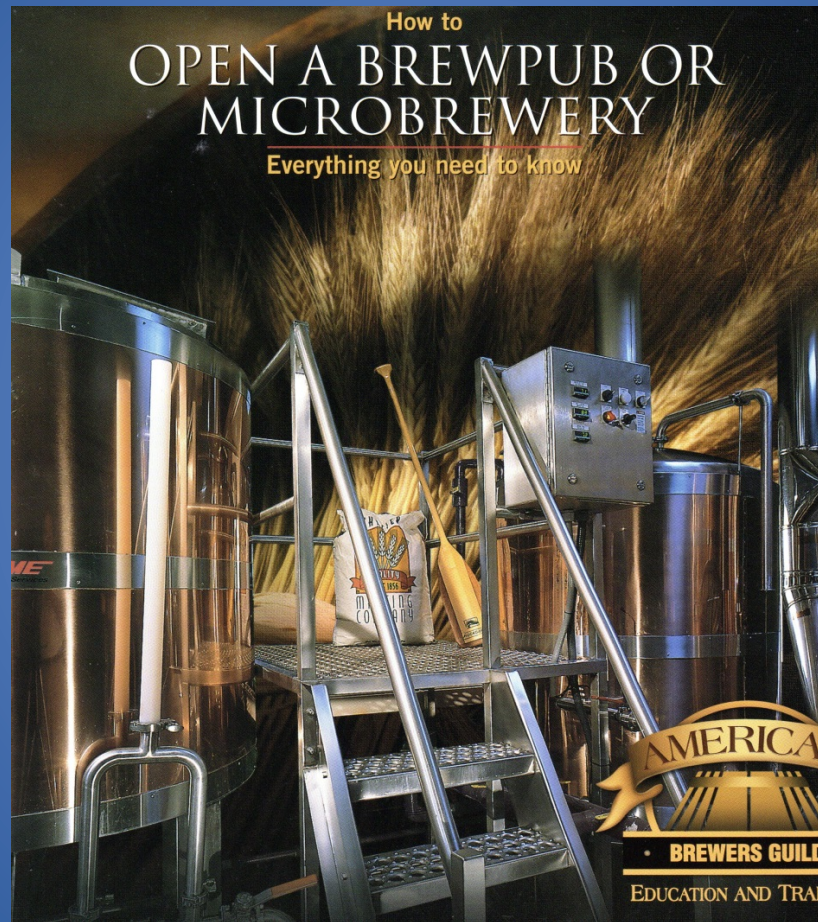
# Review Your Business Plan

- Find experts to review your business plan before submitting it to potential investors.
- Form an advisory board
- Contact your local Small Business Development Center. There's one in every State.



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# The Business Plan



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# The Business Plan

- Executive Summary
- Business Description
- Marketing
- Pricing
- Competition
- Management
- Regulatory Issues
- Employees
- Operations
- Location
- Financials
- Attachments

# Executive Summary

- A two page summary of everything that follows in detail in the plan.
- Elevator pitch - be able to summarize your plan verbally in 2 minutes



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# Business Description

## Give ready access to basic facts

- Begin by identifying legal structure and name, contact information, website
- Define your mission and vision statement
- Strategy for financial needs
- Lay out your short and long term goals



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# Naming Your Brewery

- All the good ones are taken
- Avoid trademark infringements
  - Trademarkia
  - [uspto.gov](http://uspto.gov)
  - Google search
  - Beer advocate/rate beer
- Local identity can limit broader appeal



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# Legal, Accounting, and Insurance

BEFORE you start... select the legal form for the business...

- *Sole Proprietorship: easiest to form; uses your name*
- *Partnerships: a formal, written agreement advised*
- *Corporations: Secretary of State to register*
- *Limited Liability Company (LLC): Members not personally liable for debts of the LLC.*



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# Legal, Accounting, and Insurance continued

- Apply for federal and state employer tax identification numbers if needed.
- Obtain the proper licenses that apply to your business
- Apply for workers' compensation and other insurance.



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# Legal, Accounting, and Insurance continued

- Apply for any trade name registration, fictitious name registration, trademarks, copyrights, or patents.
- Engage and consult qualified advisors in law and taxes as needed.



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# Choosing a Form of Ownership

[SBA Information on Business Structure](#)



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# Factors to Consider

- Tax Considerations
- Liability Exposure
- Start Up Capital Requirements
- Control
- Managerial Ability
- Business Goals
- Management Succession Plan
- Cost of Formation



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# Marketing Plan

## A marketing plan includes:

- Understanding your target market
- Your competitive position in that market
- How you intend to reach that market (your tactics)
- How you will differentiate yourself from your competition in order to make a sale.



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# Why Buy from You?

- **Customer Segments :** Who is your target customer
- **Value Proposition:** Great beer AND.....
- **Channels of Distribution:** Availability for customers
- **Customer Relationships:** Different tactics for wholesalers and retailers and individual consumers
- **Revenue Streams:** Make it easy to do business
- **Key Resources:** Can your physical plant cope?
- **Key Activities:** Marketing prowess
- **Key Partners:** Collaborations and ingredient suppliers
- **Cost Structure:** Provide a perceived value for money.



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# Packaging

- Kegs - 15.5, 13.2, 7.75, 5.16, 20L, Plastic, PET
- Cans – 25 oz, 19 oz, 16 oz, 12 oz
- Bottles – 750 ml, 500 ml, 22 oz, 16 oz, 12 oz
- Growlers – 128 oz, 64 oz, 32 oz
- Crowlers – 64 oz, 32 oz
- Party Cans
- Serving Tanks



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# Pricing

- Getting this right can make or break your business.
- Super premium product should be super premium priced
- Low volume high margin model is the best for a small brewer.
- Don't be afraid of the \$10+ 6 pack.
- Prestige product pricing demands matching quality.
- It is very hard to raise prices
- Avoid devaluing the brand by having “sales”



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# Typical Margins

- Cost of Goods (COG) for the Brewer 45%
- Wholesaler margin is 25-28%
- Retail (off premise) for bottles and cans is 25%
- Retail (on premise) The bar owner values COG at 25% and so bases retail pricing on the purchase price, calculating the cents per oz with a 90% yield.



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# Pricing Example

## Example Uses Industry & State Of Vt.

- Assumption is you will sell the log for \$57
- Your COGS is 44% so cost of log is \$25.08
- Distributor Works on 25% Margin so sells for \$76
- The restaurant will then look at COGS at 25-30% per glass.

Whether you self distribute, or distribute through a beer wholesaler, the price to the bar is \$76.00



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# Retail pricing example

Take a  $\frac{1}{4}$  bbl

$7.75 \times 128 \text{ oz} = 992 \text{ oz}$  of beer to sell.

However 10% is lost to foam, line cleaning, bartender twitch etc so you can only sell 892 oz.

The keg cost the bar \$115.

So the cost per oz for the beer is  $\$115/892 = 13\text{c}$ .

That's \$2.06 for a 16 oz glass.

Assume a bar works on 25% COG as a baseline they must sell that pint for  $2.06/0.25 = \$8.25$  for 16 oz.

Or \$7.28 for a 14 oz glass.



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# Competition

Why will a customer choose you over the competition?

If you were competing against yourself what would your strengths and weaknesses be?



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# Management

**This section describes your management team and staff and how your business ownership is structured.**

- People reading your business plan will be looking to see not only who's on your management team but how the skills of your management and staff will contribute to the bottom line.



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# Legal and Regulatory

The brewing industry is regulated by a number of Government bodies. These include:

## Federal

- Tax and Trade Bureau (TTB)
- Trademark office
- IRS
- Food and Drug Administration (FDA)



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# Legal and Regulatory

## State

- State Liquor Control Board
- Secretary of State's Office
- State OSHA
- Department of Labor
- Department of Taxes
- Agency of Transportation
- Workers Compensation Board
- Agency of Natural Resources



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# Legal and Regulatory

## Local

- City Planning, Development, Zoning Commission, or Select board
- Water Quality Control Board
- Town Clerk/City Manager
- City Utilities Department
- City Business License Tax
- Fire Department and Police Department



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# Employees

Today's businesses have to withstand stiff competition in key employees, and other desired relationships.

- How many employees does the company have?
- What strategic hires will be needed?
  - What is the budget for these?



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# Operations

## Operations plan

- Description of production process
- Facilities – lease or buy?
- Capacity — present and future
- Security of supply channels
- Inventory requirements



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# Cost of Equipment

## Nano Brewery



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3.5 bbl electric system \$15,000 plus fermenters



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# Cost of Equipment

## Nano Brewery

30 gallon = 100 barrels a year = \$10,000

2 barrel = 200 barrels a year = \$20,000

4 barrel = 400 barrels a year = \$25,000 - \$110,000



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# Cost of Equipment

Small microbrewery or Brewpub system



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# Microbrewery or Brewpub 15 bbl system

- Cheap Chinese = \$222,500
- Cheap North American = \$259,775
- High End Chinese = \$300,600
- Quality North American = \$312,000
- Quality north American = \$319,000
- High Quality American = \$390,000

Then kegs, boiler, chiller, pumps, lab, walk in, floors, drains, build-out, draft system, installation, commissioning and fork lift



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# Cost of Equipment



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# Equipment Packaging microbrewery

60 bbl system with a 30,000 bbl annual capacity

- Brewhouse = \$1,100,000
- Fermentation and Cellars = \$550,000
- Bottling/Canning line = \$600,000
- Kegging line \$100,000

Plus kegs, floors, drains, build out, installation and commissioning



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# Ingredients

- Significant challenges exist in the current supply chain.
- Recipes are being formulated using ingredients that may not be available in large quantities.
- Or available economically
- “I’m brewing for the first time next week and need some malt and hops”



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# Malt

- The barley and hence the malt market is global and so a drought in Russia or a storm in Germany affects a brewery in Wisconsin
- Barley is not high on the list of profitable crops to grow
- Increased animal feed prices puts pressure on malting barley supplies
- No GMO barley...so far



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# Malt

- New malthouses came on line in the last 3 yrs addressing potential shortages
- Crystal malt from the UK remains tight
- Lead times for European malt are long on the West coast
- Contract to ensure base malt supply



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# Hops

- Decades of over supply and shrinking demand led to low prices, and attrition among growers. Alpha acid surplus
- The sudden explosion of demand for aroma hops due to the craft beer segment has prompted a switch over of varieties from growers
- This response takes time resulting in shortages and long waits for certain varieties
- Many varieties are unavailable on the spot market and several are sold out for several years out through forward contracts
- Some are proprietary and so are only grown on one farm.



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# Hops

- \$9 million to put a new 250,000 acre hop farm into service, with a 10 yr payback
- Contracts let the farmer know what to plant



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# Strategies

- Hire an experienced brewer..... They will have industry connections and experience in forecasting accurately
- Use the secondary market..... Many brewers are over contracted and looking to offload surplus inventory as new crops come in.



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# Hop Supplies

Varieties sold out for 3 years

Nelson Sauvin + many other New Zealand varieties

Tight Supplies for the next year or so

Cascade

Galaxy

Amarillo

Calypso

Citra

Simcoe

Sorachi Ace

Mosaic

Centennial



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# Yeast

- Numerous supply options exist
  - Wyeast
  - White Labs
  - Brewing Science Institute
  - Fermentis
  - Lallemand
- Very expensive until you develop a reliable method for re-use
  - Requires expertise
  - Equipment
  - Laboratory



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# Sources of Yeast

- Dried Yeast
  - Easy to use - follow the directions carefully
  - Expensive - \$24/bbl for lager and \$12/bbl for ale strains
  - Fewer choices
  - Higher contamination rates
  - Can be reclaimed and re-used up to 6 times
- Yeast Supply Company
  - Expensive \$30-\$35/bbl but can be used multiple times
  - Easy to use – and reuse
- Another Brewery
  - Free
  - You inherit the other brewer's problems
- Repropagation of acquired yeast
  - Time consuming
  - Requires expertise
  - Uncertain sources



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# Location

Consider carefully and provide the reasoning in the business plan for:

- Cost,
- Condition,
- Credibility, and
- Water & Waste capabilities



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# Building Requirements

Adequate space?

Electrical/Plumbing/Drainage/Effluent?

Flow of supplies in and product out?

Zoning?

Compatibility with existing neighbors?

Room for expansion?

Waste removal?

Future neighborhood development plans?



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# Floors

Floors are critically important

- Slope to drains  $\frac{1}{4}$  inch per foot minimum
- An impermeable hard wearing coating is strongly advised
  - Ceramic Tile expensive but looks good
  - Polycrete/Ucrete \$10-\$15 per ft<sup>2</sup>



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# Distribution

3 tier system exists in America

Manufacturer – Wholesaler – Retailer

- Different States have different laws regarding various alternatives to adhere to the system.
- Some allow common ownership of all three tiers ie brewpubs that distribute to other bars, or packaging breweries that self distribute and operate taprooms
- Most limit it to two of the tiers. ie brewer and self distribution, or brewer and taproom
- Some States rigorously enforce the 3 tier system and don't allow taprooms or self distribution.



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# Establishing Your Distribution Network

## Type of wholesalers

- Major Brand
  - AB
  - Miller/Coors
  - Craft division within a major brand house
- Indie or Specialty
- Liquor Wine
- Self



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# Major Brand House

- Advantages
  - Call frequency/account saturation
  - Account influence
  - Sophistication
  - Resources
    - Refrigeration
    - Line cleaning
    - Events



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# Major Brand House

- Disadvantages
  - Major brands get the focus
  - May have limited knowledge of craft
  - A boatload of SKU's
  - Little fish in a big pond



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# Indies

- Advantages
  - Know craft, love craft, sell craft
  - Spread the gospel
  - Better access to sales staff and management
- Disadvantages
  - May be weak in 'B' and 'C' and chain accounts
  - Lack of resources
  - Weak at events



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# Liquor Wine

- Advantages
  - Cover large geographical territory
  - Strong in on-premise
  - May not have a lot of beer SKU's
- Disadvantages
  - Sales staff may not know beer
  - Call frequency
  - Draft



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# Self distribution

- Federal and State License needed
- State license may have a steep annual fee
- Reliable, adequately insured commercial vehicle is needed.
- State will have reporting requirements for commercial vehicles.
- Sales support is still needed
- Line cleaning



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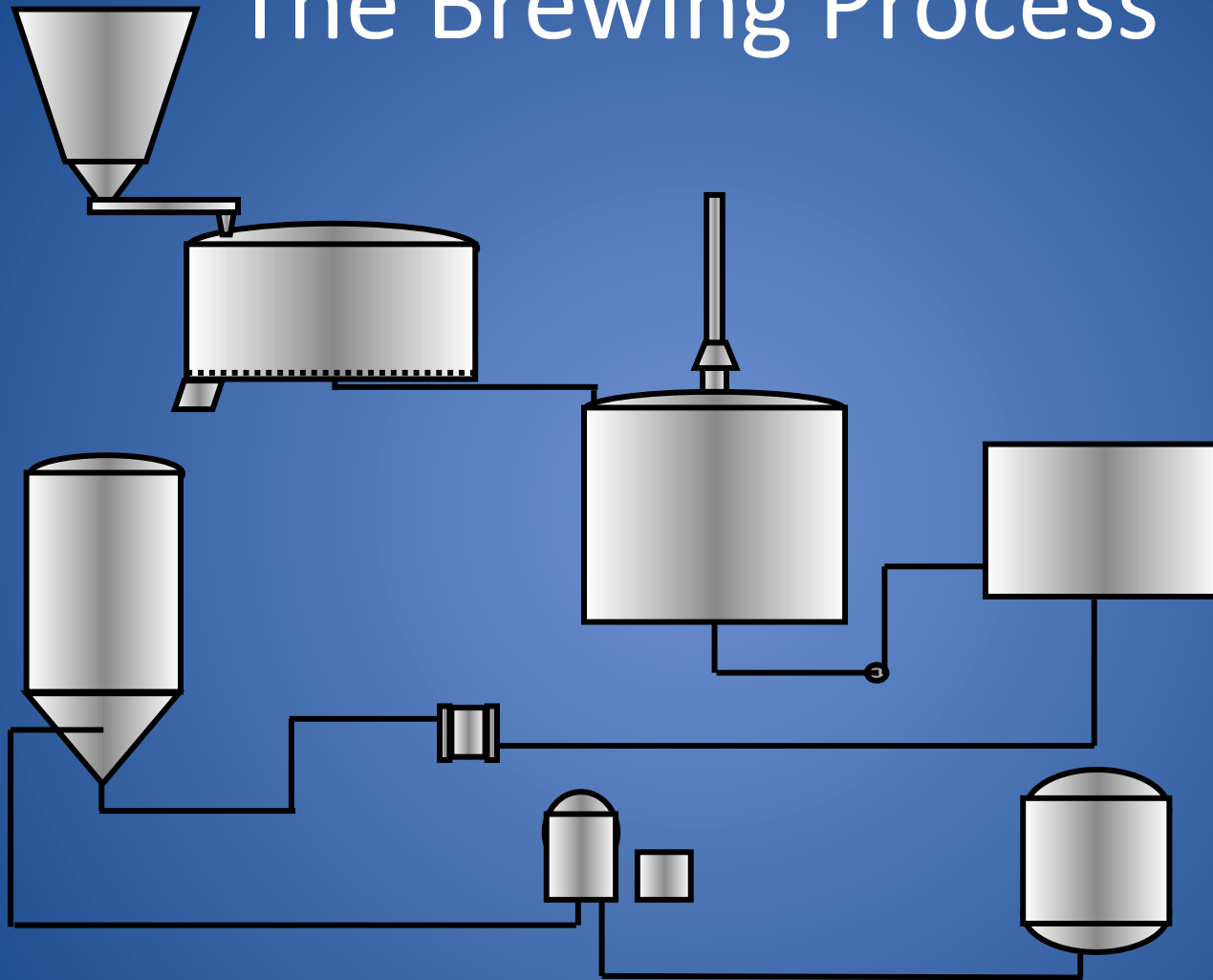
# Attachments

- Establishes the credibility and support of the business plan.
- Includes all documents that can help explain and demonstrate the information provided in the business plan and the financials.



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# The Brewing Process



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# Insulated or not BBT









# Gimmick system



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HLT  
100 GAL.

MASH TUN  
160 GAL.

BREW  
KETTLE  
160 GAL.

STICKS  
& BUTLE  
MULTI-PURPOSE  
PAIL















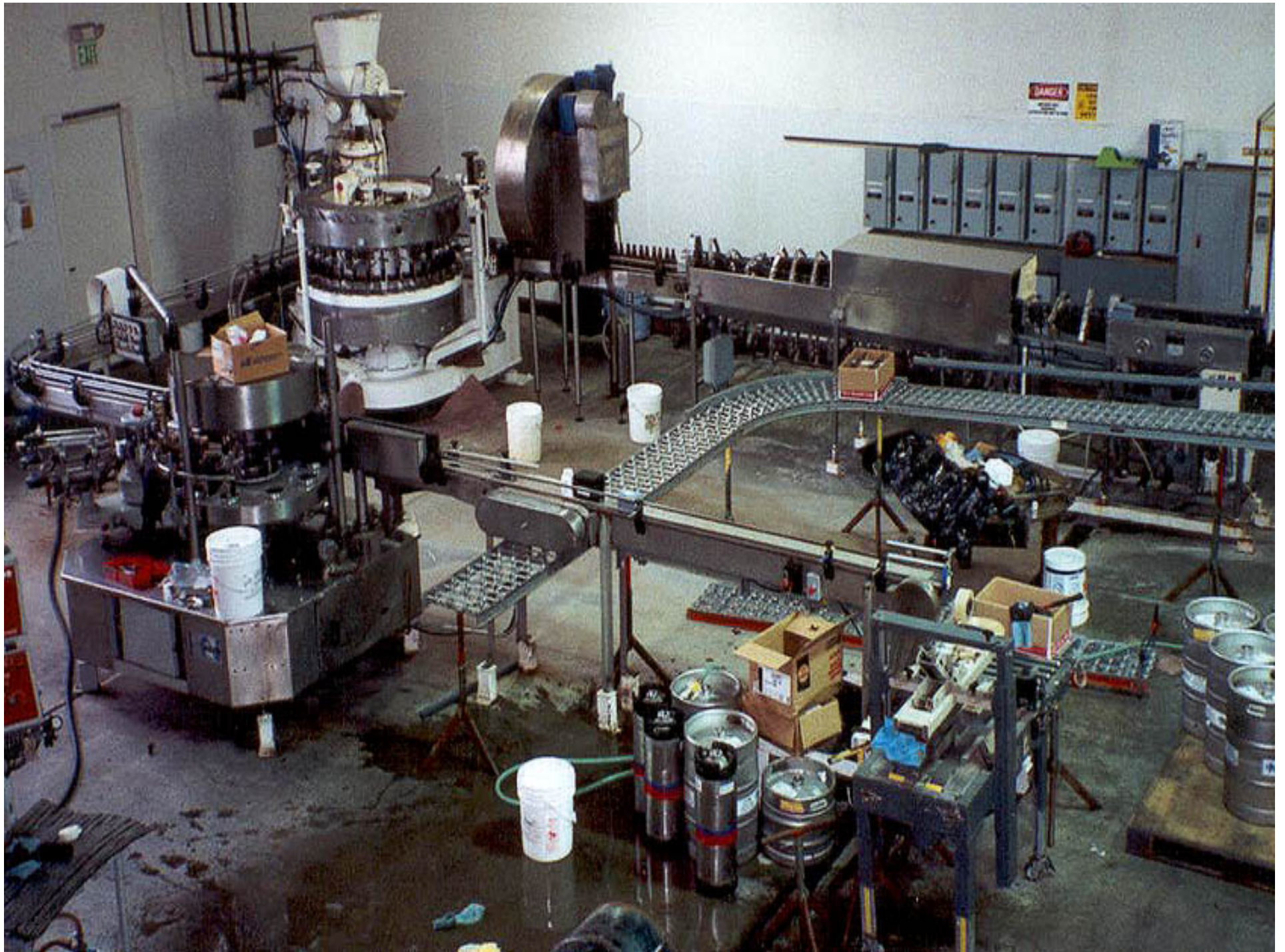
BUDWEISER

## BEECHWOOD CHIP TORPEDO

After the chips are cleaned and rinsed, they are transported to the beechwood aging tanks in torpedoes. The torpedo is positioned against the wall portside on the end of the tank and the beechwood chips are raked into the tank.

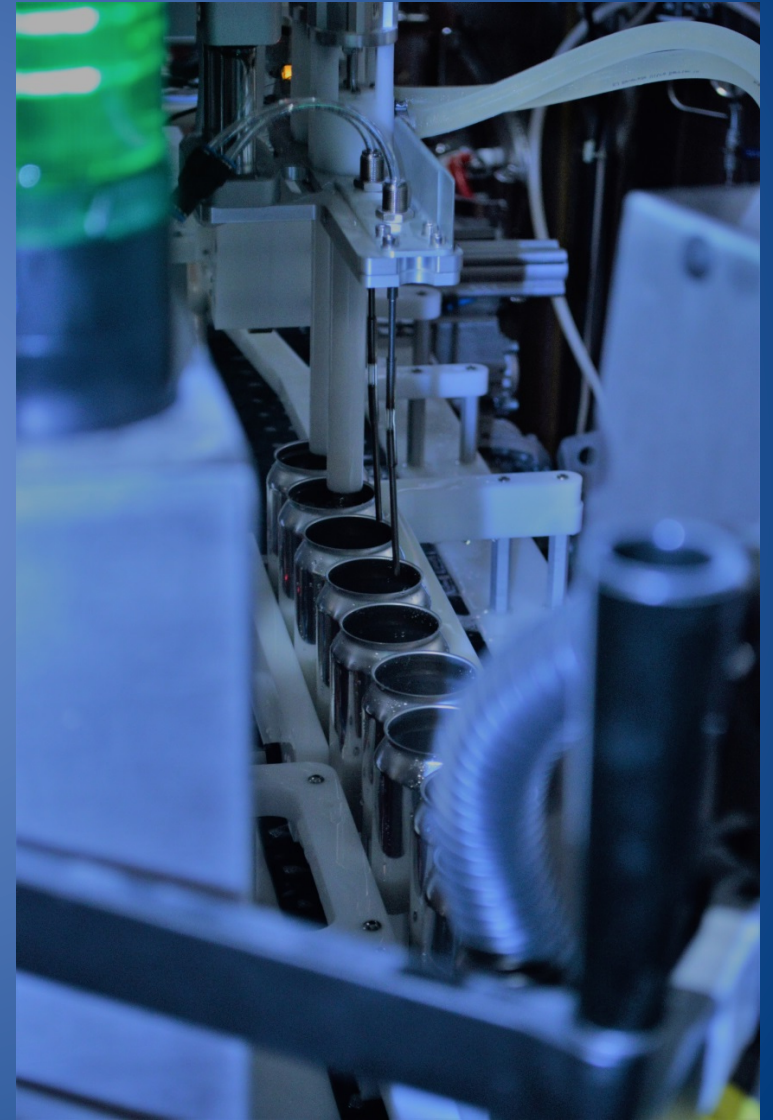
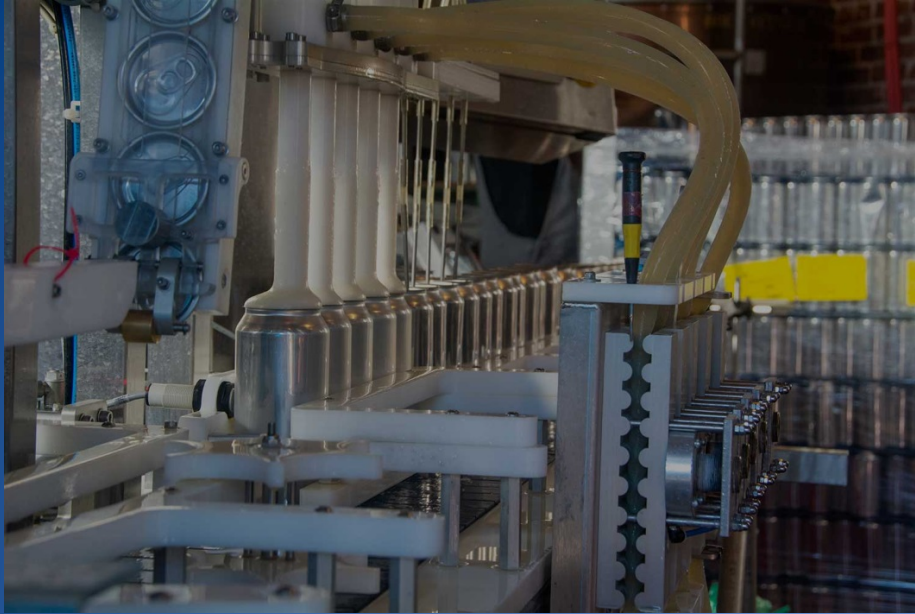




















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# Professional help

- Consultants can help you avoid costly design, build and process mistakes.
- Often pay for themselves in money they can save you.



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# Educated Brewers

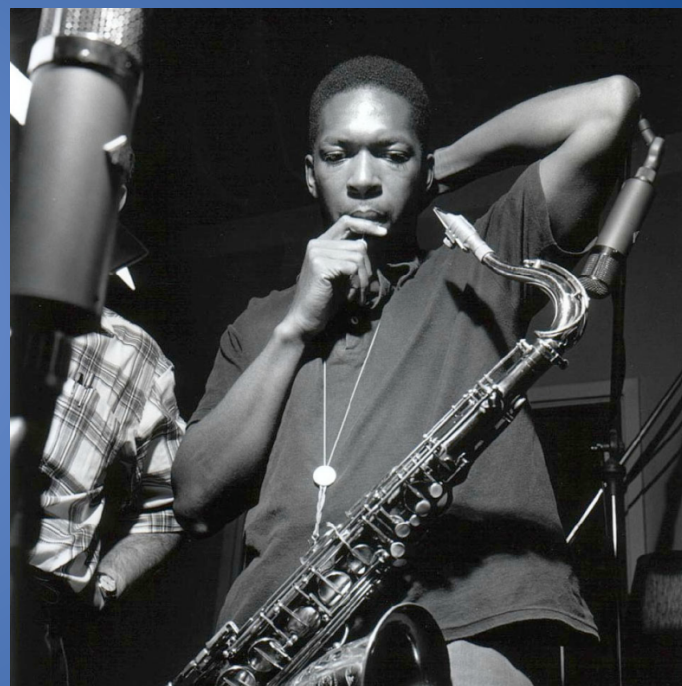
- Historical schools
- Breweries opening too fast for start-ups to find trained and educated brewers.
- Influx of college based classes (who is teaching them?)
- “The past was your’s but the future’s mine” attitude



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# Becoming a better brewer

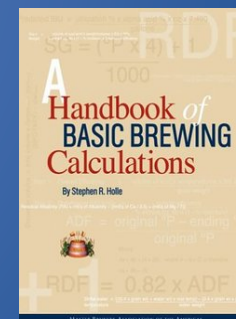
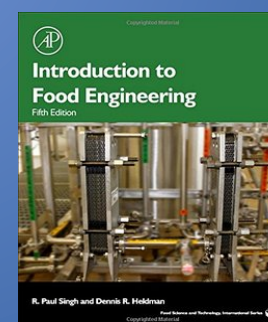
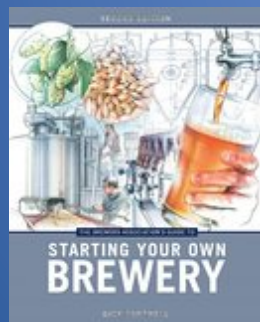
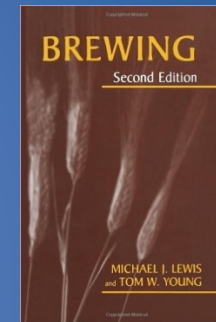
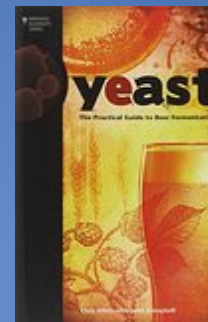
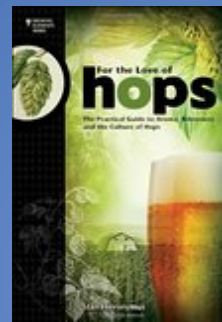
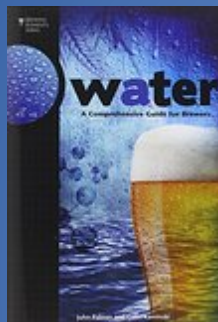
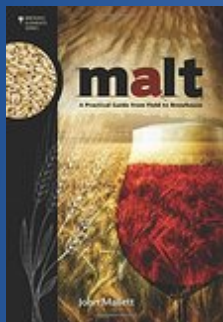
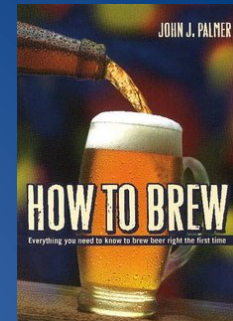
- Brew to style – master a balanced, clean, pale ale.
- Visit breweries
- Join MBAA and State Guild
- Talk to other brewers
- Judge
- Read brewing books and trade publications.



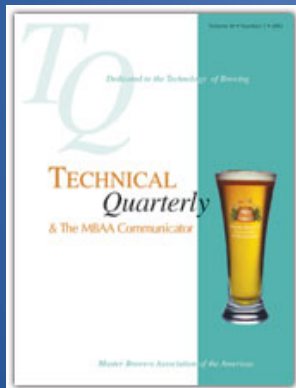
*John Coltrane*



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# New things even an experienced homebrewer still has to learn

- Ingredients
  - Access, specifications, contracts and pricing.
- Yeast
  - Harvesting, storage and pitching.
- Process
  - Engineering principles, utilities, and effluent.
- Beer Stabilization
  - Maturation, clarification, carbonation.
- Packaging
  - Bottling, kegging, and canning.
- Quality
  - Standards, laboratory work, HAACP, and recall policy.



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# Malt Analysis

**2016 Typical analysis**  
Malts and roasted barleys

All Briess malts are produced from 2-Row Malting Barley

Item # Whole Kernel	Item # Pie ground	Item Description	Available Quantity	Moisture		Gluten		Protein		Nitrogen		Extract		Extract Difference %	Protein		Alpha Amylase	Lactase	Catalase	Culm. Dextrin	
				%	g/100	%	g/100	%	g/100	%	g/100	%	g/100		%	g/100					
5298	5596	Brewers Malt	X	98	2	0	80	2	42	80.5	705	10	11.5	42.0	55	140	18				
6986	7219	Full Pint Brewers Malt		100	0	0	80	1	4.6	81.0	80	1.0	11.2	40.8	73	150	1.7				
5303	5603	Pilsen Malt		98	2	0	90	2	4.5	80.5	780	25	11.3	37.0	45	140	1.2				
5317	5612	Wheat Malt, White		98	2	0	80	2	4.0	85.0	84.0	1.0	10.0	44.0	48	140	2.5				
5323	5615	Wheat Malt, Red		98	2	0	80	2	4.0	81.0	790	2.0	13.0	42.0	50	140	2.3				
6650	6660	Goldpils® Vienna Malt		98	2	0	90	1	3.5	80.0	780	2.0	12.0	35.0	45	80	3.5				
5301	5600	Dale Ale Malt		98	2	0	80	2	4.0	80.0	785	15	11.7	42.0	45	85	3.5				
5355	5631	Ashburne® Mild Malt		95	5	0	80	2	3.5	79.0	770	2.0	11.7	40.0	45	65	5.3				
5344	5625	Borlander® Munich Malt 10L	X	95	5	0	80	2	3.3	78.0			11.7	38.0	35	40	10				
5346	5626	Aromatic Munich Malt 20L		95	5	0	80	2	2.5	77.0			11.7	36.0	25	20	20				
5419	5667	Carapils® Malt	X	0	0	100	75	5	65	75.0											
7063	7067	Victory® Malt		95	5	0	70	5	25	75.0											
7059	7061	Special Roast Malt		95	5	0	70	5	25	72.0											
5446	5671	Extra Special Malt		95	5	0	70	5	25	73.0											
5332	5620	Rye Malt		98	2	0	80	8	45	80.0			10.5	50.0	45	105	3.7				
7007	7008	Smoked Malt, Apple Wood		98	2	0	80	2	6.0	80.5			12.0	45.0	50	140	6.0				
6420	6621	Smoked Malt, Cherry Wood		98	2	0	80	2	6.0	80.5			12.0	45.0	50	140	5.0				
6928	6929	Smoked Malt, Mesquite		98	2	0	80	2	6.0	80.5			12.0	45.0	50	140	5.0				
5405	5660	Caramel Malt 10L		0	5	95	70	5	70	77.0											
7070	7072	Caramel Malt 20L	X	0	5	95	70	5	60	76.0											
5407	5661	Caramel Malt 30L		0	5	95	70	5	55	77.0											
5409	5663	Caramel Malt 40L		0	5	95	70	5	55	77.0											
5411	5664	Caramel Malt 60L	X	0	5	95	70	5	50	77.0											
5417	5666	Caramel Malt 80L		0	5	95	70	5	45	76.0											
5416	n/a	Caramel Malt 90L		0	5	95	70	5	40	75.0											
5415	7049	Caramel Malt 120L	X	0	5	95	70	5	30	75.0											
6931	6954	Caramel Rye Malt		0	10	90	80	45	50	80.0											
7051	n/a	Caramel Vienna Malt 20L		0	5	95	70	5	45	76.0											
7050	n/a	Caramel Munich Malt 60L		0	5	95	70	5	35	77.0											
6457	6522	Caracrysta® Wheat Malt		0	15	85	75	3	4.0	78.0											
6461	7039	Carabrown® Malt							2.2	79.0											
5441	5659	Chocolate Malt	X						5.5												
5444	5670	Dark Chocolate Malt							5.5												
5422	6607	Black Malt	X						6.0												
n/a	5709	Black Malted Barley Flour							6.0												
6533	6643	Blackprint® Malt							6.0												
6459	6629	Midnight Wheat Malt							6.5												
7056	7058	Roasted Barley							5.0												
7046	7047	Black Barley	X						6.0												

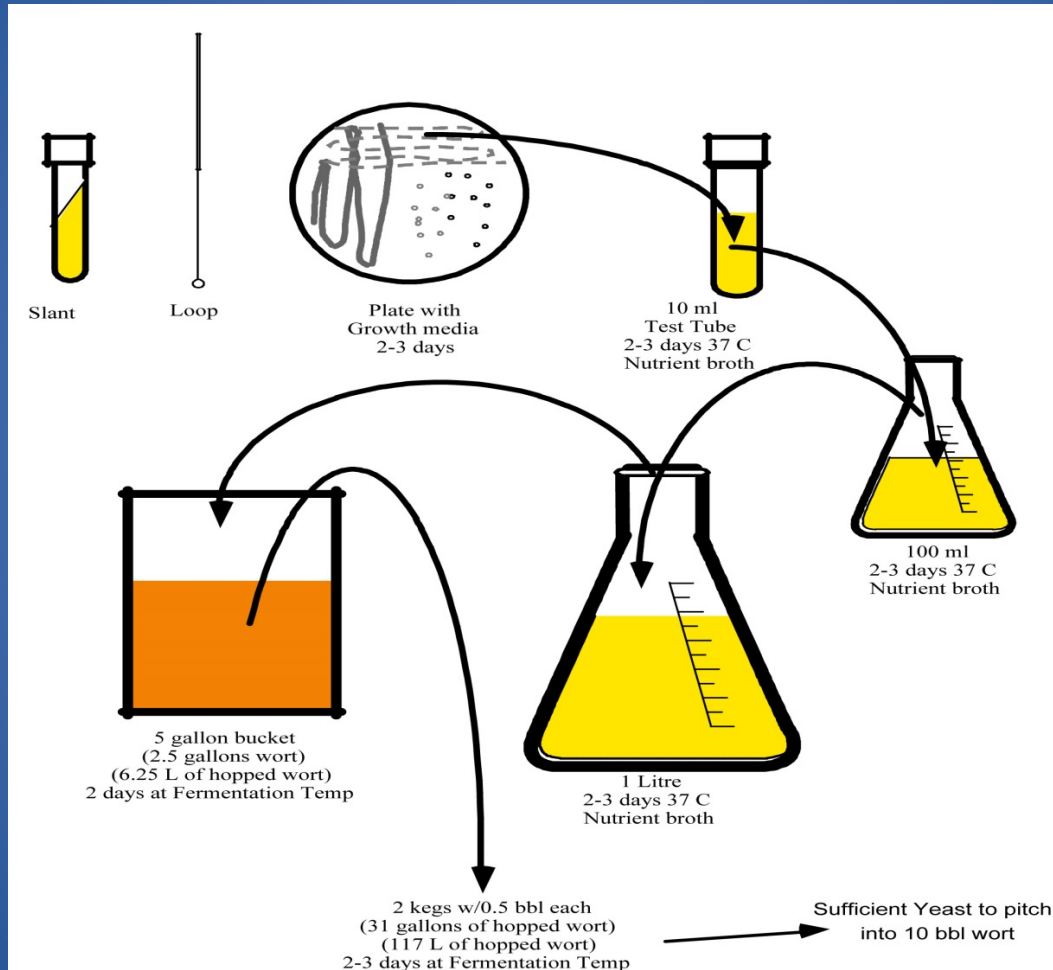
Typical analysis data is subject to standard analytical deviations. They represent average values, not to be considered as guarantees, expressed or implied, nor as a condition of sale. This data is correct to the best of our knowledge. All statements are intended only as a source of information, no statement is to be construed as violating any patent or copyright.

BRIESS | February, 2016



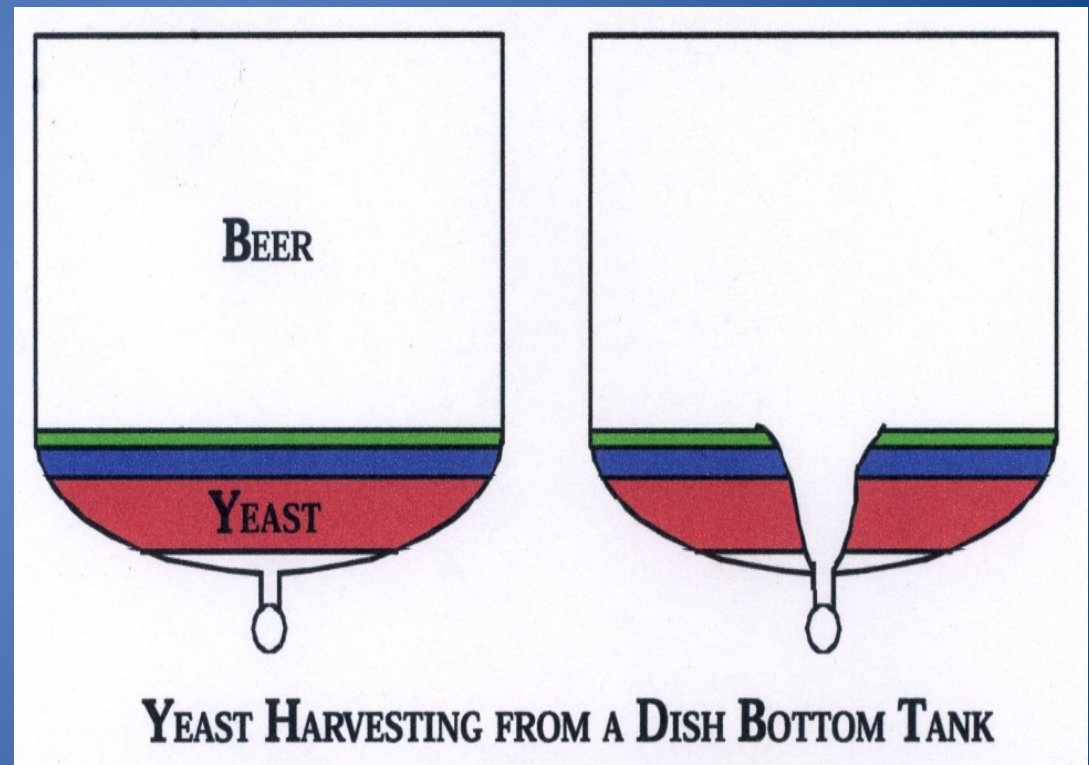
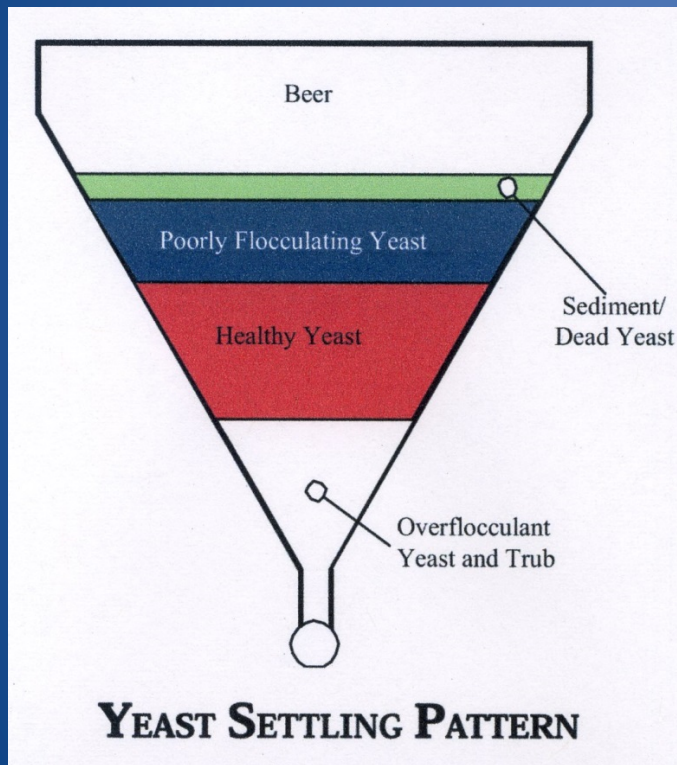
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# Repropagation



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# Yeast Harvesting - Recovery



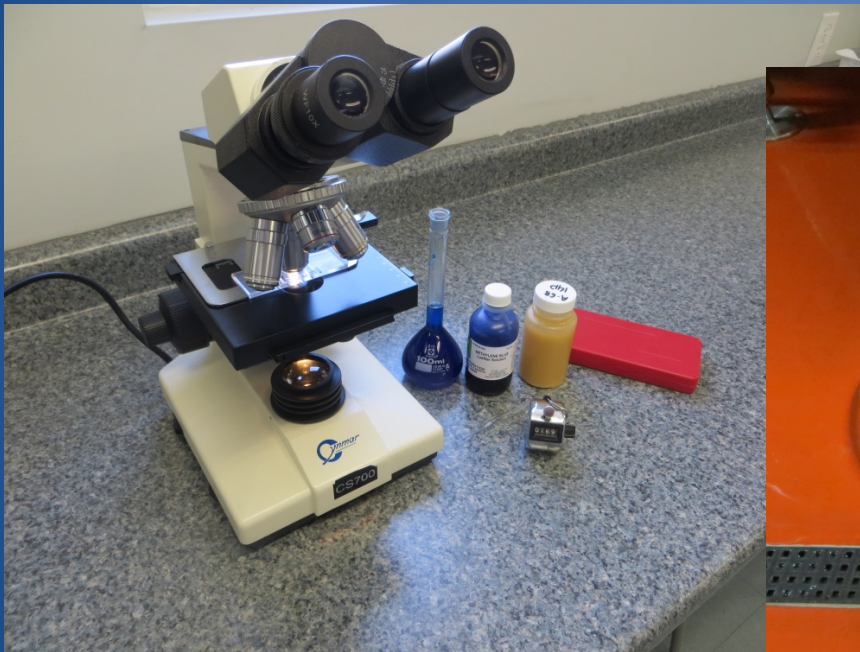
# Acquire yeast handling expertise

- Single use of yeast not an economical option.
- Brewers must learn best methods for recovery, storage and pitching.
- Invest in laboratory equipment including a microscope.
- Requires a knowledge of yeast beyond which strain produces which flavors



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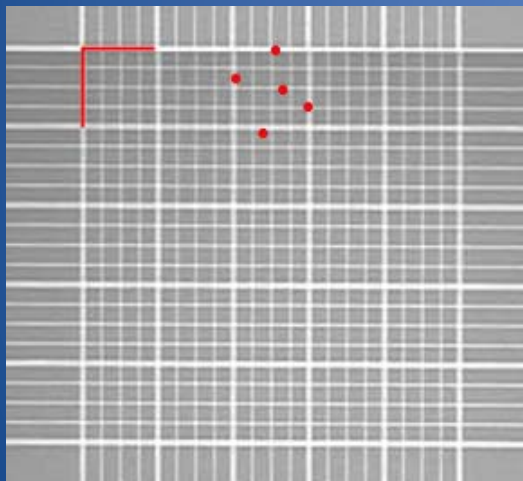
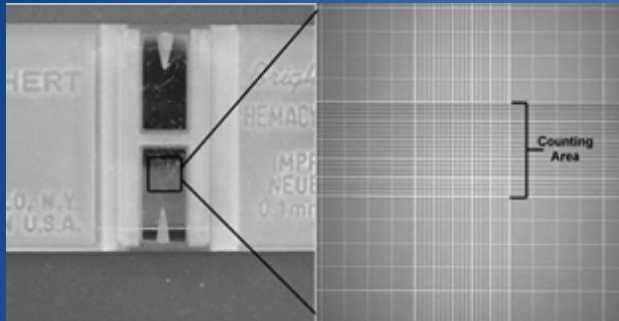
# Yeast collection, storage and pitching



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# Use a Hemocytometer

## Haemocytometer



Cell Counts	
total cells	358
viability	96.1%
total viable cells	344
multiplier	5
chamber total	1720

System Variables		
Dilution Factor	100	
Sample Weight	1.00 grams	per 100.0 ml
Wort Volume	40.0 BBL	4.69E+06 ml
Wort Gravity	12.00 °P	

System Constants	
Chamber Volume	0.0001
Cells/ml*Plato	1.00E+06
Desired Pitch Rate	1.20E+07 cells/ml

Results		
Pitch Volume	3.27E+04 ml	8.65 Gal
Pitch Weight	32745.22 grams	72.13 lb.
Viability %	96.10%	

72			77
	60		
69			80

Total Cells

5			3
	3		
2			4

Dead Cells



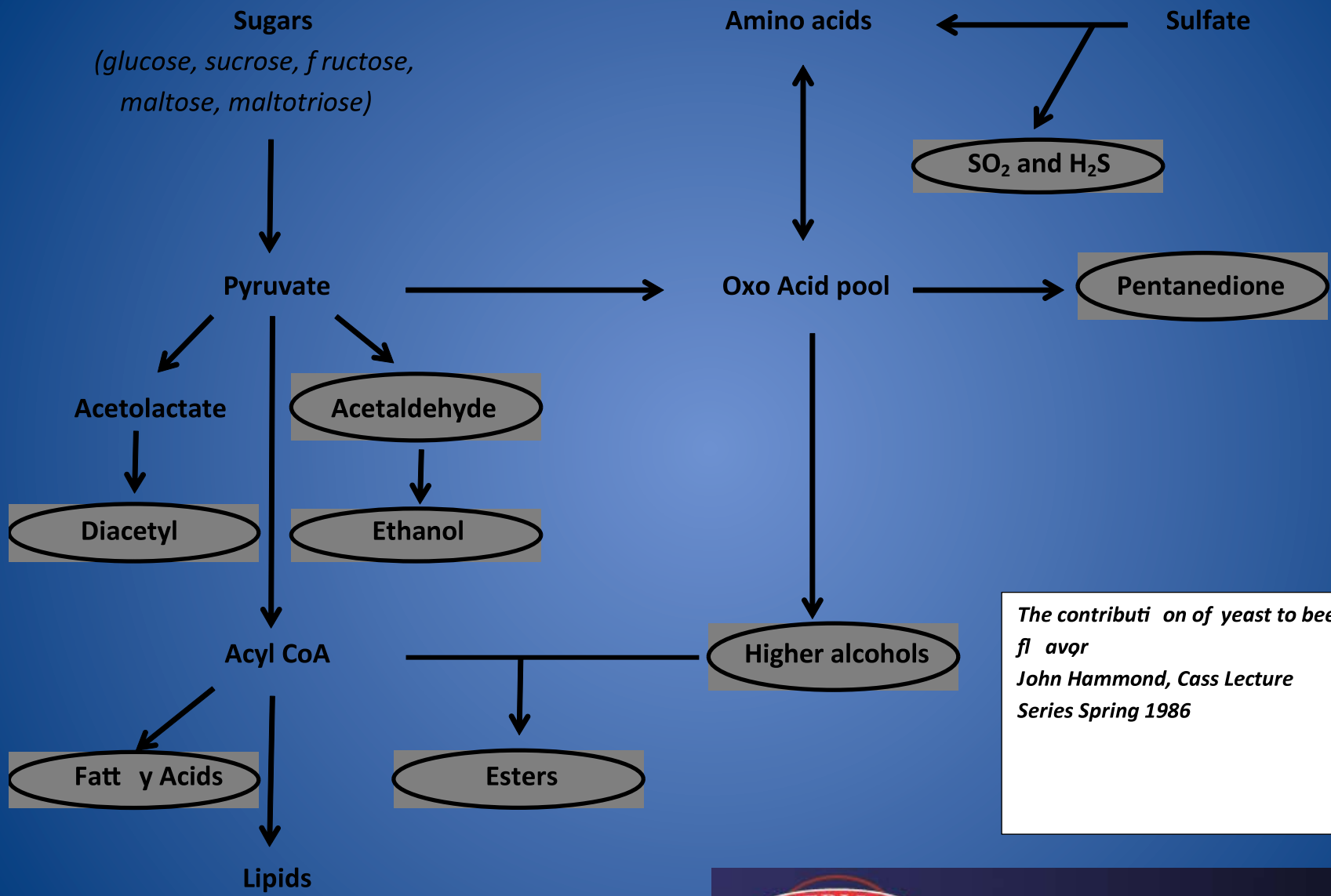
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# When to change yeast

- Over time a yeast changes with serial repitching
- Yeast may take longer to ferment
- May lose the ability to ferment more complex carbohydrates
- Change flocculation characteristics
- Produce more off flavors
- Lose the ability to produce certain flavors
- Become contaminated with microbes



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*The contribution of yeast to beer  
flavor*  
John Hammond, Cass Lecture  
Series Spring 1986



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# Engineering Principles

Rectangles,  $A = \text{length} \times \text{width}$   
 Triangles,  $A = \frac{1}{2} \text{height} \times \text{base}$   
 Circumf. of Circle,  $C = \pi \times \{\text{diam.}\}$

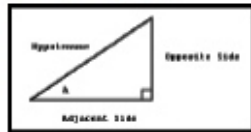
Circle  $A = \pi \times r^2$

Sphere  $A = 4 \pi r^2$   $V = \frac{4}{3} \pi r^3$

$\sin(A) = o / h$

$\cos(A) = a / h$

$\tan(A) = o / a$



$$V = \frac{1}{3} \pi r^2 h \quad \leftarrow \text{Volume of Cone}$$

$$^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32^{\circ}\text{F})$$

Pressure = Force / Area

$PV = nRT$   $R = 8.314 \text{ joule/K-mole}$   
 (Also,  $R = 0.0821 \text{ l-atm/mol K}$ )

**First Law of Thermodynamics** *Energy can not be created or destroyed, but can be transformed from one form to another.*

$Q = \text{energy, work, quantity of heat [Joule]}$

$q = \text{rate of heat flow, power}$   
 (energy/time = J/s = Watt)

$\Delta Q = 0$  (aka Energy is Conserved)

$\Delta q = 0$  (aka Energy is Conserved)

$Q = m c_p \Delta T$  [kJ]

$q = (m_{\text{dot}}) c_p \Delta T$  [kJ/s]

$q = (k / \Delta x) \cdot A \cdot \Delta T$  [kJ/s]

$q = (m_{\text{dot}}) H_2 - H_1 = (m_{\text{dot}}) \Delta H$   
 [enthalpy uses kJ/kg]

**CONCEPT ONE.** You can calculate the quantity of heat in one mass when no phase change occurs and you are at a constant pressure. Helps you find  $T_{\text{final}}$  or  $T_{\text{initial}}$  or mass of another substance.

$$Q = m c_p \Delta T$$

$$\Delta Q = 0$$

$$\{m c_p \Delta T\}_{\text{water}} + \{m c_p \Delta T\}_{\text{malt}} = 0$$

**CONCEPT TWO.** The rate of Heat Transfer across a heat exchange surface is proportional to the temperature gradient and thermal properties of the heat exchange surface. For one layer:

$$q = (k / \Delta x) \cdot A \cdot \Delta T$$

For multiple layers use Overall Heat Transfer Coefficient, U as a resistance:

$$1/U = (1/h_1) + (1/k) + (1/h_2) \dots$$

And then;

$$q = U \cdot A \cdot \Delta T$$

**CONCEPT THREE.** The total amount of heat, Q, or the heat flow, q, in any part of a process describes heating and cooling loads for that part of the process.

(Fermentation, kettle boil, heat exchange, compressors, evaporators, condensers, etc.)

$$1 \text{ ton} = 288,000 \text{ btu/24 hr} = 303,852 \text{ kJ/24 hr} = 3.5168 \text{ kW}$$

**Second Law of Thermodynamics** *The entropy of a system not in equilibrium with its surroundings tends to increase to the system's maximum (THINK ICE MELTING).*

*Temperature differences between systems in contact with each other tend to even out and that work can be obtained from these non-equilibrium differences.*

"Sensible" heat is used to calculate heat content of one mass when no phase change occurs and you are at a constant pressure.

$$Q = m c_p \Delta T = H_2 - H_1 = \Delta H$$

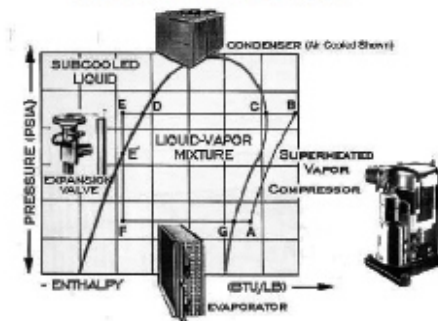
where H is a relative enthalpy

However, during Phase Change, you can heat/cool with temperature constant, and "latent" heat is added or removed.

$$L = Q / M$$

Where L is latent heat, Q is heat Power Required (kW) in a compressor:

$$= (m_{\text{dot}}) (H_2 - H_1) / (\text{efficiency})$$



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# Effluent



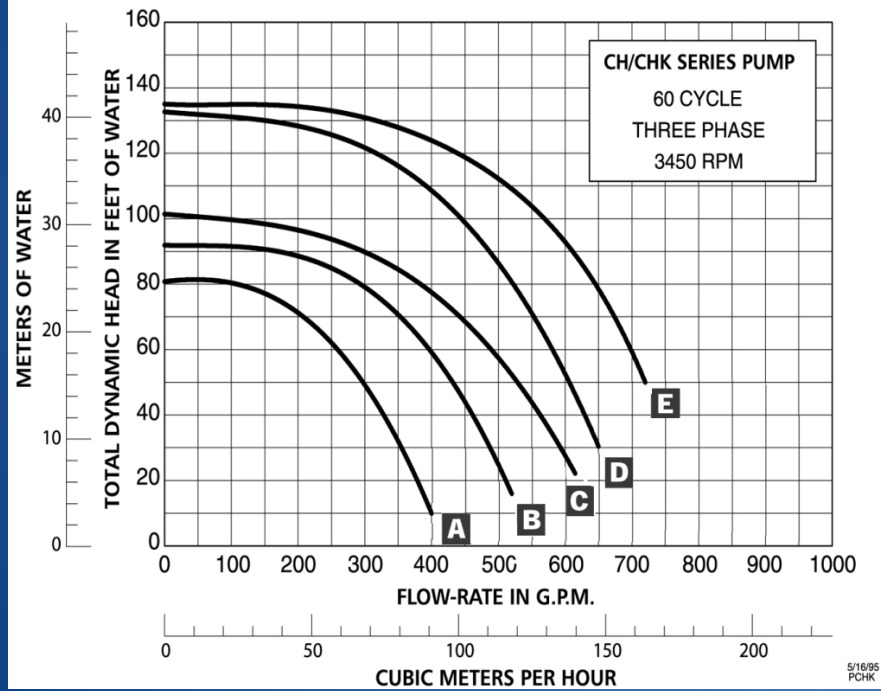
WR-43-3 COMPUTER FORM (19991231.xls)											PERMITTEE E Brewer			
Brewery 12 Main St											PERMIT No.-3-1410			
											MONTH: NOVEMBER		2016	
EFFLUENT											SIZE/TYPE OF PRIMARY FLOW DEVICE - Flow Check Performed on Effluent Meter			
DATE	BOD		pH		flow			MONTHLY PRODUCTION total gal	Date	Head in Inches	Actual Flow in MGD	Chart Flow in MGD	(Actual-Chart)/Actual X 100	
	mg/L	lbs.	low (s.u.)	high (s.u.)	Flow	GPD								
November 1			5.791	5.962	10310									
2														
3								11/7/2007	10	472	47C	0.5%	% ERROR	
4								11/14/2007	25	1181	115C	2.6%	% ERROR	
5			5.989	6.576	14320			11/19/2007	22	1039	100C	3.8%	% ERROR	
6			5.793	5.917	10940			11/29/2007	23	1087	100C	8.0%	% ERROR	
7			5.784	5.918	11490								% ERROR	
8			5.843	5.952	13960				Factory Calibration Date:				Calibrated By:	
								COMMENT S AND EXPLANATI ONS OF ANY VIOLATIONS : (Reference all attachments here)						
9														
10														
11														
12			5.791	6.386	16690			"-" = no flow						
13			5.883	6.054	13210									
14			5.786	5.947	17860									
15	1900	144	5.794	5.917	9090									
16			5.862	5.942	9200									
17														
18														
19			5.792	6.014	13420									
20			5.793	6.043	10420									
21			6.619	8.036	11760									
22														
23														
24														
25			6.062	7.306	13480									
26			5.779	6.004	10630									
27			5.882	5.972	10080									
28			5.894	5.999	9720									
29	1300	86	5.793	5.977	7980									
30			6.043	6.225	8160									
TOTAL	3200	230	112.0	118.15	222720		94240							
Average	1600	115	5.9	6.22	11722									
Max	1900	144	6.6	8.04	17860									
Min	1300	86	5.8	5.92	0									
											PREPARED BY:			
											APPROVE D BY:		Authorized Agent for the Permittee	
													One Copy to the State - Permittee to Keep One Copy	

# Utilities Engineering

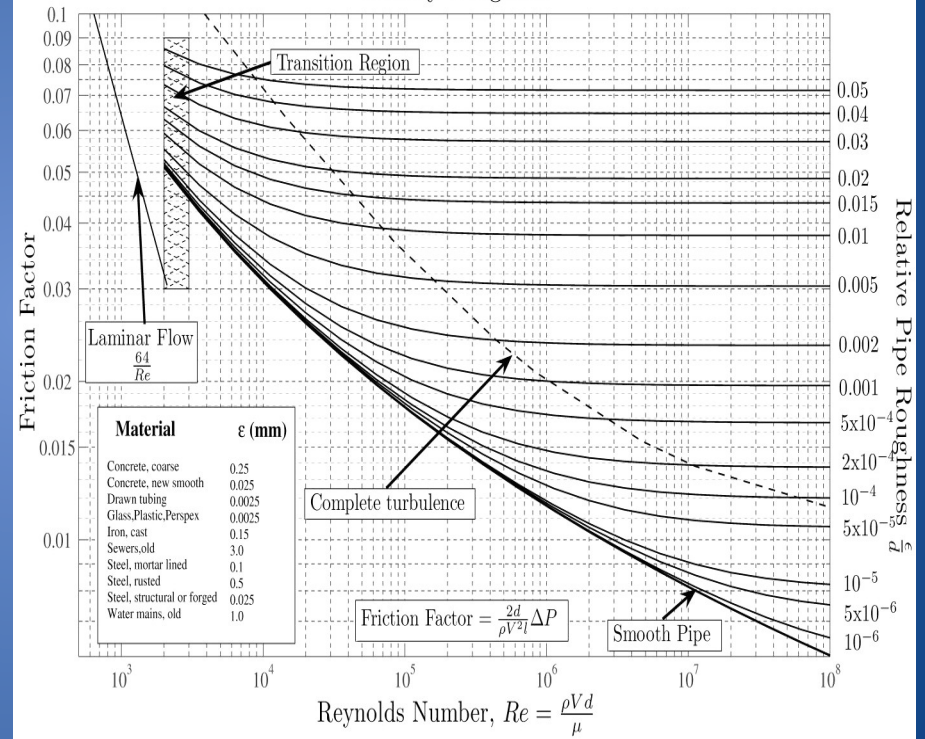


# Fluid Dynamics

**PUMP PERFORMANCE CURVE  
CH/CHK SERIES PUMP**



**Moody Diagram**



# Quality

Your first concern is consistency and to achieve it you need the following:

- Record keeping
- Standard Operating Procedures (SOP)
- Analytical tools and instruments
- Laboratory
- Education and training



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# What's happening here?



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A blogger posted this picture of two pints of the same craft beer served in two different bars on the same day



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# Clarification



D.E. Filtration



Sheet or Pad filter



Fining agents



# Clarification

- Settling - Understand Stoke's Law  $u_g = \frac{2r^2 (\rho_v - \rho_i) g}{9 \mu}$
- Filtration - Understand Darcy's Law  $Q = \frac{K \Delta P A}{L \mu}$
- Haze
  - Microbiological
  - Protein – Tannin – Oxidation Interactions
  - Chill Haze
- Fining agents



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# Quality - Flavor Stability

The role of oxygen in flavor stability is mostly understood.

All food products stale the same way including beer.

Air pickup early in the process can damage the product.

By far the most impact is from oxygen pickup late in the process.



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# Sell it fast and drink it quickly



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# Expertise

- Starting to see beers in the market with easily avoidable issues
  - Flat beer
  - Gushing Beer
  - Diacetyl
  - DMS
  - Sour beer
  - Murky beer
  - Autolysis flavors



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# Flat and gushing beer

- Carbonation consistency
- Pressurized vessel needed
- Precise yeast cell count and sugar additions
- Yeast strain that can successfully handle alcohol and pressure
- Avoid autolysis
- Yeast that sinks to the bottom and stays there



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# Diacetyl - buttery off flavor

## Understand the process

- Yeast make it then remove it
- Healthy yeast is crucial
- Strain dependent
- Correct pitching rates
- Correct wort aeration
- Timing of cooling
- Contamination



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# DiMethyl Sulfide (DMS) – corn flavor/ aroma

## Understand the process

- Formed in malting
- Reduced during malt kilning
- Paler malts have more
- Good wort boil removes it
- Rapid wort cooling prevents it



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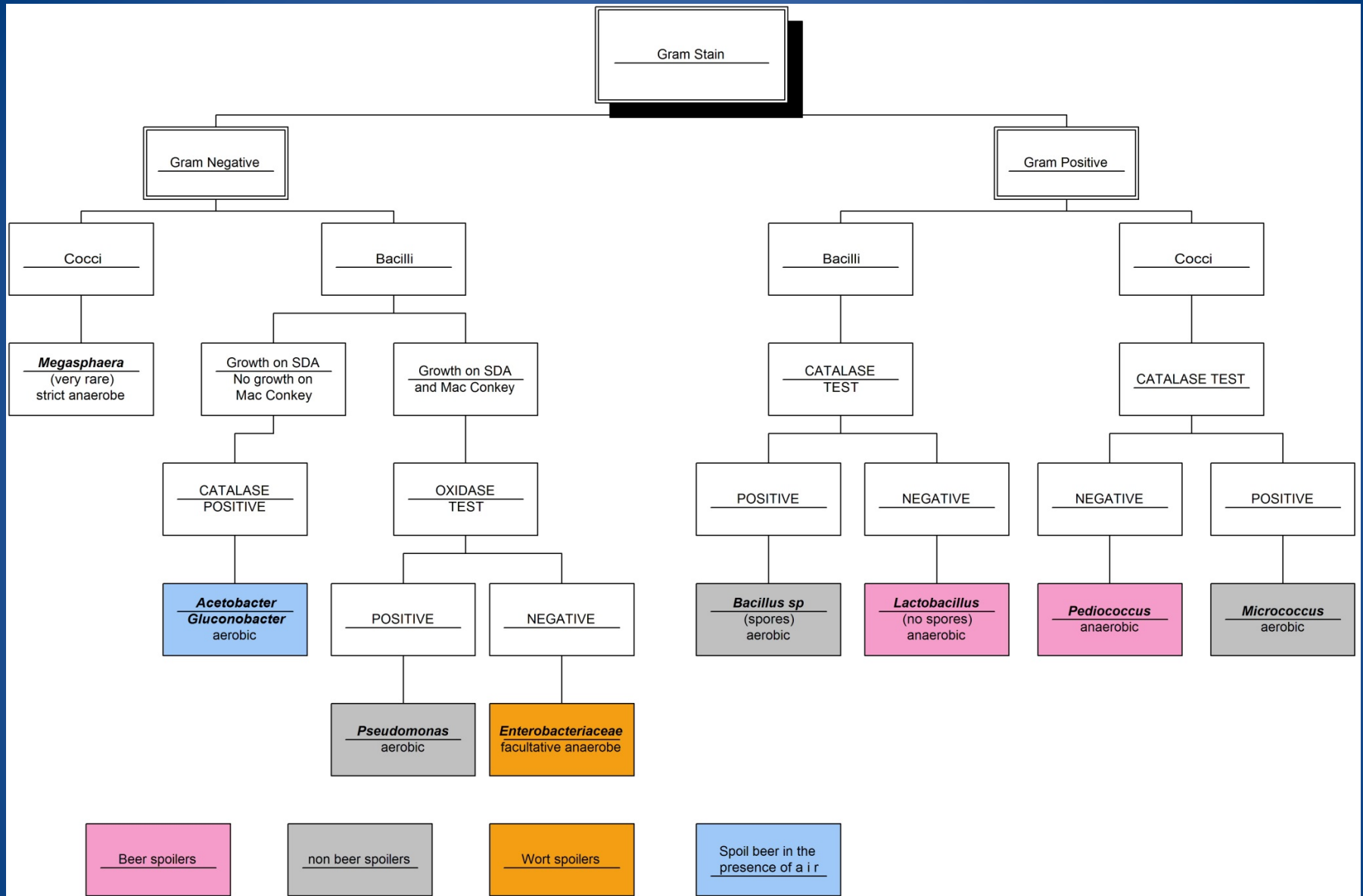


# Contamination

- Beer spoilers
  - Lactobacillus common
  - Pediococcus rare
  - Wild Yeast common
- Wort spoilers
  - Enterobacter strains rare



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# Basic Lab Equipment



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# Keys to Good Consistent Beer

- Buy the best ingredients you can
- Control your mash temperatures
- Boil your kettle vigorously and for long enough
- Pitch the right amount of HEALTHY yeast
- Keep your equipment and brewery tidy and clean.



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# What I wish I'd Known

- Plan for Expansion From the Start
- Cost + Time Commitment are way more than you planned for
- Permitting will throw up surprises and take more time than you plan for
- There's a lot more admin than you think
- A Brewpub is a restaurant that brews its own beer. A tasting room can be too



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# What I wish I'd Known continued

- TTB agents carry guns and are empowered by the 21<sup>st</sup> Amendment to regulate you. State agents are too. (same amendment)
- Owning a brewery makes you a beer salesman and if you can't do that then think twice
- American beer consumers want to know the founder's story. Seems more important than the beer quality sometimes .



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