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THE HOW-TO HOMEBREW BEER MAGAZINE

MARCH-APRIL 2013, VOL.19, NO.2

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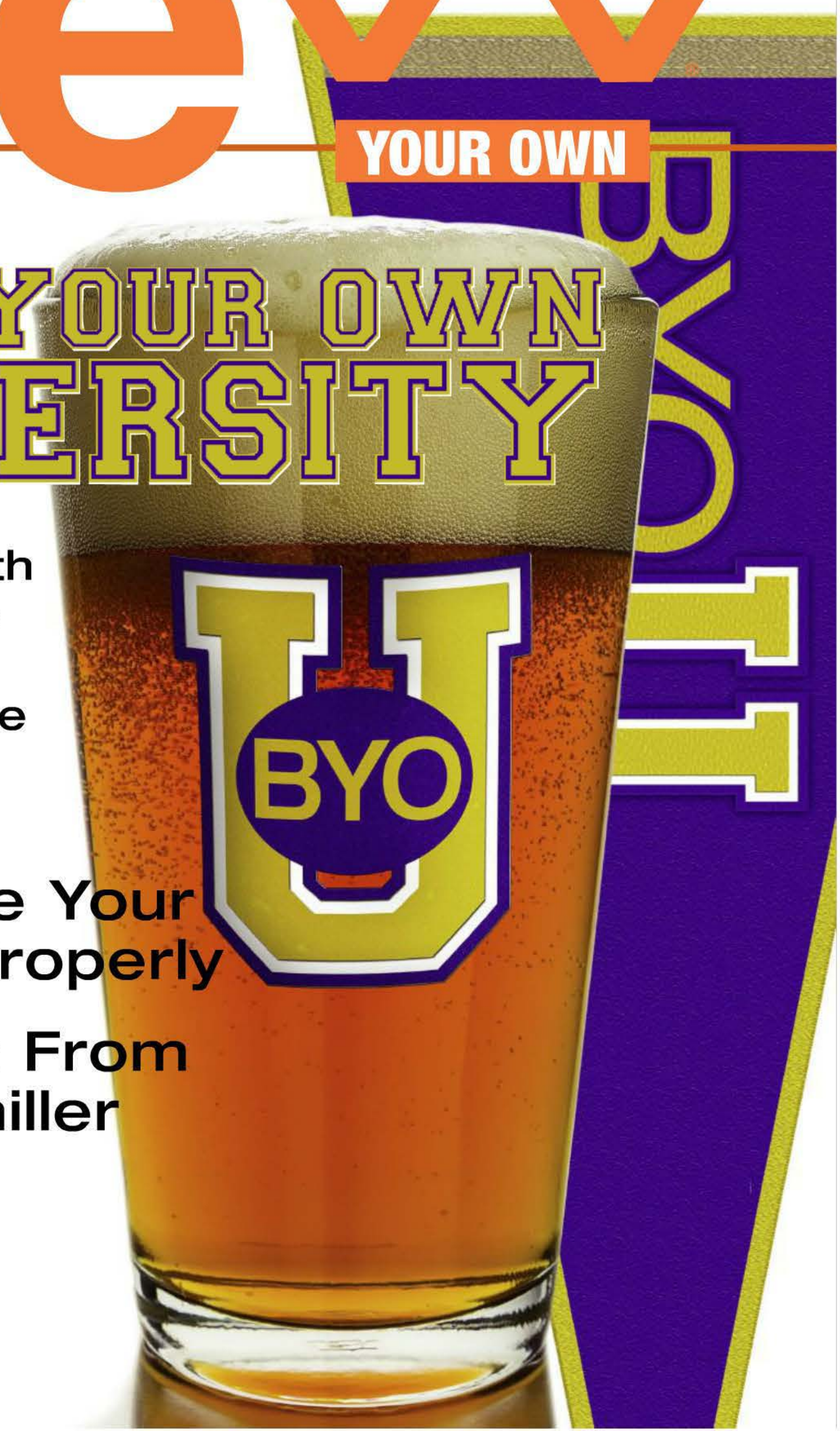

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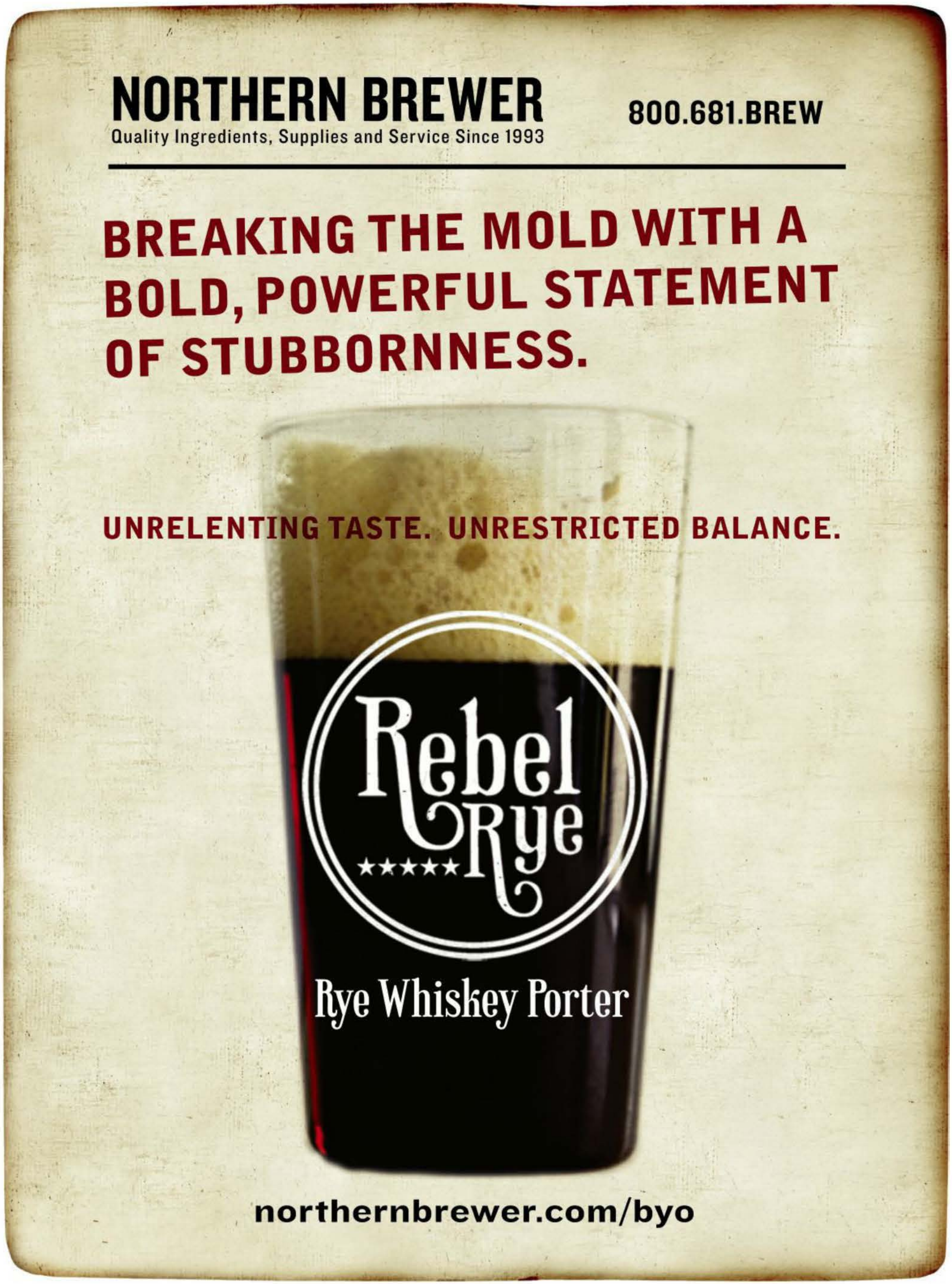
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RECIPE INDEX

BYO RECIPE STANDARDIZATION

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

Extract values for malt extract:
liquid malt extract (LME) = 1.033–1.037
dried malt extract (DME) = 1.045

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

Hops:
We calculate IBUs based on 25% hop utilization for a one hour boil of hop pellets at specific gravities less than 1.050.

THE LATEST FROM BSG HANDCRAFT 2013

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What also came out of this exploration was the realization that we were not redefining ourselves, but rather moving towards a new brand that is now actively in sync with an increased level of commitment to the quality and service that you deserve.

Here's to exploration.

Until next time, keep on HandCraftin'.

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what's happening at **BYO.COM**

Brewing With Coffee

The National Coffee Association claims that 79% of the adult population of the United States drinks coffee regularly. But what those statistics don't reveal is how many get their coffee through the beer they drink. Learn more about adding java to your next homebrew.
www.byo.com/component/resource/article/318

Try Brewing With Partial Mash

Most homebrewers identify themselves either as extract or all-grain brewers, but there's another division that may be just as important — stovetop brewers or outside brewers. If space is at a premium, but you want to brew more than extract recipes, try brewing a batch with the countertop partial mash method.
www.byo.com/component/resource/article/511

Convert an All-Grain Recipe to Extract

Ever come across an all-grain recipe that you really want to try, but you're not set up to brew all-grain? *BYO*'s Ashton Lewis explains how to formulate that recipe to brew it with extract.
www.byo.com/component/resource/article/496

Cover Photo: **Charles A. Parker**

Brew YOUR OWN — THE HOW-TO HOMEBREW BEER MAGAZINE

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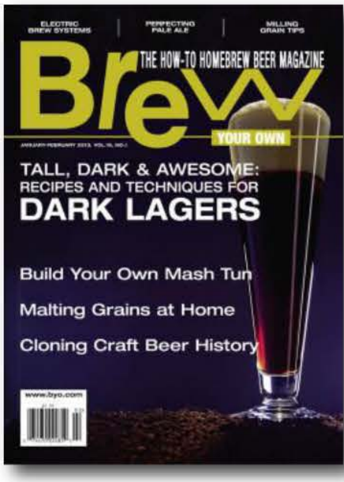

Why not more malting?

I enjoyed Graham Anderson's article on malting (January-February 2013). I had a question, though — if malting is as easy as he says, why don't more commercial breweries malt their own?

Graham Johnson
via email

This is a great question. Although a few breweries malt their own grains, 99% of the malt used by commercial brewers is produced by commercial maltsters. It is not overly difficult to make malt of a quality that will produce a fine beer. However, malt costs money and commercial maltsters are able to make malt much more efficiently than individual breweries could unless they installed a whole lot of very expensive equipment.

One of the ways maltsters produce malt efficiently is by minimizing malting loss. When barley is malted, it loses weight (dry weight). The difference in dry weight between the raw barley seed and the resulting barley malt is called malting loss. Modern maltsters are able to finely control the malting process to minimize malting loss. If individual breweries were to malt their own, they would either need to invest in a lot of expensive equipment (and hire a knowledgeable maltster) or lose a lot of money from malting loss, compared to if they simply purchased the malt. Most breweries could probably make malt that would be great from the standpoint of beer quality. It's the malting loss that would be the problem.

Of course, with craft beer sales still on the rise, beer consumers may be willing to pay a little more for beer made by a brewery that malts their own. Rogue, for example, grows some barley and malts it themselves for some of their beers. If this proves to be successful for them, maybe more breweries will get into malting.

Dough doh!

Horst Dornbusch's "Schwarzviertler" article, in the January-February 2013 issue, mentions using a dough-in instead of a mash-in. What is the difference? According

contributors

Jamil Zainasheff is the owner of Heretic Brewing Company in Pittsburg, California. He documented his transition from homebrewer to commercial brewer in his blog at byo.com. Although now a professional brewer, he keeps in touch with the homebrewing community as the host of *Can You Brew It?* on the Brewing Network (www.brewingnetwork.com) and his website Mr. Malty (www.mrmalty.com). Jamil is *Brew Your Own's* "Style Profile" columnist and author of our recent special issue *30 Great Beer Styles*.

In this issue, on page 19, he discusses how to brew oatmeal stout, including how to really accentuate the oatmeal character in this brew.

Chris Colby is Editor of *Brew Your Own* magazine. Chris brewed his first beer in 1991 while in graduate school at Boston University. A few years later, after reading the first edition of Fix's "Principles of Brewing Science" (1989, Brewers Publications), he became interested in brewing science and especially the science of brewing techniques. He currently resides in Texas.

In this issue, on page 26, Chris takes readers on a review of homebrewing practices in "Brew Your Own University." The article, which focuses on the most common techniques in homebrewing, seeks to explain the requirements for brewing quality beer and the options a brewer can explore when making beer.

Dave Green is the Advertising Sales Coordinator for *Brew Your Own* magazine. Dave is an avid all-grain brewer, and has written articles for *BYO* on step mashing (January-February 2008: http://www.byo.com/stories/techniques/article/indices/9-all-grain-brewing/1529-the-science-of-step-mashing), turbid mashing (July-August 2008: http://www.byo.com/stories/issue/article/section/0-/1566-turbid-mashing) and sour mashing (October 2008: http://www.byo.com/stories/techniques/article/indices/9-all-grain-brewing/1723-sour-mashing-techniques).

On page 56 of this issue, Dave discusses hop stands — adding hops and letting them steep in the whirlpool after the boil is shut down.

to *BYO*'s online glossary dough-in and mash-in are analogous terms.

Andrey Kayanitsa
via email

Doughing in and mashing in are the same thing. In the article, Horst says, "For homebrewers who cannot heat their mash directly, use a thick dough in instead of a mash in," meaning that a brewer in that condition should mash in thickly, not as he normally does. This could have been spelled out more explicitly. Sorry for any confusion.

Furious first wort hops

I think you have some errors in your Surly Brewing Furious clone recipe (July-August 2010). The recipe lists IBUs at 99. When I enter the recipe into BeerSmith, I get 62 IBUs, everything else is close.

Jamy Klein
via email

Replicator author Marc Martin responds: "Thanks for your inquiry about the Surly Furious recipe. I always record my phone interviews with brewers, so I went back and listened to that one. Everything checked out, but when I punched the numbers into my calculator, the IBUs did come up short.

"Not knowing what program they use for recipe calculations, I called them this morning. The problem was that, during the interview, the brewer had read off the first wort hops as Ahtanum™, when it should have been Amarillo — a big difference in alpha acid content. After making that correction, the IBUs come up into the right range (the exact number depending on the alpha acid entered.)

"One more variable you may want to check would be whose hop utilization factor you are using. The one that is most often used by homebrewers is Tinseth and the curve BYO *uses is very similar to this. Using* BYO*'s recipe calculator, the bitterness is 89 IBUs. Not the 99 stated in the recipe, admittedly, but not the 62 you calculated either. (The 20 AAUs of Warrior hops boiled for 90 minutes gives 75 IBUs alone, using our curve.) You may also want to check how the IBUs for first wort hops are calculated, as this is handled differently by different recipe software.*

"Thanks for the catch on this. Every BYO *recipe is double checked in the reviewing process, although unfortunately this error slipped through and we apologize for the error. Of course, the most important thing is how the beer tastes. Good luck brewing your Surly Furious clone and don't hesitate to let us know how this batch, or any others, come out. We are always looking for feedback from our readers."* BYO


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homebrew nation

READER PROFILE

Brewer: Aaron Vaughan

Hometown: Riverside, California

Years Brewing: 4

Type of brewer: All-grain

Homebrew Setup (volume, style, efficiency): 10-gallon (38-L) mash for 5 gallons (19 L) that allows for anything from session beers to barleywines. Fly sparge system. Homemade counterflow chiller, hop spider. On average I get about 80% efficiency, I mash at 1.5 qt/pound of grain, generally I like drier beers so I mash at 146–148 °F (63–64 °C) unless the style calls for more of a malty character. I also read *The Homebrewer's Garden* a couple of years ago and I made good use of it by incorporating a lot of my garden into brewing.

Currently fermenting: Dortmunder export, Irish red, basil honey pale ale (on WLP072), a dry mead (champagne yeast) aging on oak, brown ale and an Indian masala beer on a Belgian yeast. I'm using coriander, nutmeg, turmeric, sumac, and cumin for the spice profile.

What's on tap/in the fridge: old ale, peach sour, raisin quad, Berliner weisse, chocolate porter, mild, oktoberfest, imperial Pilsner, rauch, dry stout, strawberry mead (7%, carbonated — a wonderful afternoon wine during the summer), blackberry and pomegranate mead.

How I started brewing: My wife lived in Europe for a while and developed a taste for good beer. Three weeks after we got married she said, "We should make our own beer." The rest is history.

reader recipe

Basil Honey Ale
(5 gallons/19 L, all-grain)

OG = 1.084 FG = 1.021
IBU = 39 SRM = 9 ABV = 8.1%

Ingredients

10 lbs. (4.5 kg) Great Western 2-row pale malt
1 lb. (0.45 kg) Vienna malt
1 lb. (0.45 kg) Carapils® malt
5 lbs. (2.23 kg) flaked wheat
0.5 lb. (0.23 kg) honey
10 AAU Mt. Hood (whole hops) (2 oz./57 g at 5% alpha acids) (60 mins.)
4.5 AAU Ahtanum™ hops (0.75 oz./21 g at 6% alpha acids) (10 mins.)
3 oz. (85 g) fresh basil (10 mins.)
White Labs WLP072 (French Ale) yeast

Step by Step

Mash for 75 minutes at a ratio of 1.5 qts water per pound of grain. Boil for 1 hour, adding hops and basil at specified times. Add honey to the boil with 20 minutes left. Chill the wort to 72 °F (22 °C) using counterflow chiller, then put in the fridge overnight to get down to 50 °F (10 °C). Pitch the yeast at 50 °F (10 °C), both yeast and beer are same temperature so as not to shock the yeast. Let the temperature rise naturally to 65 °F (18 °C) in a water bath. Hold at 65 °F (18 °C) for two weeks. Crash in the fridge for three days to allow yeast and protein to settle out as much as possible, then transfer to keg. Keep at 45 °F (7 °C) at 12–14 PSI.

byo.com brew polls

Do you like to brew dark lagers?

No, I'm not intererested 73%
No, but I would like to 18%
Yes, sometimes 7%
Yes, all the time 2%

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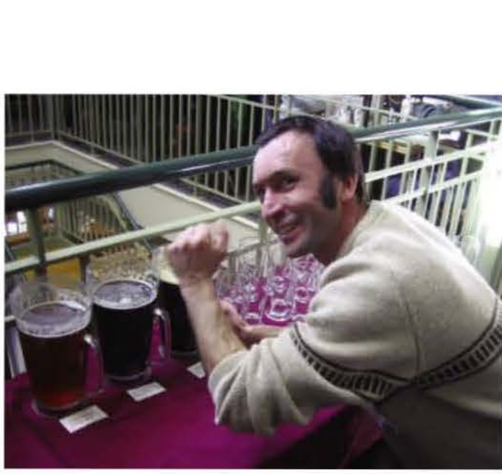
Brewer's Friend is an online set of tools and information to help you brew your best, every time. Easy to use for beginners with powerful features for advanced brewers. The site is mobile enabled and goes with you anywhere. Add recipes to scale and share, find useful charts and water profile information, utilize brewing calculators, keep track of brewing sessions, create shopping lists and more. Accommodates extract, partial mash, all-grain, BIAB and no chill brewers.

http://www.brewersfriend.com/



calendar

March 16
Hudson Valley Homebrewers Annual Homebrew Competition
Arlington, New York

The Hudson Valley Homebrewers welcome all homebrewers to enter their annual competition. Winners receive prizes, and raffle prizes will be awarded throughout the event.
Deadline: March 9
Entry Fee: $7 per entry
Contact: Justin Taylor, justintaylor84@hotmail.com
Web: www.hvhomebrewers.com/news/HVHBAnnounce2013.pdf

March 23
Charlie Orr Memorial Chicago Cup Challenge
Crest Hill, Illinois

The Brewers of South Suburbia will hold their 22nd annual homebrew competition, which is a part of the Midwest Homebrewer of the Year competition. The contest features the Chicago Beer Cup, which is awarded to the homebrew club that accumulates the most points. Ribbons and prizes will be awarded to the winners of each flight, including separate best of show awards.
Deadline: March 15
Entry Fee: $6 per entry
Contact: Steve Sikorski, BOSSBeerComp@gmail.com
Web: http://bossbeer.org/competition.html

April 6–7
Ocean State Homebrew Competition
Providence, Rhode Island

Johnson & Wales University's student-run homebrewing club, JbreW, will hold their annual homebrew competition, and welcomes entries from anywhere across the US and Canada. Entries will be judged in all 98 categories and subcategories, as well as a category specifically for gluten-free beers.
Deadline: March 17
Entry Fee: $7 for the first entry, $5 for additional entries
Contact: Jennifer Pereira, jpereira@jwu.edu
Web: http://oshc.brewcomp.com/

homebrew drool systems

VW Draft System

Chris German • Waconia, Minnesota

I'm to the point now with my 1975 Riviera with a late (1976) Westfalia interior that I'm ready to dream up projects that are not of the utmost urgency to the drivability of the vehicle. Of course, there are always systems to be maintained, but I'm ready to have some real modification fun. This summer I tackled such a project and installed a homebrewed beer draft system. It's the perfect marriage of my two favorite hobbies: Volkswagens and brewing homebrew. Given that this is a family vacation get-away vehicle and I didn't really want to have to explain myself to non-approving critics, it was a major goal of mine to make the draft system as inconspicuous as possible.

Getting a beer when camping meant opening the slider door each time and disturbing my sleeping children. So I had a stainless steel box fabricated to fit nicely in the sink drain vent hole on the outside of the bus. Inside that box I had Corny keg threads welded so I could attach beer-out and CO_2-in fittings, which allows me to snap on a beer tapper and gas.

I can serve both water and cold homebrewed beer out of the stock Westy sink faucet. This is done using a 3-way ball valve at the faucet so if the handle is turned counterclockwise, beer will flow. If the handle is turned clockwise, water flows. There is one fairly short common line going from the ball valve to the faucet and it just takes a second to clear.

A beverage tube, or line, goes from the water keg directly to the 3-way ball valve/faucet. Another beverage line, which I've insulated, goes from the beer keg and runs along behind the sink cabinet and then into the icebox. In the icebox it runs through 50-feet of stainless steel coil, which is cold from ice, and then through an insulated line to the 3-way ball valve.

beginner's block

BREWING WITH OATMEAL

by betsy parks

Once you get the basics of brewing with barley malt down, it is fun to start experimenting with other grains and adjuncts. On page 19 of this issue, Jamil Zainasheff discusses brewing oatmeal stout. If you want to try homebrewing with oatmeal, take a moment to learn a little bit about how to use it in your homebrews.

What it does

Adding oatmeal to a homebrew recipe is a great way to add a silky mouthfeel — one of the characteristic traits of oatmeal stout, as well as some porters. This happens because oats contribute unique unfermentable sugars to beer that are not found in barley, which are perceived as texture in your mouth.

Partial mash

Unfortunately for all-extract brewers, oatmeal is an adjunct that needs to be mashed, not steeped, in order to perform properly in a brewing recipe. Mashing is the process of soaking grains in a volume of controlled-temperature hot water to convert the starch in the grains into fermentable and non-fermentable sugars. The plus side of this is that brewing with oatmeal is a fun excuse to try your hand at brewing with the partial mash technique. For instructions and more information about brewing with partial mash, visit www.byo.com/component/resource/article/2624.

Types of oats

Oatmeal is available in many different forms: whole, steel-cut, rolled and flaked. Rolled and flaked oats have been exposed to heat and pressure before being dried and packaged, so their starches have been gelatinized, therefore they can be added directly to the mash for the starch to be converted to sugar. Whole oats, on the other hand, which includes steel cut oats, need to be cooked before adding them to the mash in order to gelatinize the starch (which remember then needs to go through the step of mashing). Try to start out brewing with oatmeal by using recipes that call for rolled or flaked oats to save a step — and some of the mess — during the brew day. You can find flaked oats at your favorite homebrew supplier, and rolled oats are available in the grocery store.

How much

Oatmeal is best used sparingly in beer recipes because it can cause a lot of trouble during wort separation as it leaves behind thick, viscous beta glucans. All-grain recipes tend to keep the amount of oats down to around 5–20% of the grist (although 20% is pretty high and not recommended for novice brewers). Ironically, oatmeal does not provide much flavor in beer, so if you want more of an oatmeal-y taste your best bet — instead of adding more oats — is to look for a recipe with specialty grains that provide the types of bready flavors associated with oatmeal, such as Victory® malt. Most well-designed homebrew recipes will keep the oats down to a minimum, so look for reputable sources for recipes (for example, Jamil's recipe for oatmeal stout on page 20 of this issue.)

Too much oatmeal in the mix can also cause a lot of haze in your finished beer, so it's a good idea to look for recipes that include Irish moss or another sort of kettle fining agent to cut down on the potential cloudiness.

Related links:

• Read more about brewing oatmeal stout: www.byo.com/component/resource/article/1194

• Learn more about grains and adjuncts with *BYO*'s online charts: www.byo.com/resources/grains

social homebrews

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Dale Elster of Auburn, New York shared a photo of his tap handle with *BYO* on Facebook:

"My homemade tap handle for Gunpowder Porter — a robust porter brewed with smoked malt and cracked black peppercorns!"

by marc martin

DEAR REPLICATOR, DURING A TRIP MY WIFE AND I TOOK UP THE OREGON COAST. WE STOPPED FOR DINNER IN LINCOLN CITY, OREGON AT ROAD HOUSE 101. THERE I HAD A FENDER BENDER AMBER ALE BREWED BY RUSTY TRUCK BREWING. THIS WAS THE BEST AMBER ALE I HAVE EVER HAD. IT HAD GREAT BODY, A NICE BALANCED MALTINESS AND KIND OF A NUTTY PROFILE. I WOULD LOVE TO BREW A BATCH OF THIS BEER AT HOME. ANY CHANCE YOU CAN HELP?

STEVEN WILKER
BERKELEY, CALIFORNIA

Eight years ago, Brian Whitehead bought an old, run down blues bar on highway 101 in Lincoln City, Oregon. He immediately upgraded the entire facility and re-named it Road House 101. His plan was to install a craft brewing system in this building but that proved to be too costly. Those plans were put on hold until 2011 when he had the necessary capital to complete a new 6,000-square-foot brewery building next to the restaurant and bar. They installed a 10-barrel Specific Mechanical brewhouse and their first batch, a blonde ale, was brewed in April of 2011. Their second batch was Fender Bender Amber. The odd name for the brewery is sourced from Brian's 1958 Chevy flat bed truck which serves as a landmark when parked in front of the facility.

Their original brewer, Ron Hulka, developed most of the first recipes. These have since been tweaked by the new brewer Paul Thomas. Paul started his brewing career in 1990 as a bottler at Breckenridge Brewery. From there he went on to brew in Hailey, Idaho and Hamilton, Montana. Brian contacted him in May of 2012 while he was working as head brewer at Pelican Pub & Brewery in Pacific City, Oregon. He saw the potential at the Rusty Truck and came aboard later that month.

The Fender Bender is a classic example of the American amber ale style. It is clear and bright with colors displaying dark copper and light ruby highlights. A creamy white head shows great retention. The aroma features malt up front with a pronounced citrus background. Caramel malts dominate the flavor with just enough hop bitterness to offset the residual sweetness. Melanoidin malt provides a slight nuttiness with dextrin adding to the body.

Steven, you can enjoy your new favorite amber ale because you can "Brew Your Own." For more about Rusty Truck Brewing Company visit their website www.rustytruckbrewing.com or call the brewery at 541-994-7729. BYO

RUSTY TRUCK BREWING COMPANY FENDER BENDER AMBER ALE CLONE
(5 gallons/19 L, extract with grains)

OG = 1.058 FG = 1.012 IBU = 35 SRM = 13 ABV = 6%

Ingredients

- 3.3 lbs. (1.5 kg) Briess, light, unhopped, liquid malt extract
- 2.0 lb. (0.9 kg) light, dried malt extract
- 1.2 lb. (0.54 kg) crystal malt (20 °L)
- 1.2 lb. (0.54 kg) crystal malt (40 °L)
- 14 oz. (0.39 kg) Vienna malt
- 8 oz. (0.22 kg) melanoidin malt (130 °L)
- 6 oz. (0.17 kg) cara-pils dextrin malt
- 1 oz. (28 g) black malt (450 °L)
- 6.87 AAU Magnum hop pellets (60 min.) (0.5 oz./14 g at 13.75 % alpha acids)
- 3.07 AAU Centennial hop pellets (30 min.) (0.3 oz./8.5 g at 10.25% alpha acids)
- 3.07 AAU Centennial hop pellets (15 min.) (0.3 oz./8.5 g at 10.25% alpha acids)
- 3.25 AAU Cascade hop pellets (0 min.) (0.5 oz./14 g at 6.5% alpha acids)
- ½ tsp. Irish moss (last 30 min.)
- ½ tsp. yeast nutrient (last 15 minutes of the boil)
- White Labs WLP 051 (American Ale V) or Wyeast 1272 (American Ale II) yeast
- 0.75 cup (150g) of corn sugar for priming (if bottling)

Step by Step

Steep the crushed grain in 2 gallons (7.6 L) of water at 152 °F (67 °C) for 30 minutes. Remove grains from the wort and rinse with 2 quarts (1.8 L) of hot water. Add the liquid and dried malt extracts and boil for 60 minutes. Add the hops, Irish moss and yeast nutrient to the boil as per the schedule. Add the wort to 2 gallons (7.6 L) of cold water in a sanitized fermenter and top off with cold water up to 5 gallons (19 L).

Cool the wort to 75 °F (24 °C). Pitch your yeast and aerate the wort heavily. Allow the beer to cool to 68 °F (20 °C). Hold at that temperature until fermentation is complete. Transfer to a carboy, avoiding any splashing to prevent aerating the beer. Add the dry hops and allow the beer to condition for 1 week and then bottle or keg. Allow the beer to carbonate and age for three weeks and enjoy your Fender Bender Amber ale clone.

All-grain option:

This is a single step infusion mash using 8 lbs. (3.62 kg) 2-row pale malt to replace the liquid and dried malt extracts. Mix all of the crushed grains with 6 gallons (23 L) of 173 °F (78 °C) water to stabilize at 152 °F (67 °C) for 60 minutes. Sparge slowly with 175 °F (79 °C) water. Collect approximately 6 gallons (23 L) of wort runoff to boil for 60 minutes. Reduce the 60-minute Magnum hop addition to 0.4 oz. (11 g) (5.5 AAU) and the 30- and 15-minute Centennial additions to 0.25 oz. (7 g) (2.56 AAU) to allow for the higher utilization factor of a full wort boil.
The remainder of this recipe and procedures are the same as the extract with grains recipe.

From the Vault

Cellaring beer

by Betsy Parks 

WINE ISN'T THE ONLY FERMENTED BEVERAGE THAT CAN IMPROVE WITH AGE. MANY HIGH-ALCOHOL AND SOUR BEERS CHANGE FOR THE BETTER AFTER A FEW MONTHS IN A PROPER CELLAR. IN THIS ISSUE, TWO BEER BAR EXPERTS SHARE SOME AGING ADVICE.

We are currently cellaring more than 300 different beers at The Porter Beer Bar. Our oldest beer right now is Gale's Old Prize Ale from 1996. Most of our beers aging are best at about five years, though many sours can age for up to ten to fifteen years when they are kept in the right conditions.

Aging beer requires periodically tasting and evaulating the beers over time. Many of the beers we have had come through the beer cellar are among those that we have already aged and experimented with at some point, so we know when their peak is and when they begin to decline. We revisit and taste unfamiliar beers every year to check on their progress. If it's a style we haven't cellared before we will taste it every six months. If we have cellared lots of of the same style of beer and feel confident it will take many years to age, we may only taste it once a year. We take notes so we help our servers give folks an idea of what they are ordering.

Maintaining a consistent temperature is key to cellaring beer, but a regular home refrigerator is the last place you want to store beer for a long time. If the beer is corked — which is the case for many bottle-aged beers — a refrigerator will eventually dry out the cork and the beer will oxidize. If you want to get into aging at home, a dark, cool closet is the best spot if you don't have access to a temperature-controlled cellar. Wine refrigerators can also do the trick. We keep the cellar at Porter Beer Bar between 60–65 °F (15–18 °C) all the time. We don't have different zones for different beers — though if you keep beer warmer it will age faster — but we are generally going for longevity rather than speed.

There is debate out there about standing beers up or laying them down like wine when they are in the cellar, but I prefer to keep bottled beers standing up when cellaring. Beer has yeast and sediment in it and if you lay them down it forms a much longer ring around the bottle so it's more difficult for the beer to "remix" when you are pouring it. All wine that's suitable for aging — with the exception of sparkling wine — has a porous cork, so wine is aging by slowly being exposed to air and interacting with the outside environment while beer is aging within the bottle for the most part and changing due to its bottle conditioning.

If you're looking for some guidelines about what to age, there are a few simple rules to follow when you start out. Remember that the beers that are best to cellar are above 8% alcohol by volume (ABV). The only exception to that ABV rule is for sour beers, which can be much lower gravity and age much longer. Also remember that hops in a beer will fade into malty sweetness over time. If that's what you want, that's cool, but just because something is rare doesn't make it best to age. This is why many hop-heavy IPAs and imperial IPAs aren't necessarily great for aging. I once drank a year-old Hopslam from Bell's Brewery in Kalamazoo, Michigan, and it was pure sweet honey, not a hint of bitter hop left. This is also true for many fruit beers. Bright fresh flavors of fruit dull with time. You can get some of the sweetness but the subtleties that let you know it's pear and not apricot dissapear. Also, the beers you cellar should be bottle conditioned. Otherwise it won't change much for many years.

Molly Gunn, Co-Owner of The Porter Beer Bar in Atlanta, Georgia. Molly Gunn was born and raised in Atlanta, and her first restaurant job was at Babette's Cafe on Highland Ave, where she bussed tables. She received a BA in cultural anthropology from the University of Pennsylvania in 2003 and worked in the restaurant business in Philadelphia, Washington, DC and Boston before returning to Atlanta in 2005. The Porter Beer Bar opened in September 2008. Molly is head of marketing, accounting, and the front of the house, but she prefers to be called "Boss Lady."

Erich LaSher, Owner/Resident Wino and Beer Nerd at La Cave du Vin in Cleveland Heights, Ohio. La Cave du Vin opened in 1995 and was the first bar in Cleveland to only serve craft beer. It has been consistently rated highly as one of the best beer bars in the world by Ratebeer.com and *Draft* magazine.

At any given time we will have at least a couple of hundred bottles of vintage beers in the La Cave beer cellar. We keep our cellar at about 55 °F (13 °C) all year round, which is the perfect cellar temperature and also a great drinking temperature.

Aging beer is all about experimenting and having fun. If you have a network of other people who age beer on the internet they will help you make decisions about when to pull a beer, but otherwise it's really all a matter of remembering when you put them in and experimenting.

Just like with wine, cellaring beer does not make a beer better, it makes it different. You may or may not like what that beer turns into when it ages. A lot of people don't like those secondary characteristics that happen with time. For example, for me it seems like some bottles, like Thomas Hardy Ale, seem like they can't age enough — but then I have tastings with fresh bottles and people like that way better. If you like something and want to lay it down, buy a bunch and try it every six months. But for god's sake, don't let it sit there forever.

One of the biggest mistakes I see with beer aging is cellaring the wrong stuff. Even if a brewery says that a beer is good for cellaring, it's all about what you like. Some beers just lose their moxie after even a year.

If you want to cellar beer at home, remember that light is the enemy — you want a place that is dark, cool and dry (at least this is what has worked best for me). You also need to be able to maintain a constant temperature. Keep in mind, though — most beer is a lot more stable than people give it credit for. If you get a beer that was imported from Belgium it's already been through hell and back — god only knows what happened to it during shipping. BYO

Better Boils

Adding body, mash pH

by Ashton Lewis

Q I WOULD LOVE SOME DISCUSSION ON THE BOIL. A FRIEND ONLY BOILS FROM HIS FIRST HOP ADDITION. I AM A FULL BOIL GUY AND WOULD NEVER EVEN CONSIDER CUTTING CORNERS ON THE BOIL, BUT I DO PONDER THE RATE OF BOIL. I LOVE SEEING THAT MASSIVE STEAM CLOUD WITH A HARD BOIL, BUT SUSPECT A SOFTER BOIL IS BETTER.

JONATHAN CONNOLLY
DADE CITY, FLORIDA

A Historically, the boil was important in brewing because it sterilized wort. Today we think in terms of wild yeast and bacteria that can sour beer, but in centuries past pathogens from foul drinking water were also killed in the boil. This made beer safer to drink than water. Boiling also serves to denature malt enzymes and malt proteins, the latter having a real effect on finished beer clarity. Wort gravity is affected by boiling and some brewers use the boil to produce high gravity beers. Malt aromas, namely dimethyl sulfide (DMS), are driven from wort during boiling and this is important to the aroma of the finished beer; a weak boil is often the cause of beers with strong DMS notes. And finally, boiling isomerizes alpha-acids from hops, increasing their solubility, and allows the brewer to balance malt with hop bitterness. Adding hops also has the benefit of inhibiting the growth of certain beer spoilage organisms and hops have an aroma that is loved by many.

As a very general rule, it takes anywhere from 60–90 minutes of boiling accompanied by 6–10% reduction in wort volume to accomplish the basic goals of wort boiling. Evaporation rate is really an indicator of the fact that the wort indeed boiled as expected and is also an indicator of how much DMS removal occurred during the boil. The removal of DMS has really become the single largest topic about boiling because DMS is such a distinctive and potentially objectionable aroma. During the boil, S-methyl methionine from malt is converted to the aromatic and volatile dimethyl sulfide. If the boil is not sufficiently vigorous, the boil wort may contain enough residual DMS to be detected in the beer. Many brewers judge the intensity of the boil by how much the surface appears to roll and the term "rolling boil" is applied to wort that is properly boiling. Since wort boiling is so energy intensive there are very real economic reasons to reduce evaporation and the obsession with DMS removal goes hand-in-hand with this pursuit. Excessive evaporation, over about 15%, is also an indicator of excess thermal stress and can lead to problems with beer foam, flavor stability and development of wort flavors undesirable to some beer styles.

New boiling technologies used by commercial brewers use a variety of clever ways of reducing DMS levels in wort while simultaneously allowing for a reduction in total volume reduction. The classical conundrum with this is that DMS is removed by evaporation, essentially steam distillation, so if kettle evaporation is reduced one would expect DMS levels to increase, and that is normally true. However, modifications to wort concentrators and spreaders in large kettles with internal calandrias enable brewers to more efficiently conduct the kettle boiling process. Thin film boilers and vacuum evaporation units have also

". . . in centuries past pathogens from foul drinking water were also killed in the boil. This made beer safer to drink than water."

Photo by Les Jörgensen

been successfully used to tackle the same problem. In some of these systems total evaporation rates are now less than 4% with DMS levels that are less than or equal to conventional kettle designs. Side note about internal calandrias: Internal calandrias are shell and tube heat exchangers powered by steam that are installed in larger brew kettles. They resemble coffee percolators and some brewers simple call them "percs." Calandrias normally have a chimney that directs the flow of wort and steam vapor to a spreader plate or "hat" that directs the flow of wort back into the kettle. This also helps suppress foaming in the kettle since the wort literally knocks the foam down. The thin film of wort also helps flash DMS from the wort as the steam leaves the kettle.

All of this really means very little to the homebrewer because these technologies simply do not apply to small scale boiling. The fact is that most homebrew kettles have a much higher surface area to volume ratio (calculated using the area at the top of the wort that is exposed to air) compared to larger kettles. Using the same kettle geometry (dished bottom vessel with height to diameter ratio of 0.85), I calculated the surface area to volume ratio of kettles ranging from 6 gallons (23 L) to 19,375 (73,342 L/0.2 BBL to 625 BBLs net fermenter yield) and the results are interesting. Increasing the kettle volume by a factor of five decreases the surface to volume ratio by a factor of almost two. The small kettle has 23.5 square inches per gallon and the 625 BBL kettle has only 1.4 square inches per gallon. The point with this is that small kettles have much better surface evaporation as a function of total volume than do large kettles, and one would reasonably expect homebrewers not to really understand all of the hype about DMS because this is really not a problem for beers brewed in small kettles.

The take home message is that applying commercial brewing rules to homebrewing really does not make much sense for wort boiling. Evaporation rates in small kettles are usually relatively high, often well above 10%, and I would really not worry much about this indicator. The real thing that is important is the boil time. Hop acid isomerization takes time to occur and peaks after about 60 minutes of boiling. The other goals of boiling can be achieved in far less time, especially if you are not concerned about absolute clarity in your finished beer. This is why many homebrewers are brewing great beers using short boil times. There is absolutely nothing wrong with looking for ways to improve efficiency as long as you are not sacrificing your beer quality in the process.

Q

HOW IMPORTANT IS MASH pH? I'VE BEEN HOMEBREWING FOR ALMOST 20 YEARS AND NEVER MEASURED IT. IS IT A FINE POINT IN TWEAKING YOUR BEER? DOES IT IMPROVE EFFICIENCY OR FERMENTABILITY? I BATCH SPARGE AND RUN BETWEEN 68–71% EFFICIENCY.

ANDREW IGNATZ
VIA FACEBOOK

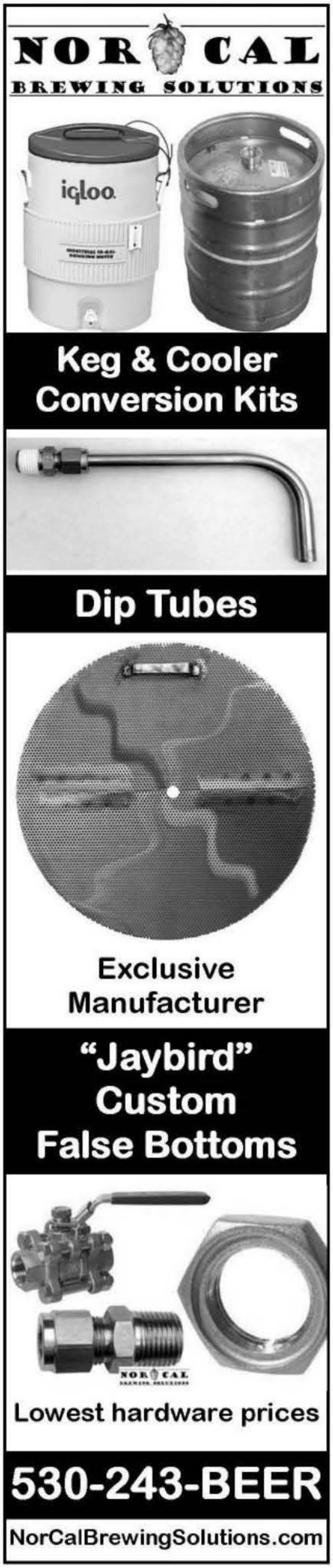
A

Mash pH is extremely important. Enzyme activity is a function of pH and all enzymes are only active in a relatively narrow range around their optimum pH. In the case of mashing, there are two enzymes of particular importance; alpha and beta amylase. The optimal range for alpha amylase is pH 5.6–5.8 and the optimal range for beta amylase is pH 5.4–5.6. If mash pH is much higher than 5.6 beta amylase activity begins to drops off and, more importantly, the pH is approaching pH 5.8, or the point where tannins really start to be extracted from malt husks. If the pH is much lower than 5.6 alpha amylase activity drops off. Lower pH levels are favored to these higher levels and most brewers like to see the mash pH in the 5.2–5.4 range. This provides good enzyme activity and does not flirt with tannin extraction.

Mash pH is principally affected by the mineral content of the brewing water and by the grains used in mashing. In general terms, dark and roasted malts tend to lower mash pH. So it is possible that mash pH can be too low when brewing dark beers like stouts, porters, dark lagers, etc. Historically, dark beers were brewed in regions where the water contained significant levels of carbonate, and it is the carbonate in the water that balances the acidity of the roasted grains. If pale beer is brewed with carbonate water, the pH can be too high. In these cases, breweries use a variety of methods to either remove carbonate from water or add acid to the mash.

Mash can be acidified by using acidulated malt, adding soured mash as a natural source of lactic acid, or by simply adding commercially available food-grade acids like lactic or phosphoric. Adding calcium, either in the form of calcium sulfate (gypsum) or calcium chloride is another way to reduce mash pH. Calcium reacts with phosphates from malt and the result of this reaction is the release of hydrogen ions and a reduction in pH. The classic pale lagers and pale ales of the world were brewed in areas that either had extremely soft water, like Pilsen in today's Czech Republic, or areas that had water rich in minerals and dominated by calcium, like Burton, England.

Mash pH and water chemistry can quickly become very confusing without a strong understanding of chemistry, especially the concept of buffering. Buffers are weak acids that resist pH changes in the region around the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Dip Tubes
Exclusive Manufacturer
"Jaybird" Custom False Bottoms
Lowest hardware prices
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NorCalBrewingSolutions.com


100% PINCH PROOF LABELS.
Shosey's Basement Brew
I'll have what the gentleman on the floor is having
O'Shosey's
St. Patricks Stout
February 2013
5% alcohol by volume
12 fl. oz.
myownlabels .com
CUSTOM BEER LABELS
happy st. patrick's day | enjoy 10% off | code CPYBRW4E7 (exp. 05/01/13)


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www.highgravitybrew.com
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Our mascot, Pippin

"As it happens, the brewer's mash is rich in buffering acids, primarily from malt proteins, and these buffering compounds make the system much more complex than water."

buffer's pK_a. (pK_a is a quantitative measure of the strength of an acid in solution). As it happens, the brewer's mash is rich in buffering acids, primarily from malt proteins, and these buffering compounds make the system much more complex than water. And to really make any sense of this a method of pH measurement better than litmus paper is required. For these reasons there are many brewers like you who don't measure mash pH or do anything to really control it other than adding water salts in approximate quantities specified by recipes.

So the question you pose is relevant to a lot of homebrewers. Here is the simple version of mash pH. When malt is mixed with water the mash pH is normally right around pH 5.6, which just so happens to be right where we as brewers like it. Is this a coincidence? I have always supposed that since the enzymes being used in the mash are also active in the growing barley seed when the seed is hydrated, that the pH of the natural environment of hydrated barley and the pH of the mash should be pretty similar. Whether or not this explanation is correct is really not relevant; the bottom line is that the mash pH normally falls right in the optimum zone.

Rarely is the pH so far outside of this zone to cause real problems. This is why there are many brewers like you who have brewed great beers with good extract yield for many years without ever measuring pH. But fine-tuning pH does have real benefits. Improved extract yield and beer flavor are the two most common reasons for adjusting mash pH. If you are interested in adjusting mash pH I suggest buying a temperature compensated, hand-held pH meter and using diluted lactic acid or acidulated malt to lower pH and baking soda, or sodium bicarbonate, to raise pH. The million-dollar question is what works best, and this, like so many other things related to brewing, depends on what you are doing. If you are in search of some fun experiments, you have arrived at the right location. BYO

Send your questions for Mr. Wizard to wiz@byo.com.

Oatmeal Stout

Smooth and silky

by Jamil Zainasheff

From time to time, a person will ask me, "What is the difference between stout and porter?" Of course, there are several types of each, so my first thought is what kind of porter and what kind of stout? Most people do not want such precision when asking about beer and soon they lose interest in my rambling answer. I'm guessing you feel differently or you would not be reading this column.

In the stout family, the question of what differentiates the three lower gravity styles (dry, sweet and oatmeal) is a good question. In brief terms, think of dry stout as having a very dry character, not big and full. Think of sweet stout as similar, but with a sweeter, fuller character. Think of oatmeal stout as between the two, with a little bit of silkiness from the oatmeal. Of course, you can find examples of oatmeal stout that are sweeter than sweet stout and some drier than dry stout, but conceptually that is one of the key differences.

Oatmeal stout just might be my favorite of the stout family. Oatmeal stout is traditionally an English style, although there are more and more "Americanized" versions available. Oatmeal stout uses oats to build body and add a touch of silkiness to the mouthfeel. It is dark and rich, full of roasted flavors and aromas. It is full-bodied and has substantial coffee and chocolate notes. The appearance is dark brown to black in color. Think of oatmeal stout as similar to dry stout in roastiness, but much fuller and sweeter. Commercial examples vary considerably, with some sweeter, some drier, and many showing a wide range in oatmeal character. They range from more British (obvious fruity esters, rich malt character) to more American (lower ester levels, a little less malt character, and sometimes a touch of late hop character). I prefer the traditional British character in this style, but there are some nice Americanized examples. If you want to impress the judges, you will tend to have more success with a slightly sweet rendition of the style with enough specialty malt character that makes them think of oatmeal cookies.

To brew a great example of this style, start with high quality British pale ale malt as the base. It provides that background rich malt character that is a key component in fine British beers. British pale ale malt is kilned a bit darker (2.5 to 3.5 °L) than the average North American two-row or pale malt (1.5 to 2.5 °L) and this higher level of kilning brings out the malt's biscuit-toasty flavors. Some brewers use North American pale ale malt or North American two-row with the addition of some specialty malts, but this will not produce the same beer as using British pale ale malt. Spend the money, make the effort and use the proper base malt if you want to make an excellent example of the style.

Similarly, extract brewers should make the effort to source an extract made from British pale ale malt. If you end up using North American two-row malt extract, you can try to compensate by partial mashing some additional specialty malts such as Munich, biscuit or Victory®.

All-grain brewers should use a single infusion mash. A temperature in the range of 150 to 156 °F (66 to 69 °C) works well. Use a lower temperature when using lower attenuating yeasts or higher starting gravities. Use a higher mash temperature when using the higher attenuating yeasts or lower starting gravity beers. If you are unsure, a great starting point is 152 °F (67 °C).

While using the proper base malt is important, oatmeal stout also requires a fair amount of specialty malt. To develop some sweetness and a caramel flavor component, you will want some crystal malt. A dry stout uses no crystal malt, but sweet stout might use up to 10%. An oatmeal

Continued on page 21

OATMEAL STOUT by the numbers

OG:	1.048–1.065 (11.9–15.9 °P)
FG:	1.010–1.018 (2.6–4.6 °P)
SRM:	22–40
IBU:	25–40
ABV:	4.2–5.9%

Photo by Charles A. Parker/Images Plus

McQuaker's Oatmeal stout
(5 gallons/19 L, all-grain)

OG = 1.055 (13.5 °P)
FG = 1.016 (4.1 °P)
IBU = 28 SRM = 35 ABV = 5.1%

Ingredients
8.5 lb. (3.85 kg) Thomas Fawcett & Sons Maris Otter pale ale malt (or similar English pale ale malt)
14.1 oz. (400 g) Great Western flaked oats 1 °L
10.6 oz. (300 g) Briess Victory® malt 28 °L
10.6 oz. (300 g) Thomas Fawcett & Sons chocolate malt 350 °L
7.1 oz. (200 g) Thomas Fawcett & Sons roasted barley 500 °L
7.1 oz. (200 g) Thomas Fawcett & Sons crystal malt 85 °L
7.5 AAU Kent Goldings pellet hops (60 min.) (1.5 oz./42 g at 5% alpha acids)
White Labs WLP002 (English Ale) or Wyeast 1968 (London ESB) yeast

Step by Step
Spread the flaked oats out on a cookie sheet and toast them in the oven around 300 °F (149 °C) until they begin to slightly color up and give off a nutty oatmeal cookie character. Mill all of the grains together and dough-in targeting a mash of around 1.5 quarts of water to 1 pound of grain (a liquor-to-grist ratio of about 3:1 by weight) and a temperature of 154 °F (68 °C). Hold the mash at 154 °F (68 °C) until enzymatic conversion is complete. Infuse the mash with near-boiling water while stirring or with a recirculating mash system raise the temperature to mash out at 168 °F (76 °C). Sparge slowly with 170 °F (77 °C) water, collecting wort until the pre-boil kettle volume is around 5.9 gallons (22.3 L) and a gravity of 1.046 (11.5 °P).

The total wort boil time is 60 minutes. Add the hops once the wort reaches a full boil and then start your timer. Add Irish moss or other kettle finings with 15 minutes left in the boil.

Chill the wort to 68 °F (20 °C) and aerate thoroughly. The proper pitch rate is two packages of liquid yeast or 1 package of liquid yeast in a 2-liter starter. Ferment at 68 °F (20 °C). When fermentation is finished, carbonate the beer to approximately 2 to 2.5 volumes.

McQuaker's Oatmeal stout
(5 gallons/19 L, extract with grains)

OG = 1.055 (13.5 °P)
FG = 1.016 (4.1 °P)
IBU = 28 SRM = 35 ABV = 5.1%

Ingredients
5.7 lb. (2.6 kg) English pale ale liquid malt extract
14.1 oz. (400 g) Great Western flaked oats 1 °L
10.6 oz. (300 g) Briess Victory® malt 28 °L
10.6 oz. (300 g) Thomas Fawcett & Sons chocolate malt 350 °L
7.1 oz. (200 g) Thomas Fawcett & Sons roasted barley 500 °L
7.1 oz. (200 g) Thomas Fawcett & Sons crystal malt 85 °L
7.5 AAU Kent Goldings pellet hops (60 min.) (1.5 oz./42 g at 5% alpha acids)
White Labs WLP002 (English Ale) or Wyeast 1968 (London ESB) yeast

Step by Step
Ask your local homebrew shop for an English-style liquid malt extract or an extract made from 100% Maris Otter malt. If you cannot get fresh liquid malt extract, it is better to use an appropriate amount of dried malt extract (DME) instead.

Spread the flaked oats out on a cookie sheet and toast them in the oven around 300 °F (149 °C) until they begin to slightly color up and give off a nutty oatmeal cookie character. Mill or coarsely crack the oats with the rest of the specialty malt and place loosely in a grain bag. Avoid packing the grains too tightly in the bag, using more bags if needed. Steep the bag in about 1 gallon (~4 liters) of water at roughly 170 °F (77 °C) for about 30 minutes. Lift the grain bag out of the steeping liquid and rinse with warm water. Allow the bags to drip into the kettle. Do not squeeze the bags. Add the malt extract and enough water to make a pre-boil volume of 5.9 gallons (22.3 L) and a gravity of 1.046 (11.5 °P). Stir thoroughly to help dissolve the extract and bring to a boil.

The total wort boil time is 60 minutes. Add the hops once the wort reaches a full boil and then start your timer. Add Irish moss or other kettle finings with 15 minutes left in the boil.

Chill the wort to 68 °F (20 °C) and aerate thoroughly. The proper pitch rate is 2 packages of liquid yeast or 1 package of liquid yeast in a 2 liter starter. Ferment at 68 °F (20 °C). When fermentation is finished, carbonate the beer to approximately 2 to 2.5 volumes.

Oatmeal Stout Commercial Examples

Bell's Oatmeal Stout
Bell's Brewery
Kalamazoo, Michigan
www.bellsbeer.com

Breakfast Cereal Killer Stout
Big Time Brewery & Alehouse
Seattle, Washington
www.bigtimebrewery.com

Oat Malt Stout
Maclay Inns Ltd.
Alloa, Scotland
www.maclay.com

The Poet
New Holland Brewing Co.
Holland, Michigan
www.newhollandbrew.com

Road Slush Stout
New Glarus Brewing Co.
New Glarus, Wisconsin
www.newglarusbrewing.com

Samuel Smith Oatmeal Stout
Samuel Smith Old Brewery
Tadcaster, England
www.samuelsmithsbrewery.co.uk

Shakespeare Oatmeal Stout
Rogue Ales
Newport, Oregon
www.rogue.com

Squatters's Captain Bastard's Oatmeal Stout
Utah Brewers Cooperative
Salt Lake City, Utah
www.utahbeers.com

Wolaver's Oatmeal Stout
Otter Creek Brewing/Wolaver's
Middlebury, Vermont
www.ottercreekbrewing.com

Young's Oatmeal Stout
Wells & Young's Ltd
Bedford, England
www.wellsandyoungs.co.uk

stout is in the middle, around 5% of a 40 to 120 °L crystal malt. I prefer to use crystal malt in the 80 °L range for darker British style beers. It provides a slightly raisiny caramel flavor that complements the fruity esters common to the style. To create the dark color and an espresso-like richness, British black malt, chocolate malt, and even roasted barley are good choices. The proper amounts are going to vary based on color and flavor. Generally, 10% of the grist is highly kilned malt in a stout. Be aware that malts of the same name from different suppliers can vary substantially in color and flavor. You might find both chocolate malt and black malt ranging from 300 °L to 500 °L, so the name the maltsters give a product is not always a reliable indicator. Always let flavor be your guide.

Many people expect to taste oatmeal in an oatmeal stout. In reality, oatmeal does not taste like much, which is why people add so much flavoring to a bowlful at breakfast. While oatmeal does add some to mouthfeel, it needs some help as far as flavor goes to produce that nutty/biscuity flavor and aroma people expect. One specialty grain that I like a lot for this is Victory® (~28 °L). It adds a toasty, nutty, bready character, which reinforces the impression of "oatmeal" in the beer. Another way to enhance the character of the oatmeal is by roasting the oats in the oven around 300 °F (149 °C). This toasting increases the oatmeal character and helps it stand out a bit more in the beer.

If you are looking for more complexity or increased head retention, you can add other malts as well. Wheat malt, Munich, biscuit and others are common additions in many recipes, but keep in mind that using too many specialty malts often ends up as a muddled malt character, not a more complex one. Emphasize one or two particular malt characters in your recipe by using two or three grains and selecting only high quality British specialty malts such as Simpsons or Thomas Fawcett. These malts have a rich malt character, which is complex on its own. Some brewers like to experiment with other adjuncts, such as brown sugar, but keep in mind that simple sugars ferment out completely and result in a thinner body, which is the opposite of what you want in oatmeal stout.

All English-style beer is best brewed with English hops, such as East Kent Goldings, Fuggles, Target, Northdown or Challenger. A new hop variety that I think might do well for an Americanized version of the style is Delta, which is a cross between Fuggle and Cascade. Hop flavor and aroma should be absent or at the most minimal. The bittering level for oatmeal stout has a wide range of 25 to 40 IBU, but you should be shooting for a balance that is even or slightly sweet. The bitterness to starting gravity ratio (IBU divided by OG) ranges from 0.4 and 0.8. What ratio you target depends on the amount and type of specialty malts and yeast attenuation. If you use more highly kilned malts or chose a more attenuative yeast, then you will want to target a lower bittering ratio. If you use more unfermentable crystal malts or a less attenuative yeast, then you go with a higher bittering ratio. It is all a matter of balance, avoiding an overly sweet or bitter beer. Generally, skip any late hop additions. If you are trying to make a more "American" version of oatmeal stout, you could use a small touch of late hopping, perhaps ¼ to ½ ounce (7 to 14 g) during the last few minutes. In a classic British version, no hop flavor or aroma is fine. At most, any hop character detected would be from the bittering hop addition.

Fermentation creates most of the flavor and aroma in many British beers. "English" yeast strains provide a variety of interesting esters and leave some residual sweetness to balance the hop bittering. Many English yeasts attenuate on the lower side (< 70%), but there are some that attenuate quite well (up to 80%). For many British-style beers you have to think about the final balance of the beer. If the beer has a high starting gravity, or you are using many specialty grains that add residual sweetness (such as crystal malts), you need to select a more attenuative strain. If you are brewing a beer with a lower starting gravity and/or limited specialty grains, then you want to go with a less attenuative yeast. This is one of the most important things to know about crafting your own British-style recipes. My favorite yeast strains for brewing oatmeal stout are White Labs WLP002 (English Ale) or Wyeast 1968 (London ESB). They both provide a wonderful ester profile without being excessively fruity, and they both attenuate to a moderate level, leaving just the right amount of malt sweetness and fuller mouthfeel.

At lower temperatures (<65 °F /18 °C), these yeasts produce a relatively low level of esters and at high temperatures (>70 °F/21 °C) they produce abundant fruity esters and fusel alcohol notes. I start fermentation in the middle of this range (68 °F/ 20 °C), letting the temperature rise a few degrees over a couple days. This creates the expected level of esters, helps the yeast attenuate fully and keeps the amount of diacetyl in the finished beer to a minimum. BYO

"Many people expect to taste oatmeal in an oatmeal stout. In reality, oatmeal does not taste like much, which is why people add so much flavoring to a bowlful at breakfast. While oatmeal does add some to mouthfeel, it needs some help as far as flavor goes to produce that nutty/biscuity flavor and aroma people expect."

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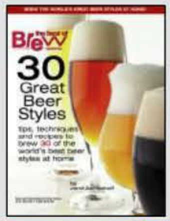

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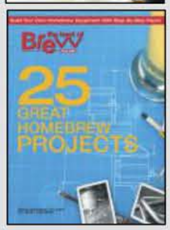

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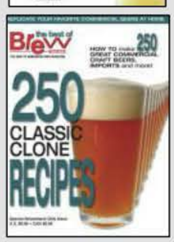

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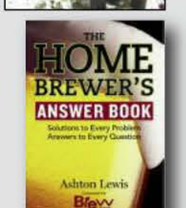

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Disorientation

Introduction to Brew Your Own University

Homebrewers are a diverse group, and they acquire their homebrewing skills from many different sources. Some homebrewers learn from friends, others by following the instructions in the homebrewing kit they got for Christmas or their birthday. Some read as much as they can from homebrewing books before they start, others jump right in. Some enjoy the benefits of a homebrew club, while others go it alone. In addition, most homebrewers have adapted what they've learned to work with the equipment in their own homebrewing set-up and other constraints. After brewing for awhile, many homebrewers get into a groove . . . or a rut, depending on how you look at it. They take what they've learned, adapted it to work on their equipment and make their beer based on that . . . and that's where Brew Your Own University may help.

The quantity of information available to homebrewers is greater now than it ever has been, and the way you've always done things may not be the most modern way to homebrew. (Then again, maybe all this new information is just proving that you've been right all along.)

Thorough cleaning and proper sanitation is required to produce quality homebrewed beer, free from contaminating microorganisms.

In this Brew Your Own University package, we'll walk through a typical brew day (for both extract and all-grain brewers), as well as the fermentation and conditioning of a beer and examine each major step. We can't discuss every possible permutation, but we will point out the key elements in each stage to making quality beer. (One downside to the explosion of brewing information is that sometimes it's hard to see the forest for the trees.) In addition, we'll take a look at the options you have during the brew day, and their consequences. And, we will focus on what can be measured while the beer is being made, to help you understand if things are going well. When we're done, you will hopefully have some ideas to improve your process and your beer.

As much as is reasonable, the articles in this Brew Your Own University package focus on techniques — what you can actually do as a homebrewer — as opposed to theory. However, in the final section, we'll give you a reading list to pursue if you're interested in the science behind the techniques.

This Brew Your Own University package has five articles, and an appendix of pointers to additional helpful information.

The first article describes wort production using malt extract, especially making wort from malt extract and steeping grains. We'll discuss how to get the best results, with an emphasis on how malt extract is produced and what that means to homebrewers. Along the way, we'll debunk a couple long-standing homebrew myths about malt extract. We'll also tackle simple ways of chilling your wort without a wort chiller.

The second section discusses wort production using malted grains. We'll discuss how to transform dried, malted grain into sweet wort, focusing on the techniques used and the variables that can be manipulated (instead of theoretical discussion of enzymes). Crushing the grains as well as the major mash variables that can be manipulated — temperature, thickness, pH — will be discussed. This section focuses mostly on single-infusion mashes.

In the third section, we'll discuss fermentation and how the manner you conduct your fermentation shapes the character of your beer. For many homebrewers, this is the area in which the most improvement to their beer could be made. we'll cover aeration, pitching rate and fermentation conditions needed to make the best beer.

In the fourth section, we'll discuss packaging and aging — especially how to do this while exposing your beer to the minimal amount of oxygen.

Finally, we'll wrap things up with a section on calibrating your brewery tools. Calibrating your instruments will give you some confidence in your measurements and help you troubleshoot problems, should they arise, more easily. The Library of Brew Your Own University includes a list of information beyond the scope of these articles.

Brew Your Own University covers a lot of ground, yet we are giving one topic short shrift — and it's the most important aspect of brewing! Yes, that's right, we're not going to cover cleaning and sanitation. Suffice it to say, that everything you read here will be rendered irrelevant if your equipment is not sparkling clean and everything that touches your chilled wort is not additionally sanitized.

If you are a beginning to intermediate brewer, we hope that reading these articles will let you make informed decisions about how you conduct your brew day and beer fermentation and that this will lead to better beer and more enjoyment from this hobby. If you are an advanced brewer, much of this will be familiar to you, but hopefully some of the finer points will be new. So, if you're suitably disoriented from reading this introduction, grab a homebrew, turn the page and begin your studies at Brew Your Own University!

Wort Production (with malt extract)

Wort made from reconstituted malt extract is dissimilar from wort made from mashing malted grains. Knowing the differences can guide you to making sound decisions regarding how to use it on brew day. The convenience of malt extract does not have to come at the price of beer quality if you know how to handle it.

In this article, we'll discuss making wort (unfermented beer) using malt extract accompanied by some steeped specialty grains. You can think of this as comprising three steps: Making sweet wort, making hopped wort and chilling the hopped wort. Sweet wort is the thick, sugary, not-yet-boiled solution made (in this case) from malt extract and steeped grains. Boiling the sweet wort and adding hops produces hopped wort, and chilling that solution yields wort that is ready to be fermented.

When making wort from malt extract, the ingredients aren't manipulated extensively — essentially, you dissolve the malt extract and boil it for awhile. Along the way you also steep the specialty grains and add the hops to the boiling wort.

Specialty grains add color and flavor to a light malt extract based beer.

Given that the process isn't that complex, your main goal is to get the most from your ingredients. In order to do this, it pays to understand the composition of your ingredients.

Malt Extract

Malt extract is condensed wort in the case of liquid malt extract (LME), or dried wort in the case of dried malt extract (DME). Wort is mostly water, with the next most abundant component being sugars. Of the sugars, maltose is the most abundant. The minor components of wort (by weight) include proteins, amino acids, lipids and all the various molecules that give wort its distinctive flavor, aroma and mouthfeel. The flavor of wort comes largely from the sweetness from the carbohydrates in the malted grains, the "malty" (bread-like, toasty) flavors from the husk of these grains and the bitterness and flavors from the hops.

Unhopped malt extract — of the type made for brewers, not for bakers — is made in the same manner as a brewer would make hopped wort, with the exception of not adding the hops. However, at the point when the boiled wort would normally be chilled, it is instead condensed or dried. (See The Library on page 53 for more extensive details of malt extract production.) Brewery grade malt extract has also had the hot break separated from it. The practical upshot of this is that all you really need to do with malt extract is dissolve it in hot water to reconstitute the original wort. You do not need to boil it as you would wort made from malted grains.

Malt extract is a food product made from grains. Just as bread will eventually go stale, so will malt extract. Stale malt extract can be detected by its flavor and aroma, as well as by the fact that stale malt extract becomes progressively darker as it stales. Liquid malt extract (LME), because of its higher water content, goes stale faster than dried malt extract (DME). Stored properly (in a cool location), LME will remain fresh for a couple months. Stored properly, cool and sealed away from moisture, DME may remain fresh for up to 8 months, Always strive to use the freshest possible malt extract when you brew.

Malted Grains

Most extract recipes call for steeping some malted grains (usually specialty grains) to add to the flavor from the malt extract (usually pale, unhopped malt extract). As with malt extract, your steeping grains should be fresh. On brew day, your grains will also need to be milled (crushed). Many homebrew shops will mill the grains sold to extract brewers because most extract brewers do not own a grain mill. Unmilled grains will stay fresh for about 8 months, while milled grains will remain fresh for, at best, a week or so. So, if you get your grains milled at your homebrew shop, use them as soon as possible, ideally within a few days. Store them in a cool, dry place until your brew day.

Specialty grains contain sugars in their interior which add to the original gravity of the beer you are making. More importantly, they impart flavors that are not present in the unhopped pale malt extract. These flavors come from the husk of the grains. Husks also contain a class of compounds you do not want in excess in your finished beer, tannins. These molecules cause a puckering astringency to your beer.

Hops

Homebrewers mostly use either pellet

Predicted Max IBUs in an OG 1.048 Beer

post-boil volume [gallons]	max IBUs extract late [boil gravity < 1.050]	max IBUs standard method [boil SG in parentheses]
1	20	5 (1.240)
2	40	30 (1.120)
2.5	50	42 (1.096)
3	60	53 (1.080)
3.5	70	66 (1.069)
4	80	77 (1.060)
5	100	100 (1.048)

Here are the predicted maximum IBUs, based on a 100 IBU assumed maximum in beer made from wort boiled at 12 °Plato (SG 1.048). In the standard method. All the malt extract is boiled for 60 minutes. In the extract late method, half is reserved until knockout.

Pellet hops can be added during the boil to add bitterness to an extract beer. Late hop additions provide more flavor and aroma as their volatile oils do not get entirely boiled off.

hops or whole hops. Less frequently, they will use plug hops. Whatever form of hop you use, it is imperative that these hops be in good shape in order to get the best hop character in your beer. Hops should be green and smell fresh. Hops that have been stored poorly will turn brown and smell cheesy.

Hops should be stored frozen or refrigerated, preferably in packaging that blocks light and is flushed with an inert gas (such as nitrogen). Over time, even properly stored hops will decline in bitterness. The alpha acid rating can decline as much as 50% per year, However, the hop's aroma may remain appealing. In fact, some breweries purposely age their aroma hops, feeling that this makes them more refined and appealing.

Recipe Considerations

You can make high-quality homebrew from malt extract if you can find an appropriate malt extract for the beer you are making. Although there are malt extracts made from a blend of base malts and specialty malts, designed to make a particular style of beer, most homebrewers base their beers on a light or pale malt extract and add the additional malt touches by steeping specialty grains. Light, extra-light or pale malt extracts are available that are suitable as the base for most English-style or American-style ales, and Pilsner malt extracts can be used for many German-style or Belgian-style beers. Wheat malt extract is also available for wheat beers. And, increasingly, you can also find malt extract made from Munich malt, Maris Otter pale ale malt, Vienna malt, smoked malt and others.

Although you can make great beer from extract, it pays extract brewers to understand that wort made from malt extract is not the same as wort made entirely from mashed base malt. First, because the extract is heated, albeit gently, during the condensation process, pale or light malt extracts yield worts slightly darker than the wort it was condensed from. In addition, the fermentability of a wort made from malt extract is usually lower than a wort made from malted grains. These drawbacks, however, only become a problem if you are attempting to brew a very light-colored, dry beer. And, there are workarounds. For example, you can subtract some of the malt extract from your recipe and perform a small partial mash of pale or Pilsner malt. Or, more simply, you can swap some of the malt extract in your recipe — up to about 20% — with table sugar (sucrose) or corn sugar (glucose). Either of these methods will lighten the color of your beer and increase the fermentability of the wort.

If you want to test the color of your malt extract, dissolve 2 oz. of dried malt extract or 3 oz. of liquid malt extract in a pint of warm water (57 or 85 g/250 mL); this will make a wort of specific gravity 1.048. This will show you approximately the color of a 5% ABV beer made from that malt extract, assuming it does not pick up any additional color in the boil.

Malt Extract Brew Day

So, once you've got your fresh ingredients assembled, your task as a brewer is to convert them into chilled, hopped wort — getting the best from each ingredient and ensuring that this wort will provide a healthy environment for the brewers yeast.

Steeping the Grains

Recommendations for steeping specialty grains run the gamut in the homebrewing literature. To get the best character from your specialty grains, you should focus on two things — temperature and steeping volume.

Dried malt extract (DME) being added to a kettle prior to the boil.

Malt extract must be stirred in thoroughly. DME will clump and LME will sink to the bottom of the kettle and scorch.

Most often, when steeping specialty grains, you want to get the same character from them as they would have imparted in an all-grain recipe. (If the recipe you are brewing is a commercial clone or an extract version of an all-grain recipe, this is certainly true.) To get the same character, you'll want to treat them in (at least roughly) the same manner. Therefore, in all but a few special cases, you should steep your specialty grains in the temperature range of a single infusion mash — 148–162 °F (64–72 °C). If the extract recipe is a conversion from an all-grain recipe, steep them at the same temperature as specified for the mash.

The amount of water you steep the grains in is also important. If all of the steeped grains in an extract recipe are specialty grains, you have a fairly wide range that they can be steeped in — from so thick that the water just barely covers the grains to quite thin (by all-grain standards)— around 3.0 qts. of water per pound of grain (6.3 L/kg). If your steeping grains contain grains that need to be mashed, as is often the case in extract recipes in *BYO*, keep the water-to-grain ratio between 1.25 qts./lb. (2.6 L/kg) and 2.5 qts./lb. (5.2 L/kg).

The quality of the crush is not as important in steeping grains as it is in mashing. As long as the grains aren't ground into a powder or mostly whole, you should be fine. Place the grains in a steeping bag so they fill no more than ⅓ of the volume of the bag. This will allow liquid to flow past the grains while they are being steeped. It's a good idea to swirl the bag full of grains in the water a few times while you steep, but you don't need to do much more than this to get the full flavor from them.

For convenience, many old recipes instructed homebrewers to put the grains in their brewpot, filled to whatever volume was to be boiled. The grain bag remained in the brewpot until the boil started, or just before. In cases in which the water-to-grain ratio was high, this could lead to the extraction of tannins. Likewise, instructions that encourage homebrewers to squeeze or twist the bag to wring out every last bit of liquid may encourage tannin extraction. Your best solution is to either let the bag drip until the liquid almost stops, press it very gently between two plastic cutting boards or rinse the grains with a small amount of water at around 170 °F (77 °C). Most modern *BYO* recipes call for rinsing the grains at this temperature with around half of the volume of steeping water. This strikes a good balance between getting all you want from the grains, but not approaching conditions that would favor excess tannin extraction.

When brewing with malt extract, you don't need to worry about the mineral content of your water. The malt extract will contain the minerals from the wort it was condensed from. Your best bet is to reconstitute the malt extract using very soft, even distilled or reverse osmosis, water.

However, if the grains you are steeping contain some base grains, add a pinch (less than ⅛ tsp. for a typical 5-gallon/19-L recipe) of either gypsum or calcium chloride if you are using very soft water.

If you are trying to brew a very hoppy beer, and are using soft water to dilute the extract, adding 1 to 2 tsp. of gypsum per 5 gallons (19 L) will accentuate the hops.

If want to get a jump on heating the water in your brewpot while you steep your grains, try steeping the grains in a separate pot and adding the "grain tea" to your brewpot when the steep is done. Alternately, if you are not steeping any grains that need to be mashed, but you are heating a lot of water in your brewpot, stir in enough malt extract to bring the specific gravity to somewhere between 1.010 and 1.020. Then steep the specialty grains in this dilute wort as it passes through the temperature range of a single infusion mash.

Boil Volume

One nice thing about brewing extract beers is the convenience. In particular, you only need to boil a few gallons of wort to make 5 gallons (19 L) of beer. But this convenience comes at a price. The thicker your wort is the more likely it is to darken during the boil, and your hop extraction efficiency is lowered. As such, as an extract brewer, always boil the largest volume that you can given your brewpot size, heat source and ability to chill allow.

Adding the Extract

One method of using malt extract that works well is to add much of the

Mix Temperatures and Chill Targets (for 70 °F/21 °C wort)

volume of boiled wort (volume of dilution water)	mixed wort temperature (water = 65 °F/18 °C) [chill target]	mixed wort temperature (water = 40 °F/4.4 °C) [chill target]
2 gallons/7.5 L wort (3 gallons/11 L water)	129 °F (54 °C) [77 °F (25 °C)]	114 °F (46 °C) [110 °F (43 °C)]
2.5 gallons/9.5 L wort (2.5 gallons/9.5 L water)	143 °F (62 °C) [75 °F (24 °C)]	131 °F (55 °C) [97 °F (36 °C)]
3 gallons/11 L wort (2 gallons/7.5 L water)	158 °F (70 °C) [73 °F (23 °C)]	148 °F (64 °C) [89 °F (32 °C)]
3.5 gallons/13 L wort (1.5 gallons/5.7 L water)	172 °F (78 °C) [72 °F (22 °C)]	164 °F (73 °C) [82 °F (28 °C)]
4 gallons/15 L wort (1 gallon/3.8 L water)	186 °F (86 °C) [71 °F (22 °C)]	181 °F (83 °C) [77 °F (25 °C)]

This chart gives the temperature of a mixture of boiling wort and cool water (to make a 1.048 wort) at two water temperatures. It also gives the "chill target" — the temperature wort would need to be such that mixing wort and water yielded 70 °F (21 °C) wort.

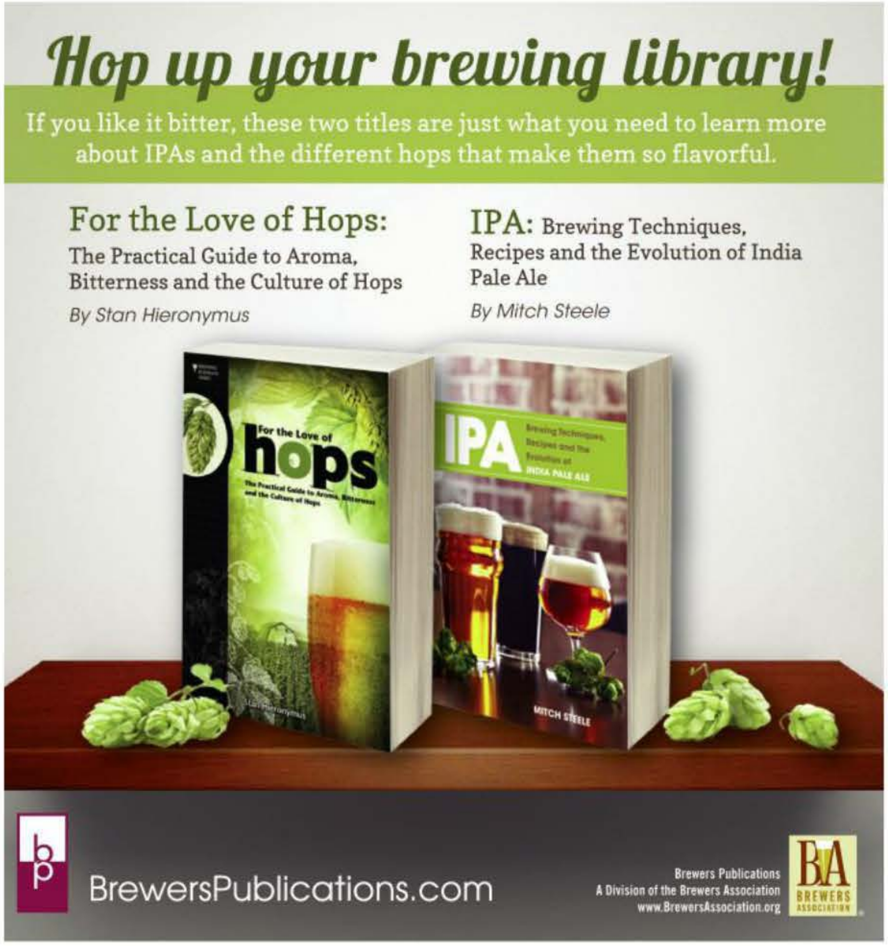
malt extract late in the boil. After you've added the "grain tea" from the steeping grains to your brewpot, stir in enough malt extract that your specific gravity is about roughly the original gravity of your beer. Withhold the rest until near the end of the boil. For example, if you were boiling 2.5 gallons (9.5 L) of wort for a 5-gallon (19-L) batch, add a little less than half of the extract at the beginning of the boil. (If you are performing a full wort boil, all the malt extract can be stirred in before the boil starts.) This, plus the sugars from steeping the grains, will make your wort roughly working strength. Then, add the remaining extract for the final 5 to 15 minutes of the boil. Most modern *BYO* recipes call for the extract to be added at the 15 minutes to go mark, but it does not need to be boiled that long. All you are really doing is reconstituting the extract. Five minutes above 170 °F (77 °C) is enough to ensure it is sanitized. You can even just let the extract "steep" for 5 minutes after shutdown as long as the wort remains above 170 °F (77 °C).

One of the biggest problems with extract brewing is not dissolving the extract sufficiently and having small amounts of it scorch on the bottom of the kettle. This adds color to the beer and — in extreme cases — can add burnt off flavors. If your extract beers are darker than you would like, it pays to find out when your wort is picking up the unwanted color. To do this, take a small sample of wort immediately after stirring in the first dose of malt extract. Take another small sample of wort right before you stir in the second addition of malt extract. Then take a third sample of cooled wort, diluted to working strength. Take small samples (an ounce/30 mL is all you need) as these will be discarded. If the first sample is unacceptably dark, your extract may be stale, or the extract itself is meant for a darker beer than you are attempting to brew. If the first sample's color is acceptable, but the second is too dark, you have scorched some malt extract in the boil. Likewise, if the first and second samples are acceptable, but the third is too dark, you have scorched some malt extract while reconstituting the late extract addition.

Easy Chilling

Stovetop extract beers, made from boiling a thick wort and later diluting it to working strength, are frequently chilled without the use of a wort chiller. If you are boiling 3 gallons (11 L) or less, you can quickly and efficiently cool your wort in a sink or bathtub. In addition, if you chill your dilution water, this will lessen the amount the thick wort needs to be chilled. If you chill in a sink, cover your brewpot and at first use only tap water for cooling. Let the pot sit for 5 minutes or until the cooling water is too hot to touch, then change the water. Repeat this a few times. Swirl the pot each time you change water (or stir with a sanitized spoon). When the pot is just cool enough to touch, start adding ice to the cooling water. I also drape the lid of the brewpot with wet paper towels, to cool the pot by evaporative cooling. If you boil more than 3 gallons (11 L) of wort, see the next section for better chilling options.

If your dilution water is colder than your fermentation temperature, you do not need to chill your wort all the way down to your fermentation temperature. See the chart above for a guide to blending cool water and warm wort. (For a variety of reasons, never simply pour boiling hot wort into your dilution water.)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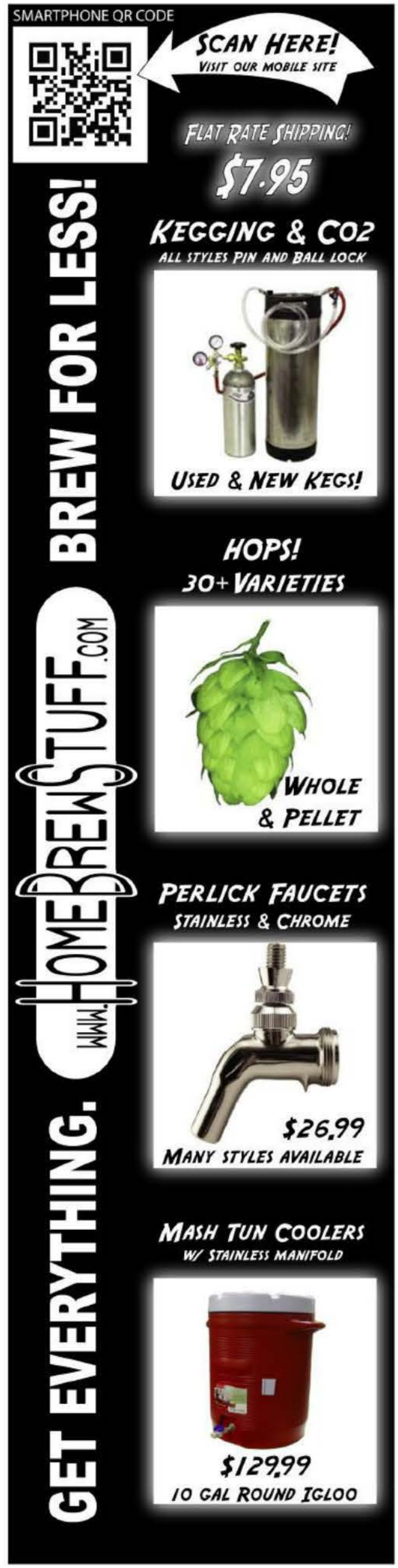
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Wort Production (with malted grains)

Making wort from malted grains gives the brewer the freedom to control the attributes of his or her wort, most notably, its fermentability. You have many options on an all-grain brew day. Some of the options depend on how your brewery is configured, while others allow you to make decisions that impact beer quality.

In this article, we'll discuss making wort from malted grains. In homebrewing terms, this would be described as making wort using all-grain methods. As with extract wort production, there are essentially three phases: Making the sweet wort, making the hopped wort and cooling this wort in preparation for fermentation. Unlike extract brewing, the production of sweet wort is more involved and more time-consuming. Essentially, the process includes soaking the crushed, malted grains in hot water. This is called mashing. Then the liquid wort is separated from the grain solids, and usually the grains are rinsed (sparged) to ensure a reasonable yield of sugars. This is called lautering. There are a number of variables that the brewer can manipulate that influence the quality of wort and quantity of extract achieved. To best understand the process, it pays to review the relevant characteristics of malted grain.

Mashing malted grains produces the sweet wort that must then be separated from the grain solids.

Malted Grains

The most widely utilized grain in brewing is barley, followed by wheat. Although small amounts of unmalted grains are occasionally used in brewing, almost all brewing grains are malted. Malting is a process that readies the interior of the grains for the mash and develops flavors in the husk. Basically, the seed grains are soaked in water until they sprout, then dried to stop any further growth. Then they are kilned (heated in an oven) to develop the bready, toasty flavors of malt — and, in the case of specialty malts, the more darkly roasted flavors of crystal malts and darkly-roasted malts, such as chocolate and black malt. Unmalted (seed) grain is very hard; malted grain is soft enough that it can be chewed. And, since malt can be chewed, you can taste it on brew day to ensure that it is fresh and lacking any of the flavors associated with staleness.

From the brewer's perspective, malted grains contain a starchy interior and a flavorful outer husk. The goal in making wort is to convert as much of the starch into sugar as possible and extract the best flavor compounds from the husks without extracting tannins (husk components that lead to astringency in beer).

The Crush

How finely you crush your malt affects your brewhouse efficiency and the ease with which you can lauter your grain bed. The more finely you crush, the higher your extract efficiency. However, it becomes difficult to collect wort the more finely your malt is crushed. In addition, excessively finely crushed malt can yield more tannins when mashed and thus give your beer some astringency. Commercial breweries seek to have each husk broken into only two or three pieces and have the starch granules divided into large pieces, small pieces and powder, with large and small pieces each constituting over one third of the total.

If you crush your malt, experiment to find the right balance. Both your mill gap and the speed at which you crush affect your crush. Faster spinning rollers yield more finely crushed malt. The rollers on hand cranked malt mills move slower than is optimum. However, when the mill is powered by an electric drill, the rollers spin much faster than is optimum. To get your rollers moving at an optimal speed, you will need to motorize your mill. (There is an article on that in The Library, page 53.) Hand cranking and powering the mill with a drill both work, but you will need to experiment with adjusting your mill gap to get the best crush.

If you are unsure about your crush, for example if you are just trying out all-grain brewing, it is better to err on the side of undercrushed malt. If you crush your malt and all the kernels are broken open, that is enough. This will make lautering as easy as it can be (although you won't get stellar extract efficiency).

Mash Temperature

Mashing has always been an extension of malting. In malting, the rock hard barley seed is transformed into the relatively soft malted barley kernel. Along the way, the seed is modified in many other ways. In the mash, these modifications may continue if the conditions are right. Long ago, brewers needed to begin mashing at lower temperatures — to take care of things like gum degradation or protein modification — before raising the mash temperature to the saccharification

After the mash is finished, the wort is recirculated to clarify it before it is collected.

Sparge water is used to rinse the grain bed, to get a better yield from the malts.

range (148–162 °F/64–72 °C) to convert the starch to sugars.

These days, most malts are made so that all a brewer needs to do is employ a single-infusion mash — a mash with only one temperature rest. Modern malts are sometimes called well-modified malts, to indicate that almost all of the modifications that need to be accomplished have been achieved during the malting process. Undermodified malts, usually Pilsner malts, can be found with a little looking and can be used if you want to do a multi-step decoction mash or other multi-step mash. In this article, I'll focus mostly on single-infusion mashes. See The Library (p. 53) for information on other types of mashing.

In a single-infusion mash, the mash temperature is the primary way for a brewer to control the fermentability of the wort. If malts are mashed at the low end of the saccharification range (148–152 °F/64–67 °C), the resulting wort will be highly fermentable. The resulting beer will be dry compared to beers made from higher-temperature mashes. If you want to make an exceedingly dry beer (from wort with a very high degree of fermentability), you can add a rest — up to a couple hours — at 140–145 °F/60–63 °C before raising the temperature into the regular saccharification range. Alternatively, you can extend the mash time to 90 minutes if you are doing a single-infusion mash. Stir the mash as frequently as is feasible. You can also substitute some highly fermentable ingredients (sugar, honey) for part of the grain bill.

If malts are mashed at the high end of the saccharification range (156–162 °F/69–72 °C), the resulting wort will show a low degree of fermentability. The resulting beer will finish at a higher specific gravity and be more filling. If you wish to make a wort with a very low degree of fermentability, employ a short (~20–30 minute) rest at the very top of the saccharification range (160–162 °F/71–72 °C), followed immediately by a mash out to 170 °F (77 °C). Additionally, you can add some relatively unfermentable carbohydrates, such as lactose, to the recipe.

For most beers, you will be striving for an intermediate level of fermentability. The key to achieving this is to pick an appropriate temperature (152–156 °F/67–69 °C) and mash long enough to get a negative result on a starch iodine test. Stir the mash and let the rest go to 30–45 minutes, if it hasn't gone on that long (to improve your efficiency a bit), then mash out.

Mash Thickness

The thickness of your mash also affects the fermentabilty of your wort. However, this effect is much less pronounced than that caused by the mash temperature. If a mash is exceedingly thick, the starch granules will not quickly or completely dissolve and the enzymes will not be able to diffuse through the liquid and reduce the starch to sugar. Likewise, in an excessively thin mash, the starch would dissolve, but the distances between starch molecules and enzymes would mean the mash would be slow to convert. In practice, there is a fairly wide window of mash thicknesses in between these extremes that work well. Anything in the 1.0–3.0 qts./lb. (2.1–6.3 L/kg) range will work.

Homebrewers, especially those with limited space in their mash tuns, tend to favor fairly-thick, English mashes around 1.25 qt./lb. (2.6 L/kg). Brewers who make German-style lagers frequently favor thinner mashes, around 1.5–2 qt./lb. (3.1–4.2 L/kg) for dark beers and up to 2.5 qt./lb. (5.2 L/kg) for pale beers. If you are performing a step mash, thinner mashes are easier to stir when the mash is being heated.

Water Chemistry and pH

When you dough in (stir the grains and brewing liquor together), the pH of the mash should settle into the 5.2 to 5.6 range (with the lower half of that range being preferable). Many times, this will happen without any intervention by the brewer if he is brewing a type of beer suitable for his water. The theory behind water chemistry and brewing is beyond the scope of this article, but a few points should be made. (For a more complete description of water chemistry and how it effects your brewing, see The Library, p. 53.)

When measuring mash pH, be aware that pH is temperature dependent. If you heat any solution, its pH will drop. As such, if you take a sample from your mash and cool it to room temperature before taking a pH measurement, you will need to subtract 0.35 from your reading to account for the rise in pH that accompanied the cooling of the sample. Cooling your sample is necessary for some pH meters and also helps prolong the life of the probe on many other models.

Arguably, the most important part of water treatment for brewers using municipal tap water is getting rid of

Mash Vessel Size Required for Grain Amounts

max weight of grain	volume of mash vessel
4.0 lbs. (1.8 kg)	2 gallons (7.6 L)
6.0 lbs. (2.7 kg)	3 gallons (11 L)
12 lbs. (5.4 kg)	5 gallons (19 L)
24 lbs. (10.9 kg)	10 gallons (38 L)
36 lbs. (16.3 kg)	15 gallons (57 L)

The more grain you plan to mash, the larger your mash tun will need to be. Here are some suggested mash tun sizes for partial mashing and full mashing.

the chlorine or chloramines used in water treatment. There are two possible ways to do this. One is to use a relatively large activated carbon filter. The filters that are housed under sinks should do the job while smaller filters (for example, the types that attach to a faucet) may not. The other is to add potassium metabisulfite, available at home winemaking shops in the form of Campden tablets. One Campden tablet stirred into 20 gallons (76 L) will almost instantly neutralize any chlorine or chloramines. Because Campden tablets release sulfur dioxide (SO_2), you should let the water stand, loosely covered, for 24 hours to let the rotten egg smell dissipate. (At 1 tablet per 20 gallons/76 L, it's faint.)

Mashing In

There are at least three ways of mashing in, adding brewing liquor (water) to the crushed grains, adding grains to the brewing liquor or adding them simultaneously. Of the three, adding your grains to your mash tun, then stirring in water, is the worst option. Stirring water into dry grains frequently leaves little "malt balls," pockets of dried malt that can be difficult to break up.

However, one small advantage to this method is you do not need to measure your brewing liquor, just keep stirring in water until you hit the correct mash thickness. This also allows you to take the mash temperature when the mash is almost mashed in, but still very thick and — if needed — make small temperature adjustments to your brewing liquor in order to hit your target mash temperature.

If you fill your mash tun with hot brewing liquor, then stir in the grains, you will likely have no problems with malt balls. Plus, it's a lot easier to stir your mash when performed this way. However, you need to measure the volume of your brewing liquor before you mash in and you do not have an opportunity to manipulate your mash temperature until you are completely mashed in. If you take good notes and are confident that by knowing your brewing liquor temperature and volume, you can hit your target mash temperature, stirring the grains into your brewing liquor is the quickest way to mash in.

A final option is to add the brewing liquor and crushed grains at (roughly) the same time. To do this, take two scoops of each volume. (I use beer pitchers.) If you add three scoops of brewing liquor to your mash tun, followed by two scoops of crushed malt, you can stir the mixture quickly and repeat. If you do this, you will add the malt and brewing liquor nearly simultaneously at a mash thickness around 1.5 qts./lb. (3.1 L/kg). You do not need to stir the grains and brewing liquor together completely for each addition as you will be stirring constantly as you proceed.

Additionally, you can always stir a few extra times when you are completely mashed in. When you are mashed in, your mash will be well-stirred with little temperature variation within the grain bed. This method also allows you to make temperature adjustments as you mash in. When you reach about ¾ of the grains mashed in, take the temperature of the grain bed. It should be very close to your target mash temperature. If it isn't, adjust the temperature of your brewing liquor to hit your target mash temperature.

Stirring

In most commercial breweries, the mash is stirred continuously. This evens out temperature variation throughout the mixture and increases brewhouse efficiency. On a homebrew scale, stirring will do both of these things, but frequently this comes at the price of losing heat to the environment. If you have a heatable mash tun, stirring the mash a few times (say every 10 minutes) and re-establishing the temperature by applying heat will likely increase your extract efficiency. If you are mashing in a cooler, at the high end of the saccharification range (with the aim of getting a less fermentable wort), stirring is not advised due to the inevitable heat loss.

Mash Out

After the mash, you have the option of performing a mash out — raising the temperature of the mash to 170 °F (77 °C) to make the grain bed easier to lauter and to greatly slow the action of the enzymes. If you are making wort with moderate to low fermentability, a mash out is highly recommended. If you can't heat your mash tun and don't have the room to stir in boiling water for a mash out, you can begin sparging with very hot water 190–212 °F (88–100 °C) until the grain bed temperature reaches 170 °F (77 °C). At this point, cool the sparge water to hold the grain bed temperature at 170 °F (77 °C).

Collecting Wort and Sparging

Homebrew setups vary wildly and sometimes decisions about brewing techniques end up being made due to equipment limitations. One design-induced decision seen in homebreweries is a failure to heat the wort as it is being collected. This happens when

Boiling sanitizes the wort and coagulates the hot break.

The alpha acids in hops are isomerized during the boil.

the mash/lauter tun is placed about waist high (often on a counter) and the kettle is below it, on the floor. Heating the wort as you collect it shortens the brew day, as — if you use continuous sparging and time things right — the wort can come to a boil immediately after you are done collecting it.

Heating the wort also keeps the enzymes from continuing to work on the available carbohydrates, especially if you did not perform a mash out. Continued enzyme action at this point is something you want to avoid unless you are brewing a maximally dry beer. An easy solution to this is to run your wort into a small vessel (a grant, in brewing terms) and empty this into your kettle frequently. On my old homebrew setup, I used two beer pitchers for this purpose. When one was full of wort, I moved the outlet tube from the mash/lauter tun to the empty pitcher and poured the wort from the full pitcher into my kettle. I adjusted the ball valve on my mash/lauter tun so each pitcher would fill in about 5 minutes; this helped me time the runoff and keep the wort flowing at a constant rate. However, it also made for a very busy brew day.

Whenever sparging is described, using sparge water at 168–170 °F (76–77 °C) is almost always recommended. The idea is that tannins are extracted from the malt at an unacceptably high rate over this temperature. There are two problems with this idea. First, the temperature of your sparge water is not what is important — it's the temperature of your grain bed. Given the small size of homebreweries, mash/lauter tuns can shed a lot of heat while you are collecting your wort. So, heat your sparge water to the point that your grain bed remains at 168–170 °F (76–77 °C) throughout wort collection, especially near the end. Second, tannin extraction is pH dependent. During most of wort collection, your pH will be low enough that excessive tannin extraction will not occur, even at temperatures near boiling.

Some homebrewers advocate lowering the pH of your sparge water by adding acid, based on the relationship between pH and tannin extraction. Adding acid to your sparge water may be appropriate, however, the pH of your sparge water is irrelevant — the pH of your grain bed near the end of wort collection is what really matters. Your mash is relatively acidic and heavily buffered, mostly because of the amino acids in solution, while your sparge water is not. No matter what the pH of your sparge water is, it will become the pH of the wort in your grain bed once it is mixed in. (The Library has an article on buffers, if you are interested.) If you're worried about your pH while sparging, the reading you need to take is the pH of your final runnings. If this climbs above 5.8, stop collecting wort. You need to be vigilant to do this, the pH of the wort you collect will remain relatively constant for awhile (while it is still in the range of the buffers); then suddenly start to rise. If your water is rich in carbonates, you may need to add acid to your sparge water. However, the pH of the sparge water is not what's important — it's adding enough acid so that you can collect all your wort at under pH 5.8. And, you'll have to find that amount out by trial and error with your water.

Continuous sparging is the most common method of sparging in commercial breweries, although in homebrewing batch sparging may now be more popular. Some homebrewers have given up continuous sparging due to difficulties in getting the flow rate onto the top of the grain bed to equal the flow rate out of the mash/lauter vessel. Others may never have tried because of the perceived complexity, or not wanting to buy the extra equipment (a sparge arm). Continuous sparging, however, can be made very simple if you practice what I call "pulsed sparging." (This may be a needless proliferation of terms, but I think it has some merit at the homebrew scale.) In pulsed sparging, you don't worry about exactly matching the flow rates into and out of the grain bed. Instead, you periodically flood the top of the grain bed with water. At a homebrew scale, this may mean quickly adding a gallon (~ 4 L) or more of hot sparge water on top of the grain bed so that there is a few inches (~8 cm) or more of water above the grain solids. Then, let the liquid level drop so the grain bed is almost exposed and repeat the addition of water. You can use a sparge arm or just pour the water (gently) on top of the grain bed.

How Much Wort to Collect

For any given weight of grain in your grist, there is an optimal volume of wort to collect from the standpoint of extract efficiency and wort quality. At this point, you have sparged the grain bed sufficiently to get a good extract efficiency, but not so extensively that you have extracted excess tannins. The exact grain weight to wort yield ratio depends on a few factors (including your crush and water chemistry),

Water Needed by Grain Weight

grain weight	mash liquor volume	sparge water (for 6.5 gallons/25 L)	sparge water (to fully sparge)
8.0 lb.(3.6 kg)	10.0 qts. (9.5 L)	4.3 gallons (16 L)	2.6 gallons (9.8 L)
10 lb. (4.5 kg)	12.5 qts. (11.8 L)	3.8 gallons (14.3 L)	3.3 gallons (12.5 L)
12 lb. (5.4 kg)	15.0 qts. (14.2 L)	3.2 gallons (12.1 L)	3.9 gallons (14.8 L)
14 lb. (6.4 kg)	17.5 qts. (16.6 L)	2.7 gallons (10.2 L)	5.2 gallons (19.7 L)
18 lb. (8.2 kg)	22.5 qts. (21.3 L)	1.6 gallons (6.1 L)	5.9 gallons (22.3 L)

Water required to mash grains at a thickness of 1.25 qts./lb. (2.6 l/kg) and then either sparge to collect 6.5 gallons (25 L) of pre-boil wort or to fully sparge the grain. Total water usage will be mash liquor plus sparge water plus water retained in "dead spaces" in brewing setup.

but expect to get a minimum of 6 gallons of wort from every 10 lbs. of grain. This works out to 0.6 gallons per pound (5.1 L per kg). If you are using continuous sparging, begin checking your final runnings when you have collected this amount of wort. Stop wort collection when the specific gravity dips below 1.008 or if the pH rises to above 5.8.

In practice, many all-grain brewers simply collect enough wort to yield their target volume after the boil. For example, a brewer may always — regardless of how much grain a recipe calls for — collect 6.5 gallons of wort and reduce it to 5 gallons (19 L) after a 90-minute boil. This actually works well for average-strength (1.040–1.057 SG/10–14 °Plato) beers. However, for progressively higher-gravity beers, this means more and more sugars are left behind in the grain bed and extract efficiency will get progressively worse. If you are interested in always getting the most from your grain bed, you will need to collect all the wort you can get from your grain bed, then boil this wort to reduce the volume.

Of course, an all-grain homebrewer may be interested in brewing a high-gravity beer, but not conducting a long boil. In this case, collecting only the high-gravity first runnings and boiling for a (relatively) short time is the solution. Shorter boils not only save time but reduce the amount of color pickup in the boil. The only cost is the price of the extra malt.

On the other side of the coin, when brewing a low-gravity beer, you may end up collecting too much wort if you collect your full pre-boil volume. In this case, you should collect all the wort you can, and then add water to make your full pre-boil volume. For example, let's say you usually get 75% extract efficiency and plan to brew 5 gallons (19 L) of dry stout with an OG of 1.038. A reasonable grain bill for this would weigh about 7.5 lbs. (3.4 kg). If you used the ratio above as a guideline, you would collect 4.5 gallons of wort and then begin checking the OG or pH (or both). Once you stop collecting, you would need to add water to yield enough volume to perform a 60–90 minute boil.

The Boil

During the boil, the wort is sanitized, the hot break is formed, dimethyl sulfide (DMS) is volatilized and the alpha acids in hops are isomerized. A lot goes on, but — if you've already decided on the total boil time and the timing of the hop additions — there is relatively little for a brewer to do. If your boil is less than rolling, a little stirring every 5 minutes or so might be helpful. Likewise, when the first bits of foam form at the beginning of the boil, removing the chunks of coagulated protein from it with a strainer can help improve the clarity and flavor of your beer.

One thing you could do is monitor the pH of your boil. Your pre-boil wort is going to have a pH slightly higher than your mash pH (because the last, higher-pH runnings will raise the pH slightly). However, after the boil, you want your wort to be in the pH 4.2 to 4.4 range. Many times, this will happen naturally. If your boil pH is fine, a visual confirmation is that your hot break will be in the form of big, fluffy flakes.

However, some times you need to adjust the pH. There are two ways to do this. If you have only a half hour left in the boil and the pH has not dropped below 4.5, you can add acid (such as phosphoric acid) until the pH is in the proper range. An easier way to do this is to add a small amount of calcium to the boil. Around 25 ppm calcium ions, from gypsum or calcium chloride is all you need. If you add calcium and suddenly see the hot break turn big and fluffy, you'll know that you have solved the problem.

How hops are added in the boil is another aspect of brewing where opinions diverge. Brewers that use pellet hops sometimes add them directly to the boiling wort while others place them in a bag, so they can be removed at the end of the boil. If you bag your pellet hops, you need to leave plenty of room for them to expand. Don't fill more than one third of the bag with pellets. Even filled loosely, however, adding the hops in a bag may limit your hop utilization. On the other hand, if you simply add the hops to your kettle, you will have to find a way to deal with the hop debris when the wort is cooled and being

Conditioned Milling

In homebrewing, malt is almost always crushed dry, using a two-roller mill. In larger commercial breweries, four or six roller mills may be employed and sometimes the malt is wetted before crushing.

In conditioned dry milling, malt is exposed to steam or sprayed with 86–95 °F (30–35 °C) water for 1–2 minutes prior to milling. Due to this treatment, the moisture content of the husks rises by couple percentage points.

In steep conditioning, the malt is sprayed with water at 140–158 °F (60–70 °C) for 50–60 seconds prior to milling. The hotter water results in faster water uptake by the husks, which reach up to 22% water by the end of the steep. (The moisture content of the interior of grain should not rise more than 1%.) For every 10 kg of malt, about 6 L of water is used. As much as half of this water, however, is not absorbed by the grain.

If you are an advanced all-grain brewer that has had problems with small husk particles, astringency or slow runoff when using finely-crushed malt, you may want to experiment with conditioning your malt. There are a couple ways you can approach this.

Conditioning with Steam

To wet your malt with steam, you'll need a large steeping bag and a heatable lauter tun with a false bottom. Add water to your lauter tun until it is just below the level of the false bottom and bring it to a strong boil. Place your (uncrushed) malt in the steeping bag and lower the bag into the lauter tun. During the next 2 minutes, steam from the boiling water will be forced up through the grains. Open the bag, take your mash paddle and stir the malt gently while it is being steamed. Put a lid on the vessel when you are not stirring. After the steaming period, lift the bag out and stir the malt for about a minute, then begin milling. The boiling water in the lauter tun can be returned to your hot liquor tank.

Conditioning with Hot Water

To wet your malt with hot water, you will need essentially the same set-up as with steam conditioning, but your lauter tun does not need to be heatable. You will also need a way to spray or sprinkle the water over the grain. A watering can, as used by gardeners, or a sparge arm will work fine. In this case, instead of boiling water below the malt, you will be sprinkling hot water over the top of it. Measure out roughly 6 L of water for every 10 kg of malt — about 3.5 gallons per 10 lbs. — you are conditioning. Heat your water to 158 °F (70 °C) and sprinkle it over the malt for 50 seconds, aiming to pour out the entire volume evenly during that span. Let the excess water drain into the space Let the malt sit for a minute or two, then crush it.

An immersion chiller is a heat exchanger that will rapidly cool the wort.

transferred to the fermenter. As such, you may need to leave behind some wort to avoid transferring too much "gunk" to your fermenter. (If you have a hop back, you can avoid this problem by letting it filter out the hop debris and trub.) Longer settling times allow the hop debris and trub to compact more at the bottom of the kettle, and whirlpooling the wort will ensure that the material is deposited in a cone near the center of the kettle.

If you add pellet hops directly to your wort, they have a tendency to cling to the side of the brew kettle, just above the wort line, after they dissolve. Be sure to knock these back down into the wort as the boil proceeds. They aren't contributing anything to your wort while they are clinging to the side of the pot.

Brewers using whole hops need a way to strain them out at the end of the boil. Some spigotted brewpots have a built-in strainer designed to screen out pellet hops, and these are also sold as add ons. If you bag the hops, they won't expand as pellet hops do, but you still need to give them room for wort to flow past them. Don't fill the bag more than half full.

You can make quality beer with either pellet hops or whole hops. On brew day, your main concern is how to deal with them after the boil.

Wort Chilling

After the boil, you need to chill the wort to the point that you can pitch the yeast into it without stunning or killing them.

Homebrewers typically use an immersion chiller or either a counterflow wort chiller or plate chiller. Any of these will chill your wort, but the different methods affect your beer.

An immersion chiller chills your wort in bulk. As you chill, the wort eventually falls through a temperature range (from 160–120 °F/71–49 °C) in which wort contaminants are no longer killed by the heat and can in fact grow quickly in the warm environment. You should cover your kettle when the wort is passing through this temperature range to minimize the amount of airborne contamination.

If you are using a counterflow or plate chiller, the surface of your wort in your kettle is always going to be near boiling, so you don't need to cover it as you chill. This type of chiller also forces you to decide what to do with the cold break, as it is not left behind in the kettle as with an immersion chiller. After the cold break settles, it is best to separate the wort from it. If you have a conical fermenter, this is as easy as opening the valve at the bottom of the cone for a moment.

Finally, using a counterflow or plate chiller allows the late addition hops, and especially the hops added at knockout, more contact time with near boiling hot wort. Switching between chiller types on different brew days can alter the late hop flavor and aroma of a beer brewed with the same recipe.

Fermentation and Conditioning

Running a healthy fermentation depends on pitching an appropriate amount of healthy yeast. Beyond that, creating proper wort conditions (with respect to aeration and nutrition) and controlling your fermentation temperatures are the keys to success. How you treat your yeast is a huge factor in determining beer quality.

In this stage of brewing, the brewer must create the proper conditions that allow the brewers yeast to transform the hopped wort into beer. After fermentation, brewers may also need to set the correct conditions for the yeast to clean up some molecules produced during fermentation (esp. diacetyl).

Trub Carryover

At the end of the boil, wort has a lot of coagulated protein and tannin in it. The large, fluffy bits floating in the otherwise clear wort are called hot break. While the wort is being cooled, more protein and tannins will come

Letting a small amount of trub carry over into the fermenter will nourish the yeast.

out of solution. This material, called cold break, is composed of smaller clumps and gives the wort a cloudy appearance, Collectively, this — along with other solids formed in the boil — ends up at the bottom of your kettle and is called trub. You can separate this material from your wort before fermentation, but should you?

Hot and cold break can be left behind in the kettle by chilling the wort and allowing it to settle before racking the wort off the top of it and into the fermenter. Likewise, if you are using a hop jack, the hot break can be screened out prior to chilling with a counterflow or plate chiller. Some homebrewers rack their chilled wort first to a temporary holding vessel (bucket or carboy), and then later to their fermenter. This will allow all the break material — whether hot and cold break, or just cold break — to be separated from the wort. Getting rid of every last bit of break material does yield clear wort. In addition, if you were to transfer all or most of the break material to your fermenter, it would add off flavors to your beer. However, studies have shown that a small amount of trub carryover contributes to yeast health. Trub contains zinc and other nutrients as well as unsaturated fatty acids that may partially decrease the amount of aeration required. It may also serve as a nucleation site for CO_2, which would lower the concentration of dissolved CO_2 in your fermenting beer and in that way lead to increased fermentation vigor. As a homebrewer, your best bet is to proceed as if you planned to separate out all the trub, but then let just enough break material through to slightly cloud the wort. If you chill your wort in your kettle, let the wort sit until the break material is almost completely settled, then transfer the clear wort to your fermenter. At the end of the transfer, let a little bit of cloudy wort transfer.

If you use a counterflow chiller, let the wort sit and settle in a temporary vessel before transferring it to your fermenter. Allow enough of the cold break to transfer to very slightly cloud your wort. If you ferment in a cylindro-conical fermenter, let the cold wort sit in the fermenter for an hour or so, then dump the trub out the bottom before proceeding with aeration and pitching.

Aeration

Once your wort is chilled, it is time to aerate it. For some homebrewers, this is done simultaneously. If you have a counterflow or plate chiller with an aeration stone placed on the wort outflow side, you can aerate your wort as it flows into your fermenter. Or, as is more common, you can aerate the wort using an aeration stone and bottled oxygen or an aquarium pump. Frequently, brewers place a HEPA filter between the stone and the source of air or oxygen to ensure no microorganisms enter the wort through their aeration efforts.

Aeration is an important step, but unfortunately homebrewers do not have an inexpensive way to measure oxygen levels in wort. Dissolved Oxygen (DO) meters have come down significantly in price in recent years, but are still more expensive than the grade of pH meters most homebrewers use. Optimally, wort should be aerated so that it contains between 8 and 10 parts per million (ppm) dissolved oxygen.

Unfortunately, there is no simple way to describe how to reach a given level of aeration in a batch of wort. You can stipulate that the wort be aerated for a certain amount of time,

Yeast Starter Size By Pitching Rate

Original Gravity Of Beer (°Plato)	Ales (low optimal) 0.75 million cells/mL/°Plato	Ales (high optimal) 1.0 million cells/mL/°Plato	Lagers 1.5 million cells/mL/°Plato
8 °Plato	1.2 qts. (1.1 L)	1.6 qts. (1.5 L)	2.4 qts. (2.3 L)
9 °Plato	1.3 qts. (1.3 L)	1.8 qts. (1.7 L)	2.7 qts. (2.6 L)
10 °Plato	1.5 qts. (1.4 L)	2.0 qts. (1.9 L)	3.0 qts. (2.8 L)
11 °Plato	1.6 qts. (1.5 L)	2.2 qts. (2.1 L)	3.3 qts. (3.1 L)
12 °Plato	1.8 qts. (1.7 L)	2.4 qts. (2.3 L)	3.6 qts. (3.4 L)
13 °Plato	1.9 qts. (1.8 L)	2.6 qts. (2.5 L)	3.9 qts. (3.7 L)
14 °Plato	2.1 qts (2.0 L)	2.8 qts. (2.6 L)	4.2 qts. (4.0 L)
15 °Plato	2.2 qts. (2.1 L)	3.0 qts. (2.8 L)	4.5 qts. (4.3 L)
16 °Plato	2.4 qts. (2.3 L)	3.2 qts. (3.0 L)	4.8 qts. (4.5 L)

Suggested yeast starter sizes for various pitching rates and wort concentrations. This assumes that you raise 100,000,000 cells/mL in your yeast starter. To do this would require a well-aerated starter. Other pitching rate calculators yield different results.

Aeration is important, but measuring wort oxygen levels requires an expensive meter.

but this doesn't account for the flow rate of the gas or the size of the holes in the aeration stone. Even if you could measure the volume of gas pumped into the wort, you have no easy way to determine how much has been retained. This depends on a few variables, including temperature. Gas dissolves more slowly the colder the wort is (although the capacity to hold gas goes up with lower temperatures) whereas swirling the fermenter while aerating increases gas diffusion.

Still, some basic guidelines can be given, and homebrewers can infer if they work or not by observing their fermentations. Generally, with a stainless steel airstone, 1 to 2 minutes of oxygenation — during which a constant cloud of tiny bubbles is coming from the airstone — should be enough to aerate a batch of beer. Likewise, 5 to 10 minutes of air (for example, pushed by a fish tank aeration pump) should get you to the minimal required level. It is possible (albeit unlikely, if you are following "normal" aeration procedures) to overaerate a batch using oxygen, but not with air.

Homebrewers need to take care to monitor their fermentations early on to see if the yeast have received adequate aeration. Adequately aerated ales should start fermenting within 24 hours. Lagers should start fermenting within 36 hours. The amount of time until a fermentation starts also depends on the yeast strain, pitching rate, wort temperature and level of wort nutrients, and therefore can vary quite a bit. Start times can be much sooner than the times given earlier, especially with healthy yeast at higher pitching rates. Incidentally, after aerating your wort, gas will begin diffusing out of solution and back into the atmosphere. For this reason, have your yeast ready to pitch immediately after aeration.

If you make a yeast starter, you will know your yeast are healthy when pitched.

For best results, rehydrate your dried yeast in water prior to pitching.

Pitching yeast from an appropriately-sized starter should yield a proper pitching rate.

Yeast Nutrition

As well as having enough oxygen, yeast also need a healthy amount of nitrogen, vitamins and minerals. For most all-malt beers, this is not a problem. If a wort is deficient in anything, it is likely zinc. Adding commercial yeast nutrients — at a rate ranging from half to the full manufacturer's recommended rate — during the boil will almost always solve the problem.

Pitching Rates

You need to pitch an adequate amount of yeast to get your fermentation to start in a reasonable amount of time, proceed in an orderly fashion and reach a reasonable final gravity (given the fermentability of your wort). A pitching rate of 1 million cells per mL per degree Plato is frequently cited as the standard rate for ales, although some sources give a lower rate. For a 5-gallon (19-L or 19,000-mL) batch of beer at 12 °Plato (SG 1.048), this would be 228 billion cells. The optimal pitching rate for lagers is often given as twice this, although again lower rates can be found in the professional literature.

To accurately measure the amount of cells, you need a microscope, a special kind of slide called a hemacytometer (designed to count blood cells) and a vital stain (methylene blue). As most homebrewers do not have this equipment, most rely on pitching a given weight or volume of a yeast slurry, pitching yeast from a yeast starter of a given volume or by pitching multiple packages of commercial yeast based on their cell counts.

For a 5-gallon (19-L) batch of moderate-strength ale, a long-standing rule of thumb has been to pitch a cup of yeast slurry. For homebrewers repitching yeast from the bottom of a fermentation bucket or carboy, this often works well because the density of yeast cells in the slurry immediately after fermentation is relatively low. This yeast sample will be liquid-like and colored with trub and hop debris that settled along with the yeast. If you harvest healthy yeast and let it settle overnight in your refrigerator, about one-third this volume (⅓ cup/ 80 mL) would be satisfactory. Yeast selected this way will be creamy to pasty in consistency. And, since the trub and hop debris will sediment in separate layers, it is relatively easy to use only yeast slurry, which will be off white in color.

If you are making a yeast starter, you can estimate the amount of cells you will raise from a given volume of starter wort. The density of yeast in a well-aerated yeast starter would vary depending on yeast strain and other variables, but 50,000,000 cells/mL to 100,000,000 cells/mL is not an unreasonable estimate. If you calculate the total number of cells you need to pitch, simply divide this number by the density of your yeast starter to yield the size of the yeast starter (in mL). Or, see the table on page 41 for starter sizes for three different pitching rates over various original gravities from 8 °Plato to 16 °Plato. The website mrmalty.com also has a calculator that suggests a suitable yeast starter volume for a given volume and gravity of wort. A rule of thumb *BYO* has used in the past is that, for moderate-strength ales, a 2 qt. (2 L) yeast starter is optimal. Mrmalty returns a value of half of this (for yeast starters initially aerated with oxygen), indicating that those calculations are based on slightly different assumptions. In reality, yeast density varies depending on yeast strain, aeration of the medium, nutrient availability and other things. If you aren't counting your yeast, you are relying on assumptions you can't test. In practice, however, beer is fairly forgiving; if you raise a healthy yeast starter and are within the ballpark of the optimal pitching rate, your beer will likely be fine.

If you are using dried yeast, making a yeast starter may be counterproductive. Dried yeast has a high amount of glycogen stored in it, and making a yeast starter (especially if the starter is too small) may deplete that store of glycogen. When using dried yeast your best option is to rehydrate the yeast in water immediately before pitching. Don't rehydrate in wort (or any sugary liquid) as this is actually worse for the yeast.

Higher pitching rates generally lead to faster starts, quicker finishes and higher attenuation. In addition, the amount of yeast character is lower in beers pitched at a high rate. If you are brewing a beer that benefits from some yeast character (esters, etc.), as is the case in most English and Belgian ales, pitching at a less than optimal rate will help accentuate the yeast byproducts as these are mostly formed when the yeast are multiplying, as opposed to when they are at a roughly constant number and fermenting. If your yeast is healthy and your sanitation is adequate, cutting the pitching rate in half (or even to one quarter) of the optimal rate can be done without too much risk. At half the optimal pitching rate, the

Stick-On Thermometer

A stick-on thermometer's reading gives you a fairly good idea of the temperature of the fermenting beer, as opposed to the surrounding environment.

Aerating with Olive Oil

The fundamentals of brewing stay fairly constant, but brewing technology is always changing. Brewers constantly try new ways to make brewing better, faster or more economical. New ideas are constantly filtering into the homebrewing community and sometimes it's fun to try out a new concept.

One such new idea arose several years ago — "aerating" your wort with olive oil. Wort aeration benefits brewers yeast because they take in oxygen and use it for sterol synthesis and unsaturated fatty acid synthesis. The idea behind olive oil aeration is, instead of the yeast taking in oxygen and converting it into these compounds, why not supply the yeast with them directly? Not only would the yeast be healthy, but the use of oxygen could be lessened or eliminated, reducing the risk of staling in finished beer. Olive oil is rich in oelic acid, a fatty acid that yeast could use or possibly also convert into other unsaturated fatty acids.

Grady Hull (of New Belgium Brewing Co, Fort Collins, Colorado) experimented with this idea and found that by adding 1 mg of olive oil per 25 billion cells in the yeast propagator, 5 hours prior to pitching the yeast, he could get unaerated wort to ferment in a similar time frame as aerated wort and produce beer that did not taste different than beer made from aerated wort.

A 2 qt. (2-L) yeast starter would contain about 250 billion cells, so you would only need 10 mg of olive oil (a tiny amount) to do this at home. Measuring that amount would be very difficult, and you don't want to add too much as oil has a negative effect on head retention. What some homebrewers have done is dipped a sanitized needle into olive oil and swished that into their yeast starter. Shake well to disperse the oil as best you can and allow the starter to work as you normally would.

yeast only have to multiply once to reach the same density as if they were pitched at the optimal rate.

Pitching Temperature

When you pitch your yeast, you should take care not to thermally shock them. In general, your pitching yeast should be within 10 °F (5 °C) of your wort temperature. If you brew lagers and raise your yeast starter at room temperature, cool the starter solution in your fermentation chamber (which should be set to a couple degrees below your planned fermentation temperature). Yeast are a little more forgiving when they are cold and pitched into a warm wort.

Temperature Control

Once the yeast have been pitched, the main goal of the brewer is to maintain the temperature of the fermentation to produce the best beer. Beer yeasts grow best at temperatures above that which produces a quality beer. Most ale yeasts produce the best beer at 65–72 °F (18–22 °C) and most lager yeasts work best at 50–55 °F (10–13 °C). In some Belgian ales, fermentation temperatures are allowed to climb much higher than in English ales (up to 85+ °F/29+ °C).

The most common way to maintain proper fermentation temperature at a homebrew scale is to place the fermenter (bucket, carboy or stainless steel fermenter) in an environment that is a few degrees colder than the planned fermentation temperature. Some times this simply means placing an ale in a cool spot in the basement. Other times it means placing the fermenter in a fermentation chamber made from a freezer or fridge and an external thermostat. At high kräusen, the environmental temperature may need to be lowered an extra degree or two to keep the desired temperature constant.

Likewise, the temperature may need to be raised to the target fermentation temperature near the end of fermentation as yeast activity slows. A stick-on thermometer affixed to the fermenter is a common way to measure beer temperature as it ferments. These are not very precise, but are inexpensive and give brewers a good idea of the beer temperature to within a degree or two.

Blow Off Tubes

Vigorous fermentations can produce so much kräusen that it rises and pushes out of the fermentation vessel through the airlock. One solution to this is to affix a blowoff tube. A blowoff tube will also remove some of the bitter compounds that get pushed up by the kräusen and cling to the inside of the tube or are expelled into the water lock. If you are brewing a malt-focused beer, this can help you achieve a smoother bitterness. In contrast, if you're brewing a double IPA, you might not want to lose those compounds. If you expect a vigorous fermentation, choose a fermenter with a headspace volume that will let you retain or blow off the kräusen, according to your desires.

Clean Up

After any fermentation, but especially lager fermentations, the yeast may need to mop up excess diacetyl. Don't ever rush to separate the beer from the yeast the minute that fermentation is complete. If you are using a diacetyl prone yeast, don't rack the beer off the yeast until you've sampled it and confirmed that the diacetyl is gone.

Post Fermentation and Packaging

After fermentation, the beer needs to be packaged into bottles or kegs. The beer must also be carbonated to the correct level. For the best results, the beer should be exposed to as little oxygen as possible during the transfer and subsequent storage. Minimizing oxygen uptake by the finished beer will prolong its shelf life.

After biological fermentation — the conversion of sugars to alcohol and carbon dioxide — has finished, most beers are conditioned for a period of time during which the yeast and other solids drop out of solution and some molecules are taken up by the yeast. After this conditioning time, which may be only a few days for some ales but up to a few months for some lagers, most beers then go to the packaging stage. In some cases, however, the brewer wants to add additional flavors or aromas post-fermentation. Two examples of this would be dry hopping or adding fruit to make fruit beer.

In dry hopping, hops are added to the beer in the fermenter. This can be done in the primary fermenter, when the beer is racked to secondary or in the keg. Dry hopping adds hop oils to the beer, providing a boost to the hop aroma. They are generally added after active fermentation has ceased to minimize the loss of hop oils. The contact time varies, from a few days to a couple weeks.

Photo by Dave Louw

A homebrewer filling a 22-oz. (650-mL) bomber of beer.

Whole hops are often used for dry hopping, but there is one potential drawback to using them — the air trapped between the bracteoles in the hops will add oxygen to your beer. If you dry hop immediately after fermentation, much of this oxygen will be scavenged by the yeast. But generally it is advisable to keep beer away from oxygen as much as is possible.

One way to get this entrained air out of your hops is straightforward. Take a pellet or two of dried ice (frozen CO_2) and place it at the bottom of a Corny keg, place the (bagged) whole hops on top of the dry ice and set the lid on the keg. (Don't affix the lid, just let it rest on top of the oval.) The dry ice will sublimate and fill the keg with CO_2, replacing most of the oxygen in the hop cones.

When making a fruit beer, there are many opportunities to add the fruit. Some recipes call for the fruit to be added to the boil, while others call for the addition to come in the primary or secondary fermenter. Adding whole fruit in the secondary fermenter has the benefit of preserving the aroma of the fruit, but the drawback that the fruit is not sanitized.

Many homebrewers therefore wonder if whole fruit needs to be sanitized before adding it. Generally, this is not needed. Although whole fruit harbors wild yeast on its exterior, these generally do not cause a problem in the beer. Fruit added after primary fermentation is going into a solution (beer) with a fairly low pH and an alcohol content that kills most microorganisms. Likewise, the brewers yeast will be reinvigorated by the sugars from the fruit addition and a brief period of fermentation will occur during which most other organisms will be competitively excluded. It is a good idea to wash your fruit before adding it, something that doesn't require too much effort at a homebrew scale. Additionally, sort through your fruit and discard any with damaged skin. And of course, canned fruit (purees, etc.) should be biologically stable and can be added without worry of contamination.

Bottling

Bottling is a fairly time-consuming part of homebrewing. You need to clean and sanitize all the bottles, then fill and cap each one. Bottling is also rewarding. When you put those two cases of homebrew in your closet to condition, there's a sense of accomplishment — and anticipation.

When bottling homebrew, there are two major goals. First, you want to carbonate the beer to the correct level. Second, you don't want to prime the beer to stale quickly by introducing oxygen as you bottle.

After fermentation is complete, most of the carbon dioxide generated by fermentation will have bubbled out of solution, but a small amount will remain dissolved in the beer. How much depends on temperature. A beer that fermented at a steady 72 °F (22 °C) is going to contain slightly less CO_2 than one fermented at a steady 68 °F (20 °C), about 0.80 volumes of CO_2 and 0.85 volumes of CO_2 respectively, because gases are more soluble in colder liquids. However,

Bottles Per 5-gallon (19-L) Batch			
Package Size English (metric)	Batch Size 5 gallons (19 L)	10 gallons (38 L)	15 gallons (57 L)
12 oz. (355 mL)	53	106	160
16 oz. (473 mL)	40	80	120
22 oz. (650 mL)	29	58	87
1 qt. (946 mL)	20	40	60
2 qt. (1,900 mL)	10	20	30
5 gallon (19 L)	1	2	3

The table lists how many bottles or kegs of various sizes it would take to package three common batch sizes for homebrewers. Numbers are rounded to the nearest bottle.

even at lager temperatures the amount of carbon dioxide retained is below the level of carbonation of English ales.

Homebrewers commonly transform fermented, lightly-carbonated beer into fully-carbonated beers one of two ways, by bottle conditioning or by forced carbonation.

In bottle-conditioned homebrew, the beer is primed with a small amount of fermentable sugar and then sealed. The carbon dioxide created during the fermentation of this sugar is trapped in the sealed bottle.

Many older homebrew sources cite a single amount of corn sugar for priming a 5-gallon (19 L) batch, usually ¾ cup. This produces a level of carbonation suitable for English ales. For more control over your level of carbonation, you need to consider the residual level of carbonation and then add sugar to reach your target level, which will vary for different beers.

From the chart on page 47, read the residual level of carbonation in your beer, based on your fermentation temperature. Then subtract this amount from your target level of carbonation. That is the amount of carbonation you need to generate during bottle conditioning. You can get that amount from the chart (or see the charts at www.byo.com/resources/carbonation).

To prime your beer, dissolve the sugar in the least amount of hot water possible, then simmer for 5 minutes (you don't want to darken the sugar extensively). You should put the priming sugar into your bottling bucket first (and it doesn't matter if it's still hot), then siphon your beer into it with as little splashing as possible. Siphoning the beer into the priming sugar so the mixture swirls should ensure that it is mixed in thoroughly. To make sure, give the beer a slow stir or two with a sanitized spoon. (Don't stir too vigorously as that just allows more oxygen to enter the beer.) Then, bottle as quickly as possible. The longer the beer sits in the bottling bucket, exposed to air, the more oxygen will get into your brew. You don't need to rush, but have everything ready to go — sugar heated, bottles, caps and capper handy — when you open the fermenter and begin siphoning the beer into the bottling bucket. Cap the bottles, with oxygen-absorbing caps, as each bottle is filled.

If you have a kegging system, you can add a squirt of CO_2 to your bottling bucket before you siphon the beer in, and then again once it's full. If you cover the bucket with aluminum foil, you will trap much of the CO_2 and this will provide a partial barrier against oxygen. You could also try putting a pellet of dry ice in a nylon bag and letting it hang in the bottling bucket above the level of the beer. The cold CO_2 would drift down over the surface of the beer and offer some protection. Don't drop the dry ice into the beer, though, or you'll make a beer geyser and potentially lose some beer.

With the right amount of priming sugar in the beer and the beer bottled and capped promptly, the yeast is ready to carbonate your beer. For best results, store the beer relatively warm for about 2 weeks. Around 75–80 °F (24–27 °C) would be great for most beers. When two weeks is up, take one beer as a test and place it in the fridge overnight. Open it the next day and check the carbonation levels. If it's OK, move the rest of the beer to cooler storage — preferably at refrigerator temperatures, but anything below ale fermentation temperatures will be adequate.

Kegging

The most popular alternative to bottle conditioning homebrew is kegging it in Cornelius (or Corny) kegs. These kegs, with the 5-gallon (19-L) size being the most common, are the right size for most homebrewers and are more convenient for most home homebrewers. Although moderately expensive, it takes much less effort to rack a 5-gallon (19-L) batch of beer into a single Corny keg than it does to put it into 53 12-oz. (355-mL) bottles. Plus, you force carbonate beer in a keg and even adjust the carbonation level as needed.

As with bottling, you want to minimize the amount of oxygen the beer is exposed to. When kegging, there is one way that works well. Fill your clean, sanitized keg completely

Residual Carbonation and Priming

Fermentation Temperature °F (°C)	Volumes CO_2 (residual)	Priming Sugar (corn sugar) [weight/5 gal (19L)]	Volumes CO_2 (bottle conditioning)
50 °F (10 °C)	1.15	1.0 oz. (28 g)	0.34
53 °F (12 °C)	1.09	2.0 oz. (57 g)	0.68
56 °F (13 °C)	1.04	3.0 oz. (85 g)	1.02
59 °F (15 °C)	0.988	4.0 oz. (113 g)	1.36
62 °F (17 °C)	0.940	5.0 oz. (142 g)	1.70
65 °F (18 °C)	0.894	6.0 oz. (170 g)	2.04
68 °F (20 °C)	0.850	7.0 oz. (198 g)	2.37
71 °F (22 °C)	0.807	8.0 oz. (227 g)	2.71
		9.0 oz. (255 g)	3.05

with water, then use CO_2 pressure to completely empty the keg. You now have a keg that contains only CO_2. Rack the beer quietly to this keg, keeping the lid of keg loosely set over the opening (or cover the opening with aluminum foil) and you will rack the beer in under a cover of CO_2.

Seal the keg as soon as the beer has transferred and apply CO_2 pressure (only a few PSI is needed), and pull the pressure relief valve a few times. Each time, some headspace gas (which will have a small amount of oxygen in it) will exit the keg and be replaced with pure CO_2. A few spurts of CO_2 will adequately purge the headspace and your beer will be less prone to stale quickly.

There are many ways to carbonate a keg of homebrew. These include bubbling CO_2 through the beer with an aeration stone, agitating a keg under high CO_2 pressure on the beer, letting the beer set under the correct serving pressure and priming the keg with sugar as you would during bottle conditioning. Unfortunately, there are no simple ways to measure the amount of CO_2 in homebrew. As such, the most common methods of quickly carbonating kegs — by injecting CO_2 or shaking the keg — involve some guess work or prior experience to work properly.

Waiting for the keg to carbonate by storing it at the appropriate temperature and CO_2 for a given carbonation level is much more accurate and repeatable, but takes more time. The same thing goes for priming with sugar. For many homebrewers, a hybrid method produces results that split the difference between being extremely quick and more controllable. For example, the brewer will inject CO_2 (or shake the keg) to a degree that experience has taught him will give him slightly less carbonation than needed, then let the keg set at the appropriate temperature and pressure for a few additional days to settle into the right carbonation level.

Another benefit of kegging is that you can counterpressure bottle your beer. Counterpressure bottling involves transferring carbonated beer from a keg to a bottle. The beer is under CO_2 pressure during the transfer, so carbonation of the beer is maintained. (The bottling apparatus is removed before the bottle is capped, so a little CO_2 is lost, but this can be compensated for by slightly overcarbonating the beer destined to be bottled.) Counterpressure bottling is a way to produce sediment-free bottles of homebrew, and many homebrewers use this method to package a few beers from their kegs to take to homebrew meetings (or other parties) or to send to homebrew contests.

As with packaging bottle conditioned beers, limiting the amount of oxygen the beer is exposed to is advised. With counterpressure bottling, there is a simple way (in theory) to do this — cap the beer over foam. The idea is to fill the beer, then — when the bottling apparatus is removed from the bottle — induce the bottle to produce just enough foam to flow out the opening. The crown cap is then placed over the foam and very little oxygen has entered the beer, compared to a bottle capped over an empty headspace. Getting the beer to foam on command isn't always easy, however. If a bottle has not produced enough foam to cap over, lightly tapping the bottom of the bottle against a hard surface will induce it to foam. This can lead to uncontrollable gushing, however, if you rap the bottle too hard.

Once beer is bottled or kegged, store it so it lasts as long as possible. Your best option is to store the beer refrigerated. Your next best bet is to store the beer as cool as possible at a steady temperature. The amount of time homebrew will keep is dependent on many factors. These include the level of contamination in your beer, how well you managed to keep oxygen away from the beer, whether it's bottle conditioned, the strength of the beer and other variables.


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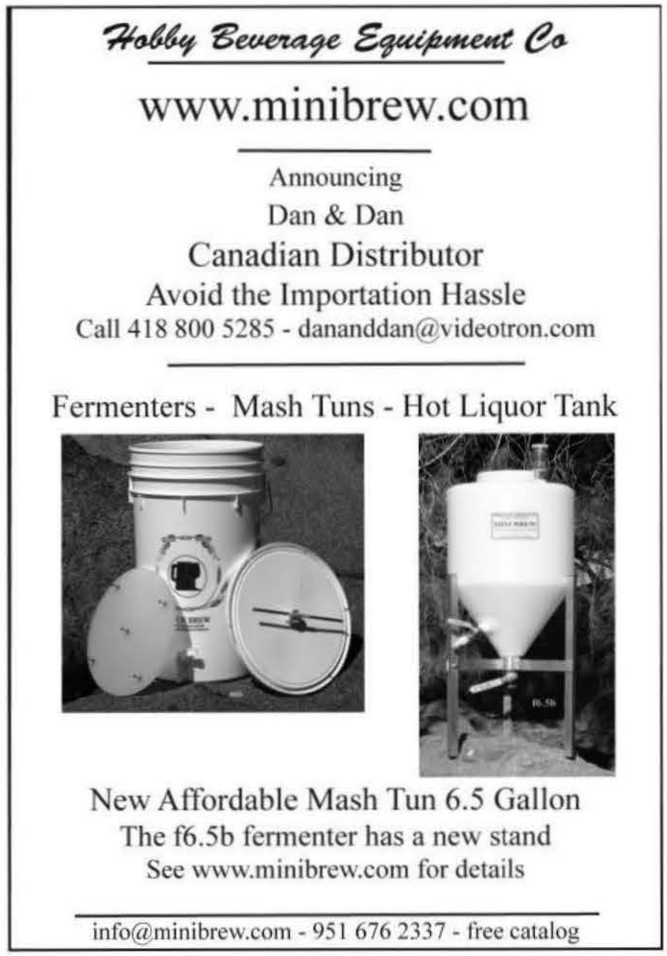
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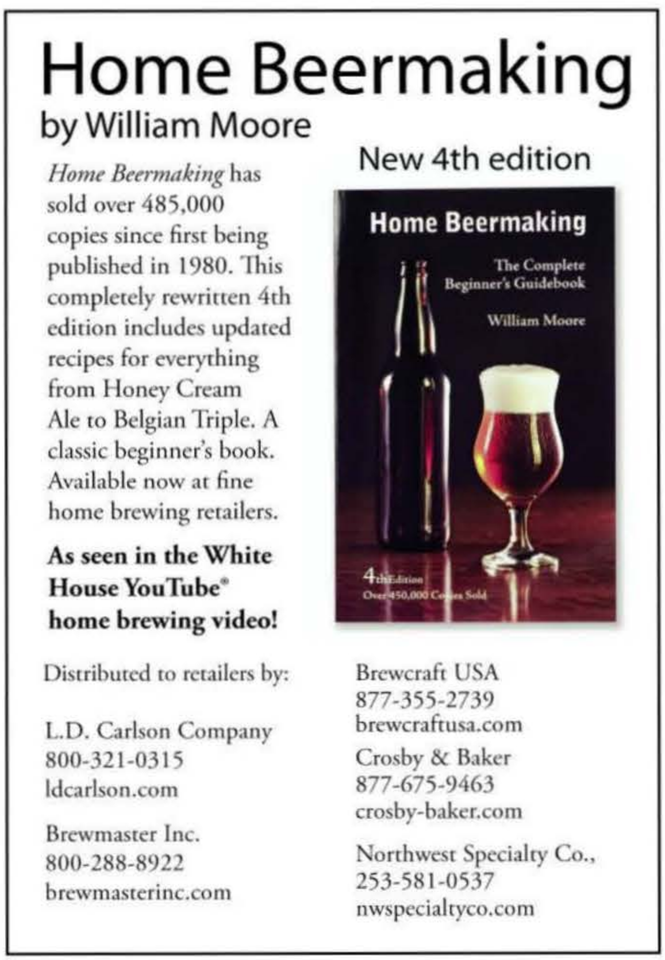
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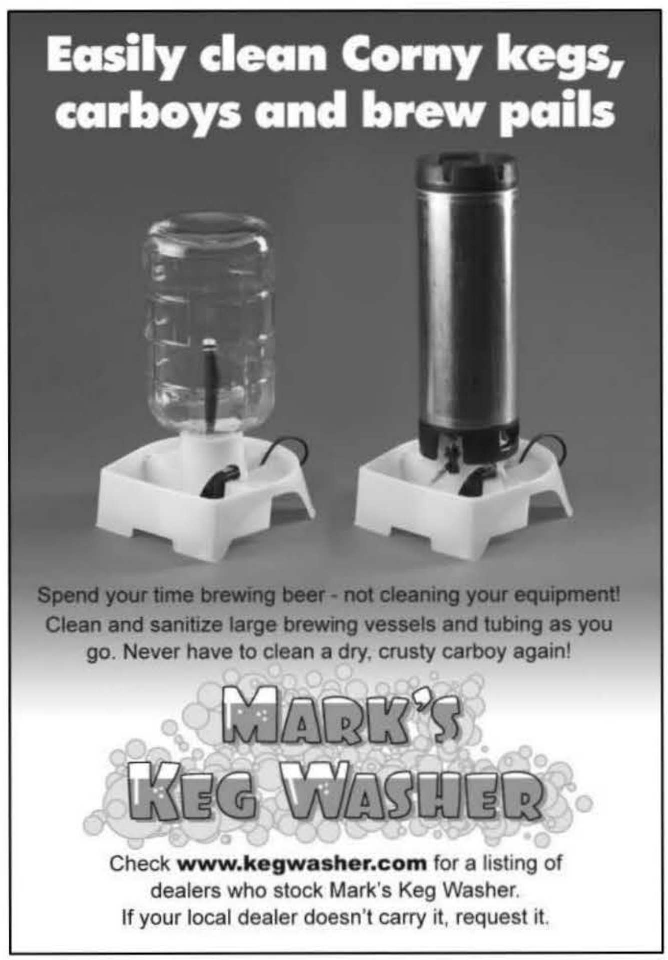
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Calibration and Conclusion

Homebrewers have a variety of tools at their disposal — including hydrometers, thermometers and pH meters — to measure important variables during the brew day. It is important that these be calibrated, so that you can have some confidence in your measurements. Fortunately, calibration is not very difficult. Here's how:

One theme running through this collection of articles is that we can't always easily measure what we want in homebrewing. However, there are several instruments with which we can get adequately precise measurements. In this article, we'll learn how to calibrate the key tools in a homebrewing lab.

It's the (Density of) Water

Density is the weight of an object divided by the volume it occupies. Water has a density of one kilogram (kg) per liter (L) at 4 °C. In other words, if you had exactly 1 L of water at 4 °C and placed it on a (properly calibrated) scale, it would weigh exactly 1 kg. Expressed in English units, the density of water is roughly 8 lbs. 5.5 oz. per gallon. (In this article, we'll mostly be using metric units and will only give conversions to English units if that knowledge is useful.)

A refractometer (top) and digital thermometer. Both should be calibrated before use.

When we use our hydrometers, we are measuring the density of extract in our wort or beer. ("Extract" here means dissolved solids, not malt extract.) Homebrewers tend to express this in terms of specific gravity, which is the density of a liquid relative to pure water. Liquids that are equally as dense as water have a specific gravity of 1.

Single-Point Calibration

If your hydrometer is properly calibrated, it should read 1.000 when floating in pure water. Because the density of water changes with temperature, hydrometers are meant to be used at a specific temperature (either 60 °F/16 °C or 68 °F/20 °C). This temperature should be printed on the slip of paper inside the hydrometer. Tables that take temperature into account can be found in most beginning homebrew books.

Two-Point Calibration

Checking the reading of your hydrometer in pure water is a single point calibration, and this is all most homebrewers will ever do for their hydrometers. However, what if the hydrometer read correctly at 1 but the scale printed on the paper sleeve inside the hydrometer was compressed or elongated compared to what it should be? To check to see if your hydrometer reads correctly in the range you use it in, do a two-point calibration. If you have a (calibrated) scale, you can make a sugar solution with a density equivalent to the average density of your wort. You can use this to check if your hydrometer reads correctly in that range.

The final step is knowing the degrees Plato (°Plato) is the percentage of sucrose (table sugar), by weight, dissolved in a water solution. For example, if you had 10 g of sucrose dissolved in 90 g of water, you would have a 10 °Plato solution — i.e. 10 g of sugar in a solution that weighs 100 g overall is 10% sugar (w/w). There is a quick and dirty way to convert between degrees Plato and specific gravity — just multiply the value in degrees Plato by four to get the value in "gravity points." Conversely, you can divide the number of "gravity points" by four to yield the value in degrees Plato. For example, the 10 °Plato solution mentioned before would have a specific gravity of 40 "gravity points — 1.040.

This "times 4" rule is only an approximation however, as specific gravity and degrees Plato do not have a linear relationship. A 10 °Plato wort really does have a specific gravity of 1.040. However, as you get farther away from 10 °Plato, this approximation gets less accurate.

So let's say you brew mostly pale ales and porters and your target original gravity is SG 1.048. A specific gravity of 1.048 is equivalent to 12 ° Plato. (Actually 12 °Plato is 1.04838, but the difference here is only 0.38 "gravity points.")

If you dissolve 12 g of sucrose in 88 g of water, you will have a 12 °Plato or SG 1.048 solution. (And actually, to have enough liquid to be able to float a standard-sized homebrew hydrometer, you will need a solution consisting of 24 g of sucrose and 176 g of water.)

When you make this sugar solution, you must use sucrose (table sugar), not corn sugar. Why? Because the type of corn sugar (glucose monohydrate) sold at homebrewing stores usually has water associated with it. As such, part of the weight of the sugar is due to the attached water molecule (the "monohydrate").

If you have a refractometer, you can calibrate it in the same manner. In this case, using sucrose is required because °Plato (the unit that most refractometer read in) is defined as a weight to weight percentage of sucrose in water.

Volume

Many times during the brew day and later during fermentation, it pays to be able to accurately measure the volume of your wort. Likewise, it is worthwhile to calibrate all of your brewing vessels so you can read the volume of liquid in them anytime during the brew day.

The basic idea for calibrating brewing vessels is simple — add a known volume of water to the vessel and make a mark at that level. For example, you could pour a gallon of water into your carboy and place a piece of tape on the outside that corresponds to that level. Repeat this process four more times to mark the 2-, 3-, 4- and 5-gallon marks. The only catch to the above plan is — how do we measure exactly one gallon?

Standard kitchen measuring cups are not very accurate. (Neither are the hash marks printed on the outside of your brewing bucket.) What you need is something that measures volume accurately. For homebrewers, a 250-mL graduated cylinder will work well (and can double as a hydrometer test jar). A decent graduated cylinder will say how accurate it is. Mine says 250 mL +/- 2 mL at 20 °C. So, it's accurate to about 1% — which should be good enough for most homebrewing applications.

To help in calibrating larger vessels, I like to make an intermediate calibrated vessel. A one gallon (3.8 L) milk or water jug works well for this. Pour 250 mL in it almost 16 times, and you can measure out 3.79 L or 3,790 mL (1.00 gallon). Mark the 1-gallon mark on the jug and then use it to calibrate your larger vessels.

To calibrate brewing buckets, you can use a permanent marker to write on the outside of the bucket. For carboys, labeled pieces of tape can be placed at every gallon (or half-gallon) mark. For water tanks or other vessels with sight glasses, volume marks can be painted on the sight glass. For any vessel that is not see-through, you can make a dip stick.

Scales and Balances

With a reasonably accurate 250 mL graduated cylinder, you can easily make 1 L of water — 4 X 250 mL = 1 L. Recall that 1 L of water at 4 °C (refrigerator temperature) weighs exactly 1 kg. With this information, you should be able to calibrate any scales or balances in your brewery.

Thermometer

Most homebrewers probably have a variety of thermometers. Many homebrewers may be unaware of how inaccurate thermometers can be. Cheap thermometers can be off by as much as 20 °F (11 °C). Even more expensive thermometers can be off enough to make a difference in brewing. As such, every homebrewer should know how to check and calibrate their thermometers.

Every serious homebrewer should get one good thermometer — a laboratory-grade mercury thermometer or good digital thermometer — and use this to check and adjust their working thermometers. However, even the most expensive thermometers should be checked for accuracy.

To check a thermometer, you should take the temperature of two solutions that you know the temperature of. The Catch-22 here is that, without a calibrated thermometer, how do you know the temperature of a solution? The answer is you rely on the physical properties of water to supply you with two set points.

The best place to start is at the freezing point of water. Pure water freezes at 32 °F (0 °C). If you can make a solution of ice and water right at that point, you can check if your thermometer reads right at freezing. To make a 32 °F (0 °C) solution, do the following:

A pH meter needs to be calibrated frequently or its readings will begin to drift.

Take a clean styrofoam cup and fill it with crushed ice, heaped to the top. (Technically, the ice should be made from distilled water, but using tap water won't affect your result by enough to matter in brewing.) Don't add any water to the ice. Put the cup in your refrigerator and wait until enough ice melts to submerge your thermometer to a depth that is adequate to take a reading. (Glass laboratory thermometers will have an immersion line showing how far the thermometer tip should be submerged.) It will take a few hours for the ice to melt to this point, so plan ahead. You want to take the temperature of a solution with a lot of ice and just enough water to take a reading.

Note that you can't just take a (warm) cup, add (warm) tap water, plunk down a few ice cubes and expect the temperature to be 32 °F (0 °C). Waiting for ice to melt ensures the resulting ice and water mixture is right at the freezing point as long as the amount of ice is much greater than the amount of water in the mix.

Once the ice water is prepared, take the temperature of the solution. Remember that your thermometer is warmer than the ice water and will warm the local area it is inserted into, so swirl the tip of the thermometer a bit as you take the reading. Keep the thermometer in the slush until it gives a steady reading.

The second point to measure is the boiling point. Water boils at 212 °F (100 °C) at sea level, at standard barometric pressure (29.9 inches of mercury (in. Hg)). But what if you're not at sea level and standard barometric pressure? If you don't know your altitude, you can find out at the US Geological Survey's Geographic Names Information System (or the USGS's GNIS, for acronym lovers) Their web site is located at geonames.usgs.gov (no "www").

If you wish to take barometric pressure into account, you can find your local barometric pressure at the weather channel (www.weather.com) or from a home barometer — if it's calibrated! Alternately, take your reading when your local barometric pressure is between 29.6 and 30.2 inches of mercury (in. Hg) and you'll be off by a ½ degree Fahrenheit (0.28 °C) at most.

If your thermometer does not read correctly at 32 °F (0 °C), 212 °F (100 °C) or both, you can set up a standard curve to translate your thermometer's reading into the actual temperature. Take a piece of graph paper and label both axes from just below the freezing point of water to just about the freezing point of water. Label the y axis as thermometer temperature and the x axis as actual temperature. Plot two points corresponding to your two calibration measurements. For example, if your thermometer read 4 °C at 0 °C, plot one point at (0, 4) on your graph. Once you've plotted both points, take a ruler and connect them with a straight line. This is your standard curve. When you take a measurement, find the value on the y-axis and trace a horizontal line over to the curve. Then trace a horizontal line straight down. Your actual temperature is the value on the x axis where the line crosses it.

Once you've calibrated your best thermometer using the methods above, use it as a reference to calibrate the rest of your thermometers.

pH Meters

Handheld pH meters are popular among homebrewers. These relatively inexpensive meters give very accurate readings, but should be calibrated every time they are used. (The same goes for expensive bench-top meters.)

The meter is calibrated by placing the electrode in solutions of known pH and ensuring that it reads right. For calibrating, you will need a pH 7.01 buffer and a pH 4.01 buffer — which are often sold as a kit, along with electrode storage solution, wherever pH meters are sold.

Calibration is important because pH meters will "drift" between uses — and sometimes within a long day of taking pH readings. If you don't calibrate them, their pH readings will change over time. Also, pH electrodes eventually wear out. Letting their storage solution run out will speed their demise. If the readings of the meter bounce around and won't settle down, or if the meter quickly goes out of calibration, this may be a sign that a new electrode is needed. As a quick check on how stable your pH meter is, take the pH of your two buffer solutions at the end of any session of pH measurement. If the meter doesn't give their pH values as 7 and 4, the meter has drifted and will need to be recalibrated.

Once you've calibrated the equipment in your brewery, you will know that your readings of temperature, specific gravity, volume and weight are accurate. This knowledge can help you to consistently brew the best beers possible.

Graduation

Hopefully, you will have learned something from this collection of articles that you can use to brew better beer. Like almost everything in the world, brewing great beer requires that you pay attention to every step along the way. There are no "silver bullets" that will make your beer great, and the "weakest link in the chain" is going to be what determines your beer's quality. Reviewing your brewery practices and doing each step in the best possible manner will allow you to push your beer to new heights.

Another important key to brewing better beer is to learn from your own successes and failures. When you start brewing, you will mostly be following a set of directions. As you continue brewing, however, you will learn by trial and error what works in your homebrewery and what doesn't. You will make adjustments to get things to work on your equipment and with your water. It is important not to let that hard-earned knowledge slip away. For that reason, you should keep a brewing notebook and record not only what your plans for each brew was, but how it was brewed in actuality. If you accidentally heated your sparge water 10 °F (5 °C) above your target, write that down in your brewing notebook.

When your beer is done, take tasting notes and reread what you did on brewing day. See if you can find any connections. (Did the too-hot sparge water lead to an astringent mouthfeel in your beer?)

Finally, once you've learned the basics of brewing from those brewers that have gone before us, and you've learned for yourself how to get things to work on your own homebrew setup, put that knowledge to use by brewing as much as possible. It will help you become a better brewer. Knowledge plus experience is an unbeatable combination.

Visit The Library (the next section) for more topics to explore . . . and of course, don't forget to relax at the campus pub. And don't worry about your grades — the only test here is whether you can take any information that was new to you and use it to brew better beer.

The Library

Welcome to The Library at Brew Your Own University. If you're new to brewing, the magazine articles should help you get up to speed on most commonly practiced homebrewing techniques. If you've brewed for awhile, the professional brewing texts will give you access to a wealth of brewing knowledge.

In the BYO U package, we hoped to discuss the most important aspects of each stage in the brewing process, the decisions that can be made along the way and measurements that can (and can't) be made. To explore further, here are some reading materials with which you can examine individual topics raised here in more depth. Most of the topics that rated a paragraph or more in the BYO U articles have a corresponding article that takes a closer look at the idea. As with the Brew Your Own University articles, most of the articles in The Library focus on techniques, not ingredients, equipment or beer styles.

We hope that the Brew Your Own University package is valuable to all homebrewers, regardless of their experience. If BYO U was mostly a refresher course, the references to the professional texts may be your next step in your continuing brewing education.

These books aren't cheap, but they contain a wealth of information.

Professional Brewing Texts

"Malting and Brewing Science: Volume I Malt and Sweet Wort (Second Edition)," by Briggs, Hough, Stevens and Young, 1981, Kluwer Academic/Plenum Publishers, New York (387 pages)

"Malting and Brewing Science: Volume 2 Hopped Wort and Beer (Second Edition)," by Hough, Briggs, Stevens and Young, 1999, Aspen Publishers, Gaithersburg, Maryland (914 pages)

These two volumes are core reference materials for any serious brewer. The authors cover the topic of (commercial) brewing completely, including the basic relevant brewing science, ingredient handling and brewery practices. Unfortunately, they are somewhat expensive (just short of $300 each new), but it's not too hard to find used texts for about half that price.

"Technology Brewing and Malting (3rd International Edition)," by Wolfgang Kunze, 2004, VLB, Berlin (949 pages)

A German brewing text, translated into English. Lots of material, but far fewer references to the original literature than in Briggs, et. al. The English translation is a bit rough in places and some of the figures retain their German titles and labels. Similarly expensive as the above texts, but very good, especially if you are interested in German-style brewing.

"Brewing (Second Edition)," by Lewis and Young, 2002, Kluwer Academic/Plenum Publishers, New York (398 pages)

A much more affordable brewing text (~$60, new) that is a good overview of commercial brewing. More up to date than the Briggs, et. al. volumes, but covers less ground.

Brew Your Own Articles (And Special Issues)

Ingredients

"Malting at Home," by Graham Anderson (January-February 2013)

"Making Malt Extract," by Bob Hansen (May-June 2008) http://www.byo.com/stories/issue/article/issues/252-mayjun-2008/1106-making-malt-extract

BYO's Hop Lover's Guide (Special Issue)

Mashing

"From Grain to Glass: Your First All-Grain Beer," by Chris Colby (July-August 2010)

"Making the Most of Your Mashes (Extract Efficiency)," by Chris Colby (July-August 2006) http://www.byo.com/stories/issue/article/issues/237-julaug-2006/1110-making-the-most-of-your-mashes-techniques

"Homebrew Decoction Made Easy," by Horst Dornbusch (December 2010)

"The Science of Step Mashing," by Dave Green (January-February 2008) http://www.byo.com/stories/issue/article/issues/250-janfeb-2008/1529-the-science-of-step-mashing

"Cereal Mashing," by Jon Stika (December 2007)

"Lautering," by Chris Colby (May-June 2003)

"Water Profiles: Create your own Chemistry," by Jon Stika (October 2009)

"Countertop Partial Mashing," by Chris Colby (October 2006) http://www.byo.com/stories/issue/article/issues/239-october-2006/511-countertop-partial-mashing

"Hot Wort! (Boiling)," by Chris Colby (July-August 2003)

"Lighten Up: Late Extract Additions," by Terry Foster (September 2012)

Chilling and Aeration

"Wort Chilling," by Chris Colby (December 2002) http://www.byo.com/stories/issue/article/issues/209-december-2002/1684-wort-chilling-techniques

"To Aer is Human (Wort Aeration)," by Chris Colby (October 2000)

"Olive Oil Aeration," by John McKissack (May-June 2008)

Yeast and Fermentation

"Fermentation: Homebrewing Options for Fermenting your Wort," by Chris Colby (January-February 2003)

"Yeast and Fermentation," by Chris Colby. Greg Doss and Chris White (September 2009)
This is a package of four articles.

"Make a Yeast Starter," by Jon Stika (July-August 2007) http://www.byo.com/stories/issue/article/issues/245-julaug-2007/1088-make-a-yeast-starter-techniques

"Yeast Counting," by Chris Colby (December 2003)

"Keeping it Cool (Lagering)," by Chris Colby (July-August 2004)

"Lagering Techniques," by James Spencer (March-April 2011)

"Fermenting Belgian-Style Beers," by Stan Hieronymus (July-August 2006) http://www.byo.com/stories/article/indices/31-fermentation/640-fermenting-belgian-style-beers

"Kräusening," by Chris Colby (November 2006) http://www.byo.com/stories/issue/article/issues/240-november-2006/970-kraeusening-techniques

"Dry Hopping," by Donald Million, (September 2003) http://www.byo.com/stories/article/indices/37-hops/573-dry-hopping-techniques

Bottling and Kegging

"Priming with Sugar," by Robert McGill (November 2006) http://www.byo.com/stories/issue/article/issues/240-november-2006/1276-priming-with-sugar

"Keg it!" by Andy Sparks (November 2010)

"Counter-Pressure Bottling," by Chris Colby (November 2002) http://www.byo.com/stories/issue/article/issues/208-november-2002/509-counter-pressure-bottling-techniques

"Homebrewing Cask Ales," by Dave Louw (July-August 2012)

BYO's Guide to Kegging (Special Issue)

Measurement

"Home Lab Tests," by Chris Colby (December 2004) http://www.byo.com/stories/issue/article/issues/225-december-2004/770-home-lab-tests-advanced-homebrewing

"A Matter of Degrees (Temperature Measurement)," by Steve Parkes (November 2003)

"The pH pHiles (Testing pH)," by Chris Colby (May 2001)

Projects

"Motorize a Grain Mill," by Steve Van Tassell (December 2010)

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Brewing Science

"Deep Water (Water Chemistry)," by Steve Parkes (January-February 2002)

"pH pHacts," by Steve Parkes (September 2003)

"Buffers," by Chris Colby (September 2008) http://www.byo.com/stories/article/indices/18-brewing-science/1707-advanced-brewing

"Boil Basics," by Steve Parkes (May-June 2002)

"The Big Chill (Wort Chilling)," by Steve Parkes (July-August 2002)

"Fermentation," by Steve Parkes (October 2002)

"Ferment and Flavor (Yeast Byproducts)," by Steve Parkes (December 2002) http://www.byo.com/stories/article/indices/18-brewing-science/634-fermentation-a-flavor-compounds-homebrew-science

"Dreaded Diacetyl," by Steve Parkes (November 2002) http://www.byo.com/stories/article/indices/18-brewing-science/550-diacetyl-homebrew-science

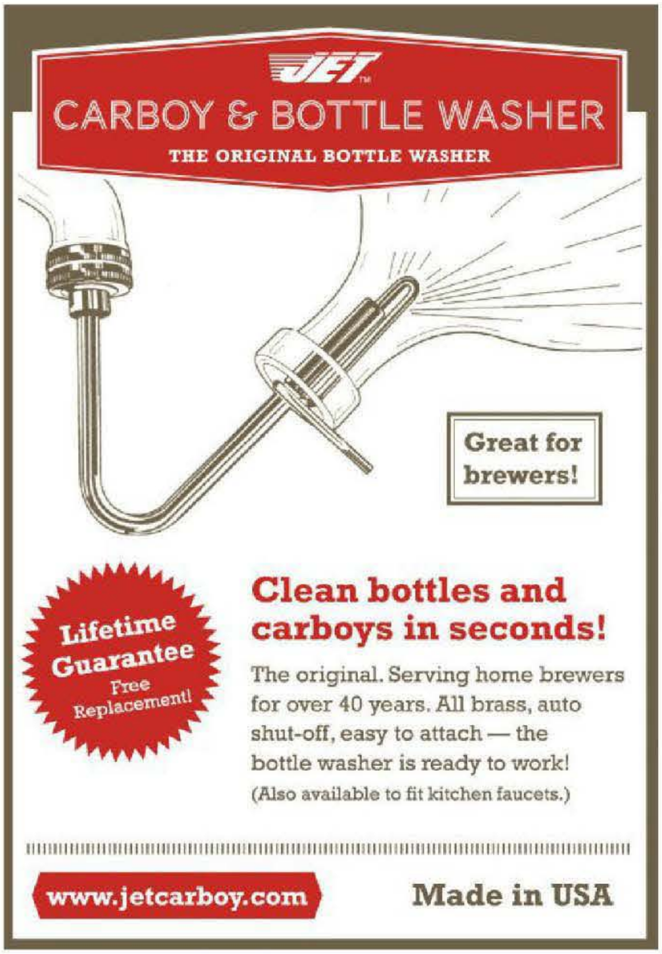
"Flavor Maturation," by Steve Parkes (January-February 2003)

"Carbonation," by Steve Parkes (March-April 2003) http://www.byo.com/stories/article/indices/21-carbonation/440-carbonation-homebrew-science

"Oxidation = Bad," by Steve Parkes (July-August 2003)

Miscellaneous

"Improve Your Homebrews," by Chris Colby (January-February 2012) BYO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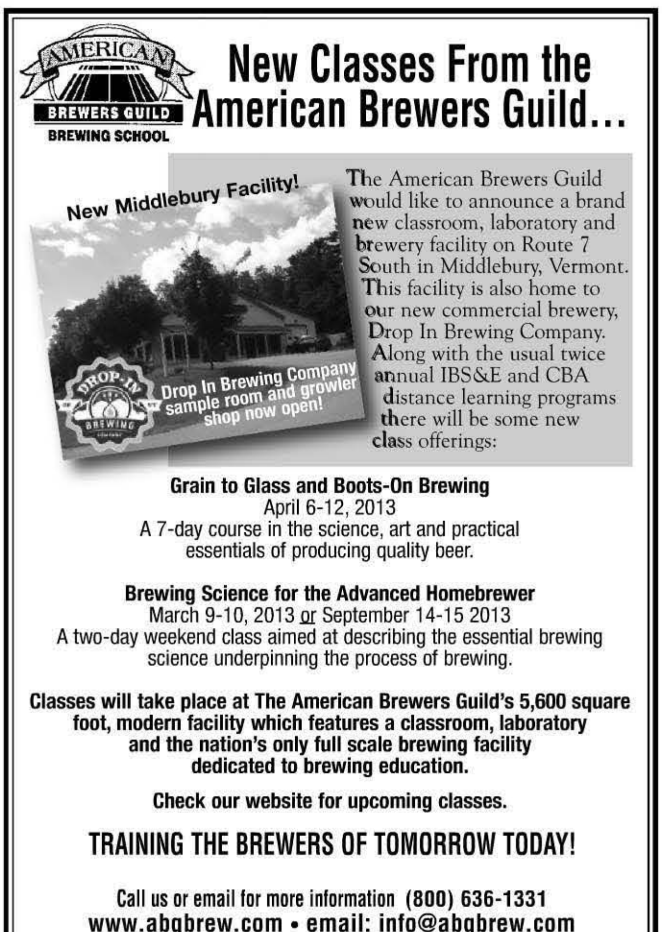
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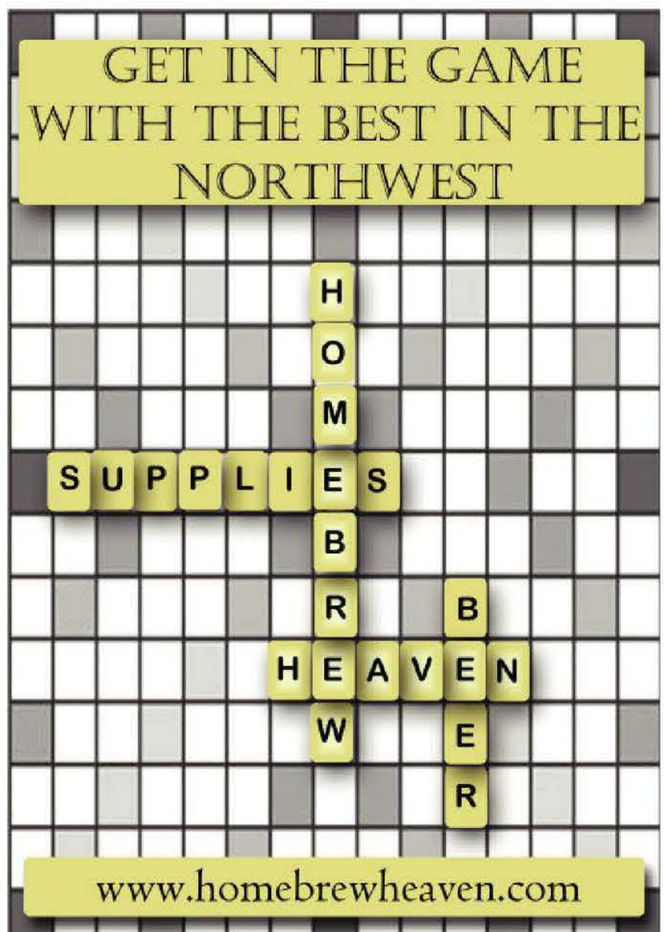
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HOP STANDS

THE WHY AND HOW OF WHIRLPOOL HOPPING

By **Dave Green**

Ask eight brewers the key to crafting a great IPA and you will probably get nine different answers. One technique that is well-established in the professional brewing world but just recently gaining traction with homebrewers is hop standing or whirlpool hopping. While the buzz around hop stands mainly revolves around highly hopped beers, there is a lot more to this technique than just trying to crank your DIPA up to an 11. (I will be calling this technique whirlpool hopping, but keep in mind that homebrewers don't need to keep their wort constantly swirling in the kettle for this technique to work.)

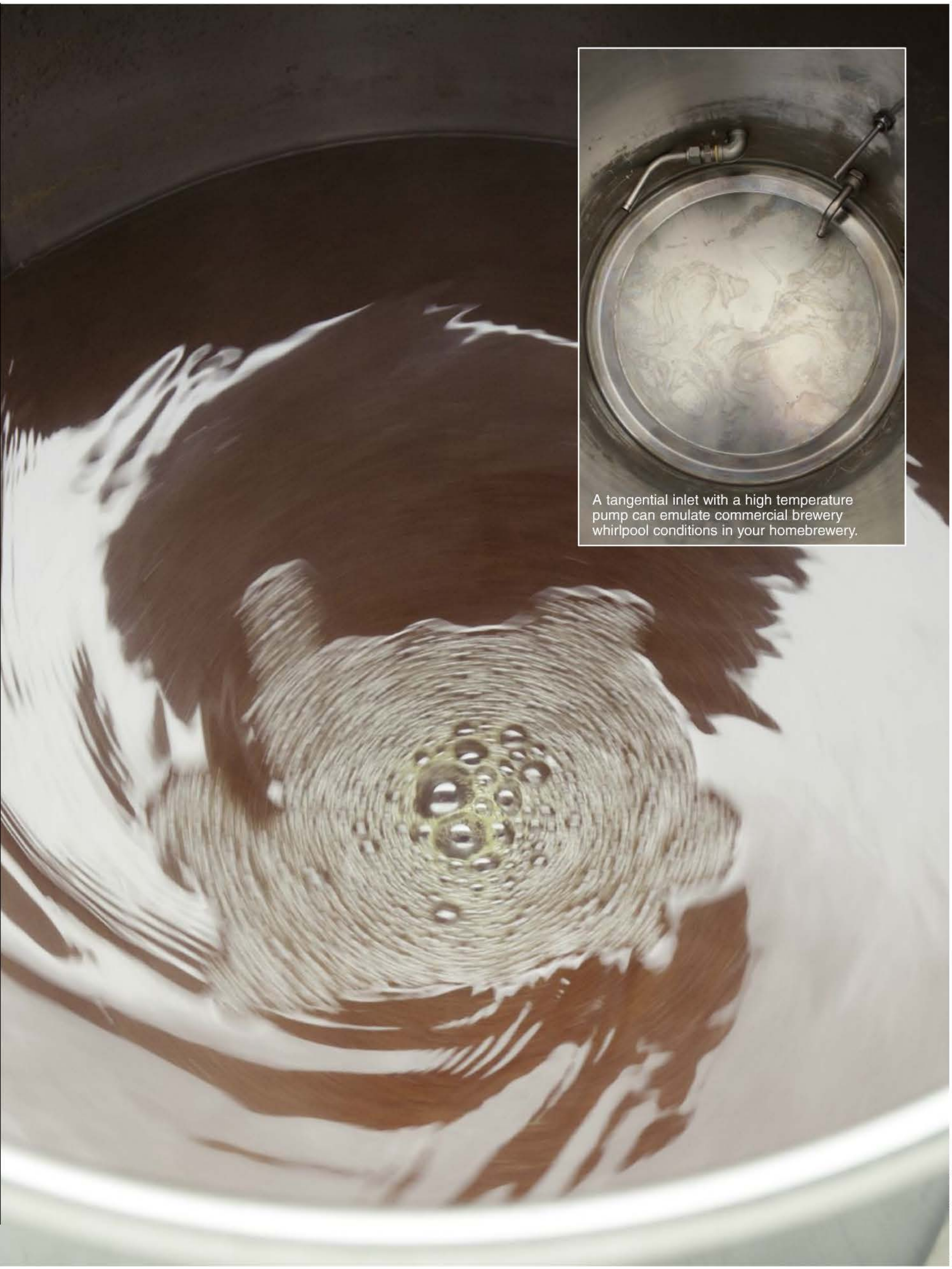
The What and Why

A hop stand is simply allowing the boiled wort an extended contact period with the flameout hops prior to chilling the wort. Pro brewers typically create a whirlpool either in their kettle or in a separate whirlpool vessel with the hot wort and the ensuing vortex creates a cone shaped pile in the center of the vessel made up of the unwanted trub and left over hop material. Whether on purpose or inadvertently, pro brewers were giving their flameout hops extended contact time with the wort. This allows the hops added at flameout a period to release their essential oils into the wort, while minimizing the vaporization of these essential oils. In essence, adding a kick of hop flavor and aroma while also adding what can best be described as a smooth bitterness. In short, whirlpool hopping can add significantly to the hop flavor and aroma of beer.

Hop Essential Oils

The essential oils found in hops are volatile and provide beer with the hop flavor and aroma hop aficionados enjoy. While there are hundreds of essential oil components, for practical purposes brewers tend to focus on 4-8 main essential oils that play vital roles in providing hop varietal characteristics. One important characteristic is the essential oil's flashpoint, or the temperature at which the essential oil is actively vaporizing to the point where it could ignite if sufficient vapors were present. At wort boiling temperatures, all hop essential oils have surpassed their flashpoints, so a vigorous boil will drive them off fairly quickly. The best way to

Continued on page 59



A tangential inlet with a high temperature pump can emulate commercial brewery whirlpool conditions in your homebrewery.

Photos by Les Jörgensen

Whirlpool-Hopped Double IPA

Over the Topper DIPA
(5 gallons/19 L, all-grain)

OG = 1.074 (18.5 °P)
FG = 1.012 (3 °P)
IBU = 100+ SRM = 6 ABV = 8%

This is a clone of one of my favorite double IPAs, Heady Topper, from The Alchemist Brewery in Vermont.

Ingredients

13 lbs. (5.9 kg) British pale ale malt
4.0 oz. (113 g) Caravienne® malt
1.0 lb. (0.45 kg) sucrose
19.5 AAU Simcoe® hops (30 min)
(1.5 oz./42 g at 13% alpha acids)
5.75 AAU Cascade hops (knockout)
(1.0 oz./28 g at 5.75% alpha acids)
17.2 AAU Apollo hops (knockout)
(1.0 oz./28 g at 17.2% alpha acids)
13 AAU Simcoe® hops (knockout)
(1.0 oz./28 g at 13% alpha acids)
10.5 AAU Centennial hops
(30 min into hop stand)
(1 oz./28 g at 10.5% alpha acids)
13 AAU Simcoe® hops
(30 min into hop stand)
(1 oz./28 g at 5.75% alpha acids)
14 AAU Columbus hops
(30 min into hop stand)
(1 oz./28 g at 14% alpha acids)
1.0 oz. (28 g) Chinook hops
(primary dry hop)
1.0 oz. (28 g) Citra® hops
(primary dry hop)
1.0 oz. (28 g) Simcoe® hops
(primary dry hop)
1.25 oz. (35 g) Centennial hops
(secondary dry hop)
1.25 oz. (35 g) Simcoe® hops
(secondary dry hop)
White Labs WLP001 (California Ale) or
Wyeast 1056 (American Ale) yeast
(1.5 qt./~1.5 L yeast starter)
or
Lallemand BRY 097 or Fermentis
Safale US-05 yeast (1 sachet)

Step by Step

Mash at 155 °F (68 °C) for 40 minutes. Sparge enough to collect roughly 7.5 gallons (28 L) in your kettle to achieve 6.5 gallons (25 L) at knockout. Boil for a grand total of 75 minutes. Just after knockout toss in the first set of knockout hops and begin the whirlpool process. You can either run your pump for 10 minutes or you can stir for a minute and then let spin down and settle. After 30 minutes have gone past after knockout, reduce wort temperature to 170 °F (77 °C) and then add the second set of hops to the hop stand and once again whirlpool. After 15 more minutes have passed, begin final cooling process. The goal is to get at least 5.5 gallons (21 L) into your fermenter to compensate for the loss of wort which will occur during dry hopping. Make sure your primary fermenter has enough headspace to accommodate that much wort plus a large kräusen. Pitch a healthy dose of yeast when wort hits 65 °F (18 °C). After final gravity has been achieved, add a clarifying agent such as polyclar. Allow three days for clarifying agent to work, then add first set of dry hops to primary fermenter. After 7 days, rack beer off dry hops & yeast cake either into a keg or secondary fermenter. Try to purge with carbon dioxide if available to you. Add second round of dry hops and wait 5 days. Bottle or begin carbonation process.

Over the Topper DIPA
(5 gallons/19 L, extract with grains)

OG = 1.074 (18.5 °P)
FG = 1.012 (3 °P)
IBU = 100+ SRM = 6 ABV = 8%

Ingredients

10 lbs (4.5 kg) pale/gold liquid
malt extract
4.0 oz. (113 g) Caravienne® malt
1.0 lb. (0.45 kg) sucrose
19.5 AAU Simcoe® hops (30 min)
(1.5 oz./42 g at 13% alpha acids)
5.75 AAU Cascade hops (knockout)
(1.0 oz./28 g at 5.75% alpha acids)
17.2 AAU Apollo hops (knockout)
(1.0 oz./28 g at 17.2% alpha acids)
13 AAU Simcoe® hops (knockout)
(1.0 oz./28 g at 13% alpha acids)
10.5 AAU Centennial hops
(30 min into hop stand)
(1 oz./28 g at 10.5% alpha acids)
13 AAU Simcoe® hops
(30 min into hop stand)
(1 oz./28 g at 5.75% alpha acids)
14 AAU Columbus hops
(30 min into hop stand)
(1 oz./28 g at 14% alpha acids)
1.0 oz. (28 g) Chinook hops
(primary dry hop)
1.0 oz. (28 g) Citra® hops
(primary dry hop)
1.0 oz. (28 g) Simcoe® hops
(primary dry hop)
1.25 oz. (35 g) Centennial hops
(secondary dry hop)
1.25 oz. (35 g) Simcoe® hops
(secondary dry hop)
1.5 L starter with White Labs WLP001
(California Ale) or Wyeast 1056
(American Ale), or use 1 sachet of
either Lallemand BRY 097, or
Fermentis Safale US-05

Step by Step

Place crushed grains in a small steeping bag and steep in 3.0 gallons (11 L) until temperature reaches 170 °F (77 °C). Boil for a grand total of 60 minutes. Just after knockout toss in the first set of knockout hops and begin the whirlpool process. You can either run your pump for 10 minutes or you can stir for a minute and then let spin down and settle. After 30 minutes have gone past after knockout, reduce wort temperature to 170 °F (77 °C) and then add the second set of hops to the hop stand and once again whirlpool. After 15 more minutes have passed, begin final cooling process. Top off to at least 5.5 gallons (21 L) in your fermenter to compensate for the loss of wort which will occur during dry hopping. Make sure your primary fermenter has enough headspace to accommodate a large kräusen. Follow the all-grain instructions for fermentation and beyond.

Web extra:

For two more hop stand recipes, visit Brew Your Own on the Web:
www.byo.com/component/resource/article/2653

think about the driving off process is in terms of half lives. The lower the flashpoint, the faster the oil vaporizes and the faster the half life. The longer the hops are boiled and the lower the flashpoint, the less the essential oil will impact the beer. In effect, whirlpool hopping removes the rolling boil (for the whirlpool hops), lowering the temperature of the wort and therefore reducing the vaporization rate of the essential oils, allowing the essential oils to really "soak in" to the wort. The specifics of the "soak in" process is still very much a gray area but the general idea is that essential oils will be retained in the beer longer and enhance the hop flavor and aroma of the finished beer.

Alpha Acid Isomerization

Alpha acids will continue to isomerize after flameout until the temperature of the wort reaches about 175 °F (79 °C). Homebrewers trying to calculate a beer's IBUs will need to guesstimate how much isomerization is occurring. The closer the wort is to 212 °F (100 °C) the higher the alpha acid isomerization rate. To do this, we can look to professional brewers for some guidelines. Ultimately, however, the thermal capacity of a professional 60bbl whirlpool vessel is quite different than 5 gallons (19 L) of homebrew, so the comparisons can only be rough guidelines at best.

Matt Brynildson of Firestone Walker Brewing Company says, "The fact that there is some isomerization (about 15% in whirlpool versus 35% in the kettle) of alpha acid means that not only hop aroma and hop flavor can be achieved, but also some bittering."

For Pelican Pub & Brewery's Kiwanda Cream Ale, brewmaster Darron Welch adds the beer's only hop addition at flameout. Welch gets about 25 IBUs from adding roughly 0.75 lbs./bbl (0.34 kg/bbl) of Mt. Hood hops at flameout then allowing a 30 minute whirlpool stage. This means that Darron is getting roughly 16% utilization on his 15 bbl system for a 1.049 specific gravity wort. As mentioned, in a homebrewers hop stand, the 5-gallon (19-L) kettle is going to cool much faster and therefore create lower utilization rates. Brad Smith, creator of the BeerSmith brewing calculator, gives this advice to homebrewers, "Something in the 10% range is not a bad estimate if hops are added near boiling and left in during the cool-down period."

From my own experience with extended hop stands in 11-gallon (42-L) batches, a 10% utilization rate for whirlpool hops seems reasonable.

The When and How

While hop-forward beers can benefit from this technique, any beer where some hop nose is desired is also a good candidate. For low IBU beers, you can add no-boil hops or you can add a tiny bittering charge of hops to help break surface tension of the beer and then add all or the majority of the IBU contribution at knockout, with the 10–15% utilization in mind.

If your brewing system has a pump, you may opt to setup a tangential inlet for your kettle to allow the pump to perform the whirlpool for you. Keep in mind that you do not need a vigorous whirlpool; just a simple spinning of the wort. If you do not have a pump, a simple spoon or paddle will work to achieve the same results.

The second factor to consider is the length of your hop stand. There are no right or wrong answers, but anywhere from 10 minutes to 90 minutes — or even an overnight stand — can be employed. For most super-charged, hop-forward beers, my hop stands will run 45 to 60 minutes. For a mid-range hop profile like an American pale ale or a beer I am looking to get a significant IBU contribution from, I will usually shorten that stand to 30 minutes. If the beer is not to be hop forward nor do I need significant IBUs from the hop stand, then a 10–15 minute hop stand usually will suffice.

Three temperature profiles that seem to be popular among homebrewers are just off boil range 190–212 °F (88–100 °C), the sub-isomerization range 160–170 °F (71–77 °C), and a tepid hop stand range 140–150 °F (60–66 °C). The 190–212 °F (88–100 °C) range will allow essential oils with higher flashpoints an easier time to solubulize into the wort and also will allow some alpha acid isomerization to occur with the best estimates of between 5–15% utilization. Some homebrewers will keep their kettle burner on low to keep the temperature of the wort elevated above 200 °F (93 °C) during their extended hop stands which would better emulate the conditions in commercial whirlpools. A hop stand in the 160–170 °F (71–77 °C) range will basically shut down the alpha acid isomerization reaction and the lower temperatures will reduce the vaporization of the essential oils. Homebrewers can use their wort chillers to bring the wort down to this range before adding the knockout hops or they can add a second dose of knockout hops. The 140–150 °F (60–66 °C) range will once again reduce vaporization of the low flashpoint oils, but may take longer to get the same amount of essential oils extracted.

I have never had dimethyl sulfide (DMS) issues with any of the beers I have performed a hop stand on and have always left the lid on. If using a Pilsner malt or other DMS-prone, lightly-kilned base malt, you may want to increase your boil time to 90 minutes.

Dry Hop Considerations

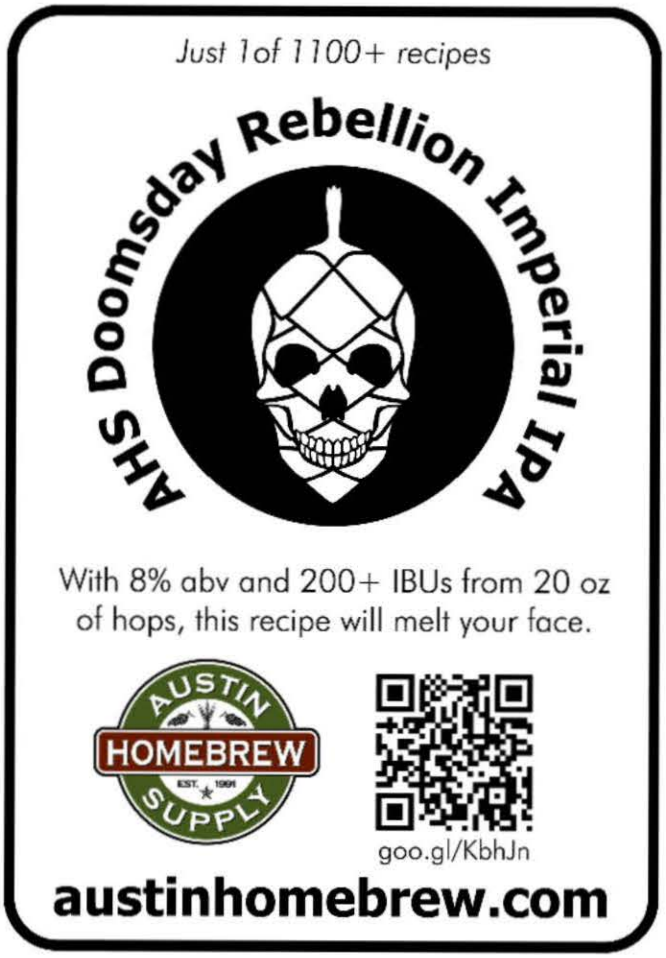
Another factor to consider is how to handle dry hopping your hop-forward beers if you employ an extended hop stand. Rock Bottom Restaurant & Brewery performed an extensive study on hop stands and dry hopping under the guidance of the Portland, Oregon brewmaster at the time Van Havig, (now of Gigantic Brewing Co., Portland, Oregon). The study was published by the *Master Brewers Association of the Americas Technical Quarterly* and considered beers that were hopped in four different ways, short hop stand (50 minutes) and no dry hops, long hop stand (80 minutes) and no dry hops, no hop stand and just dry hops and finally half the hops in hop stand (80 minutes) and half the hops for dry hopping. Beers produced using exclusively hop stands and the beers produced using exclusively dry hops will both result in well-developed hop characteristics, but there were some nuances. The long hop stand developed more hop flavor and aroma than the short hop stand indicating that essential oils were still soaking into the wort after 50 minutes. The exclusively dry hopped beer received its best marks in the aroma department, higher than the hop stand beers, but scored lower for its hop flavor. The beers where only half of the hops were added for the hop stand and half were added for aroma ended up scoring high in both departments. Havig's study also showed that adding 1 lb./bbl (0.45 kg/bbl) Amarillo® dry hops produced the same amount of hop aroma as ½ lb./bbl (0.23 kg/bbl), indicating diminishing returns at higher dry hop rates.

So if you are just giving this technique a try, here is what I would suggest based on the study's findings. Take all the hops you plan to add for late addition hops and dry hops and cut them in half. Add half at knockout and the second half as a dry hop addition. Again, don't feel the need to go overboard with these additions.

If you are interested in using this technique in your brewhouse, I have included three recipes I have used with great success to craft some of the best beers that have graced my kegerator. (One is on page 58 and the other two are online at www.byo.com/component/resource/article/2653.) I assumed 10% hop utilization rates for the hops added for the hop stand. BYO

Related Links:

- Read more about dry hopping your homebrews: www.byo.com/component/resource/article/2482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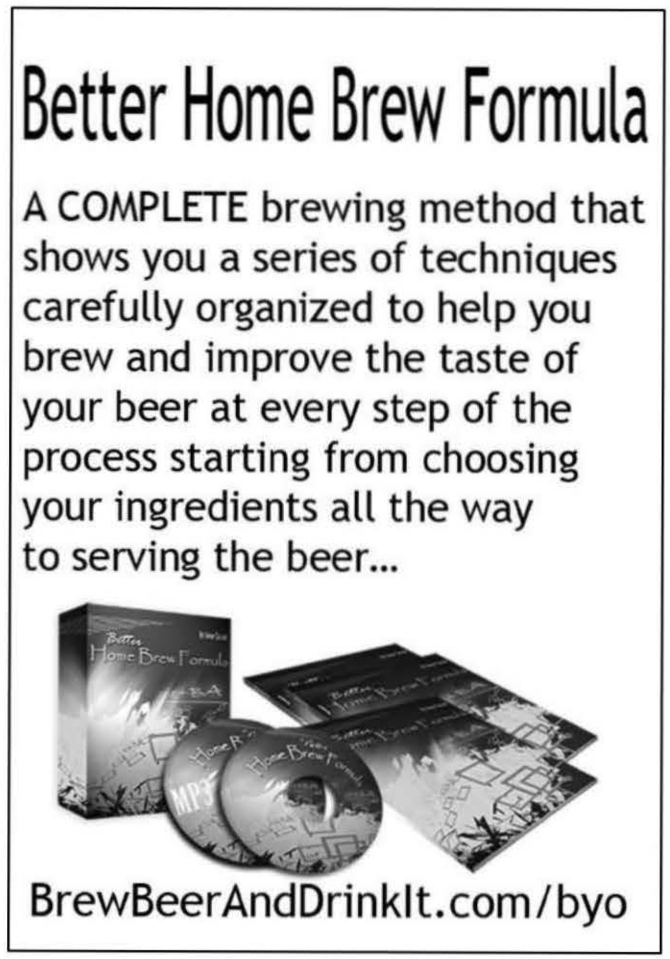
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To Keep or Not To Keep

Cellaring beer

by Terry Foster

The headline in this issue's column may not be quite the question Hamlet asked himself, but it is one homebrewers and beer drinkers in general might well ask themselves. If you have a beer you like, isn't it worth keeping a few to one side, not just to drink later, but in order that the beer may "improve" in flavor? The first answer is a resounding "No!" You may be surprised at that answer since many authors and pundits have recommended laying down a few bottles of each brew so that the beer can mature and develop its real flavor. Unfortunately that is just not true as I shall explain, although there are of course exceptions.

In my area of Connecticut I introduced the concept of keeping a "beer cellar," which I began to do in the 1970s. I brought this cellar with me when I came to the US in 1978, and the quality of some of those beers induced others to lay down their own cellars. But what was then a modest cellar contained two very important beers, which are relevant to this discussion. These were some 1975 Thomas Hardy Ales (brewed by Eldridge Pope the originators of the beer), and 1978 Barclay's Russian Imperial Stout, each bottle proudly labeled with the year in which the beer was brewed.

The Hardy Ale was billed as being capable of keeping for up to 25 years, and although the Barclay's beer was brewed at much the same strength it made no such claim. I cherished these beers for some years and it was not until the 1990s when they were about 20 years old that I tasted them with a few friends. The Hardy Ale had held up well and was malty, nutty, with Sherry-like overtones and not too sweet. The Barclay's beer was flaccid, almost tasteless and quite clearly well over the hill. In short there was no comparison between the two, and I was bitterly disappointed that a famous beer that I had nursed for so long had turned out so poorly.

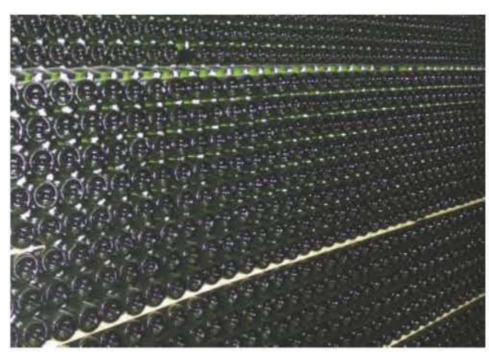
Of course, that immediately raised the question as to why such apparently similar beers should have turned out so differently. My friend, Jeff Browning (the brewer at BrüRm@BAR in New Haven, Connecticut) and I have debated the matter ever since and come up with our own approach to selecting beers for laying down. I shall discuss that later in this column, but first I'll give you another example with two beers I tasted just yesterday. One was a recreation of a porter from a 1750 recipe, 5 gallons (19 L) of which I brewed at home, and it was 15 years old when tasted. We brewed a version of this on a 10-barrel scale, and it was exactly 10 years old when it was sampled. Both beers held a fundamentally good flavor, malty and rich, but both were somewhat spoilt by being too acidic, with the younger beer being more sour than the older one.

Neither of the beers had had any noticeable acidity when bottled, so it had developed on storage. And it seems likely that this difference between the two beers was in how they had been handled. The homebrewed one had been bottled right after fermentation was complete, while the other had been kegged from a serving tank, kept there some time, racked into another keg and then bottled. Clearly the second had been handled more often so there was more chance of it picking up acid-producing bacteria. This demonstrates a very important point about aging beer, which is that any fault in the beer, and not just acidity, will be magnified over time. For some more detailed comments on the chemistry of aging beers see the "Advanced Brewing" column in the December 2012 issue of *Brew Your Own*.

Which beer?

By now you're probably wondering when I'm going to stop talking and get

> "In this area of Connecticut I introduced the whole concept of keeping a 'beer cellar,' which I began to do in the 1970s."



down to some useful advice. First let me point out that these "rules" apply to both commercial and homebrewed beers. And if you are not already doing so, you ought to be buying commercial craft beers, both to develop your own palate and to have a "marker" to judge your own beers by. The basic points are these:

1. Think about the beer
2. Taste it carefully
3. Ask yourself if it is possible to improve on its present taste
4. If you decide to keep it put aside several bottles
5. Test a bottle at intervals
6. If it tastes good at any point, go ahead and drink it

Let me explain these points. The first one is something you ought always to do. If it is your own brew, what did you intend it to be? If it is one you bought, try to think what the person who brewed it intended it to taste like, taking into account the style it is supposed to be. There's a good argument that you should always eat the dish the way the chef intended you should, and not to add extras such as seasonings. Or to put it another way, there are good reasons why brewers will often tell you the beer is at its best at the brewery, where it is at its freshest. When you have done that move to point two and taste it. Did you hit the nail on the head with your own beer? If so drink it now, don't keep it. If the commercial beer matches its description, you should do the same.

But what if it doesn't match expectation? Then you ask yourself where it differs from what you expected, and whether any flavor aspect sticks out and unbalances the beer. If there is an obvious fault, is that one that will disappear with age, or will it get worse? If it is the latter, drink it now. For example, if the alcohol stands out and the beer tastes a little hot, then that might well mellow out with keeping. But if the beer is out of balance because it is over-attenuated and tastes thin, that won't change on storage, so drink it up. Similarly, if the beer is too bitter or too hoppy in general it won't improve with keeping, so use it up quickly. If it is a little too sweet that can be reduced by keeping it so long as some yeast is still present, although this can result in over-carbonation, and might be better cured by keeping it longer in bulk in the secondary. It should be clear that any hint of oxidation, such as a cardboard flavor, or any sign of infection, such as over-acidity means that the beer is doomed.

The last three points go together, and help you to guard against wasting a good beer. A beer that improves with aging will generally only do so for a certain period. After that it will drop off the cliff very rapidly, so you want to catch it before it does so. Also, it will tell you whether there is any improvement after, say, a year or eighteen months. If not there is probably never going to be any, so best get it down your throat now.

What styles do I suggest might be worth keeping? Well, any beer below 6% ABV should not be left to hang around — alcohol is a great preservative. Lager beers in general do not improve over time, as they have done their mellowing in the lagering stage. Highly-hopped beers are not candidates for long maturing as hop aroma characteristics can spoil through oxidation and hop bitterness can fade with time, throwing the beer out of balance. So we are basically looking at big, malty beers, such as barleywines, imperial stouts and the inaccurately-named imperial porters. Very strong lagers (Samichlaus from Austria at 14% ABV comes to mind) will also keep well, although it could be argued that they do not actually improve but simply maintain their level of quality. There is also an argument that big beers flavored with chocolate, coffee, oak, and so on can benefit from maturation if the flavor has not melded in to give a balanced drink. Similarly, such as an imperial stout aged in a whisky or bourbon barrel may take a little while to mellow out, although those from craft brewers are generally only released when the brewer considers them ready to drink.

How to cellar beer

There are a number of points to take into account in order to get the best results when aging beer.

1. Brew the cleanest beer you can
2. Store cool
3. Keep away from light (artificial or natural) as much as possible
4. Use only brown bottles, avoid green or clear ones
5. Check as often as you can how the beer is doing

The first point is that you must be scrupulous about cleaning and sanitizing all vessels. You may find it boring that pundits keep offering this advice, but a brewer is first and foremost a cleaner. You also want to avoid hot side aeration, which is often the cause of introducing the precursors of staling compounds into the beer, and cellaring will give them ample time to convert them into compounds giving off flavors, such as wet cardboard tastes. And, of course you want to avoid oxygen pick-up as much as possible, so avoid splashing whenever the beer is transferred. It is probably best if you can age in bulk in a stainless steel keg rather than bottling, which can easily introduce both oxygen and bacteria. If you do bottle the beer, then use a counter-pressure filler, make the beer "fob" over the top of the bottle, and use oxygen scavenger caps. And finally, keep the yeast in the beer at as low a level as possible, just enough to permit conditioning to take place, which shouldn't be a problem in the timeframe we are talking about. I know that yeast will help to keep oxygen levels down, but in a beer kept for months or even years it can also undergo autolysis and produce unwelcome flavors.

The second point is very important because the rate of chemical reactions, such as oxidation and staling are accelerated as the temperature is increased. You may think you have a nice cool basement when you lay the beer down in winter, but how much does it warm up in the summer? The maximum you really want is 52 °F (11 °C), which isn't always easy to achieve. My basement is pretty good, but in a New England summer it can sometimes get up to 70 °F (21 °C). I overcome that with a beer freezer kept at around 45 °F (7 °C). If you can't keep the temperature down your cellaring experiments are doomed.

Points three and four really go together, because the ultraviolet part of the visible spectrum is no good for beer. Long exposure to it even in brown bottles will result in skunky flavors. Green and brown bottles are asking for trouble for they transmit ultraviolet light much too easily. My personal rule is also that I just will not buy a beer in a clear bottle, period.

Finally, the last point I have already dealt with, but it needs repeating. Keep an eye on the beer, and if it tastes as if it has come to a peak drink it because it can go downhill quickly. BYO

Plate Chillers

Big cooling in a small package

by Chris Bible

Wort chilling is a key step in the brewing process. It is important to bring the boiling wort temperature down to the optimal temperature for fermentation as quickly as possible. By chilling the wort as quickly as possible, the brewer helps minimize the potential for contamination of the wort and minimize the production of dimethyl sulfide (DMS) precursors within the wort. Rapid chilling of the wort also helps maximize the precipitation of protein and protein-polyphenol complexes out of the wort in the form of cold break.

Plate chillers

There are several different types of wort chillers available to the homebrewer. A plate-type chiller typically consists of numerous stainless steel plates that have been welded together in such a way as to allow hot wort to flow across one side of each plate, and cooling water to flow along the other side of each plate. The plates are made to allow liquids to flow in the gaps between each plate, with the cooling water and wort filling the gap between alternating plates.

Plate-type chillers are configured in such a way as to essentially act as a very high-surface-area-per-unit-volume counterflow chiller. For example the Blichmann Therminator has physical dimensions that are advertised as 7.5" x 4" x 3" (a volume of approximately 0.05 ft^3), but has approximately 6.5 ft^2 of heat exchange surface area. Because of this, plate chillers are very efficient at cooling wort and use the least amount of cooling water per unit heat transfer.

Plate chiller performance

Plate chiller performance is driven largely by the surface area of the chiller, the temperature difference between the hot and cold liquids within the system, and the value of an overall heat transfer coefficient. This is shown succinctly by the equation:

$$Q = U A \Delta T_{LM}$$

Where:
Q = Rate of heat transfer (BTU/hr)
U = Overall heat transfer coefficient (BTU/hr-ft^2-°F)
A = Surface area for heat transfer within the chiller (ft^2)
ΔT_{LM} = "Log Mean Temperature Difference" between hot and cold liquids

With the expressions for U and ΔT_{LM} (not shown), you can predict the performance of a plate chiller. Figures 1 (pg. 68) and 2 (pg. 69) show the predicted performance of a plate chiller for different cooling water temperatures and wort flow rates. The graphs assume a heat exchange surface area of 6.5 ft^2 — same as the Blichmann Therminator and in the ballpark of most homebrew-sized plate chillers.

Practical discussions

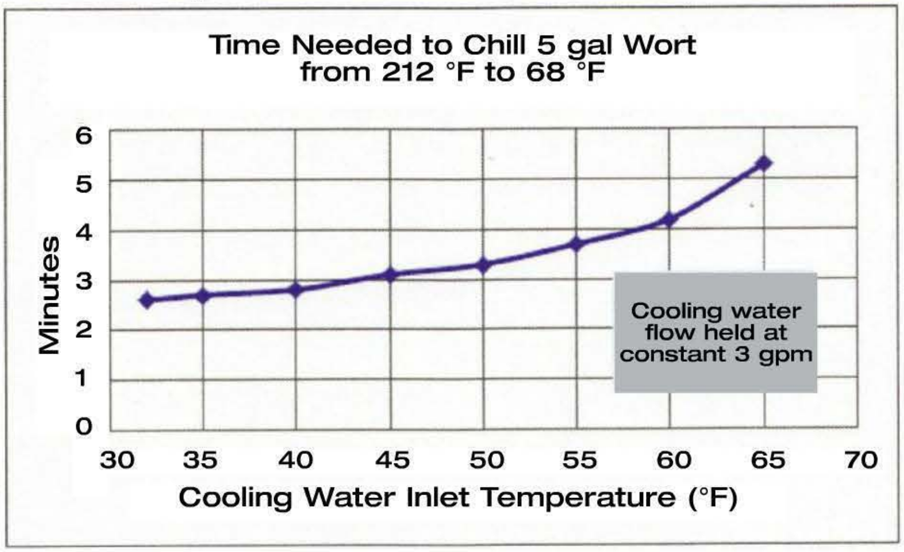
Homebrewers commonly use immersion chillers, counterflow chillers and plate-type chillers. Each type of chiller can be effective and each has positive and negative attributes. These depend upon your specific brewing equipment configuration, your wort production amounts during a brew session and your brewing technique.

Immersion chillers are very simple, inexpensive, easy to construct, easy to clean, easy to sanitize and require little maintenance. However, immersion chillers require more hands-on work from the brewer on brew day, and are not as quick to chill the wort as the other chiller types. Immersion chillers, especially if they are the smaller, 25-foot (7.6-m) long version, are not the best choice if you typically brew volumes greater than 5 gallons (19 L) per batch. It would likely take longer than desired for an immersed 25-foot (7.6-m) copper coil to chill a 20+ gallon (76+ L) batch of wort.

"Plate-type chillers are configured in such a way as to essentially act as a very high-surface-area-per-unit-volume counterflow chiller."

Photo courtesy of Blichmann Engineering

Figure 1: Effect of Cooling Water Inlet Temperature on Plate Chiller Performance



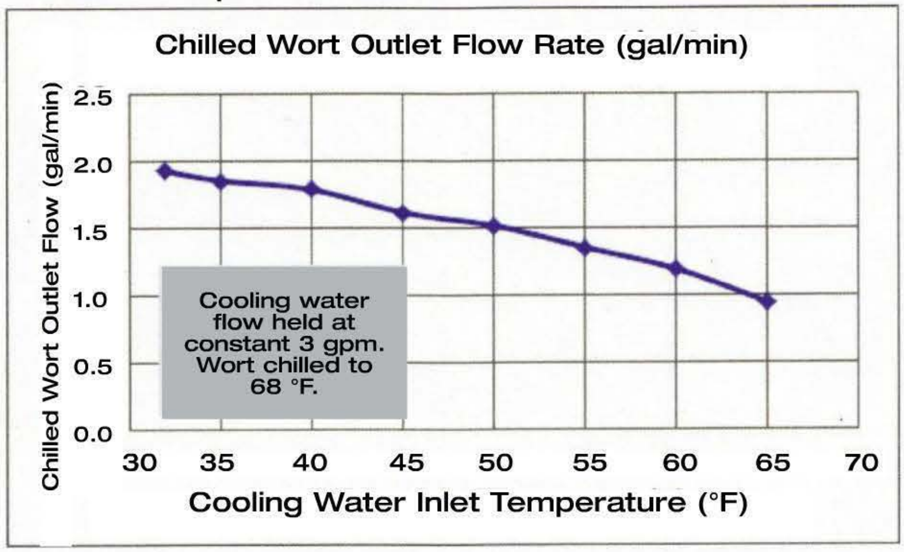
Counterflow chillers are more complex than an immersion chiller. They are also less easy to clean and sanitize than an immersion chiller. Because wort flows through an inner tube, any particulate matter contained in the wort (e.g. bits of hops or hot break material) or precipitate from the wort during cooling (e.g. cold break) has the potential to deposit on the inner wall of the tube. These deposits, if not removed, will increase the resistance to heat transfer within the system and will cause decreased heat transfer efficiency. Counterflow chillers require very little hands-on work by the brewer during the actual wort chilling operation, but do require that the brewer properly clean and flush out the system after the chilling. Counterflow chillers are a good option if you brew more than 5 gallons (19 L) at a time. Since the homebrewer can adjust both the wort flow rate and the cooling water flow rate, it is straightforward to "dial in" these variables in order to achieve your desired wort temperature.

Plate-type chillers are relatively simple and can be thought of as a very high-surface-area-per-unit-volume counterflow chiller. They also can't be constructed at home unless you are a very skilled welder who is also equipped with the necessary metal-working tools. Plate chillers are less easy to clean and sanitize than an immersion chiller, but are (arguably) easier to clean and sanitize than a conventional, coiled, counterflow chiller due to their smaller size and all-metal construction.

Plate chillers have the same issue as counterflow chillers with internal fouling, but because of their relatively small size, a plate-type chiller can usually be detached from the brewing system and be fully immersed in cleaning solution, and then be easily flushed. Due to their all-metal construction, they can also be exposed to higher temperatures during cleaning and sanitizing than a counterflow chiller with an outer pipe made of garden hose. Live steam can be used to clean and sanitize a plate-type chiller, or you can place the chiller into an oven to heat-sanitize it.

Plate chillers require very little hands-on work by the brewer on brew day during the actual wort chilling operation, but do require that the brewer properly clean and flush out the system after the chilling operation in order to remove any solid material that may have been left in the interior after chilling. Plate chillers are a good option if you brew larger volumes each batch and have the same operational advantages as the counterflow chiller. Finally, as with counterflow wort chillers, brewers can increase the rate of cooling by decreasing the temperature of the cooling water, increasing the flow rate of the cooling water or decreasing the flow rate of the wort. The figures on pages 68 and above can guide you in choosing your initial flow rates, based on your tap water temperature the first time you use your plate chiller. From there, a little tweaking of the flow rates should be all it takes to dial in your chilled wort temperature.

Figure 2: Effect of Cooling Water Inlet Temperature on Chilled Wort Flow Rate

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Fermentation Cabinet

Keep your carboys cool

by Les Svarny

How can I make my homebrew better? That was and still is the #1 question for most homebrewers. Temperature control during the fermentation is very important but it was difficult for me to control. Cooling was my problem, so I came up with this fermentation conditioner idea. I decided to take an old dehumidifier and donate it to a better cause. The only tricky challenge was reworking the Freon coil without damaging it. After that I could insert the coil into an insulated box with a gasketed door. I also needed a fan to blow air over the coil to keep the coil from icing and improve the air circulation in the chamber. The controls consisted of an external temperature controller with a capillary tube inside the box. A good dial thermometer and a vent to let the "yeast exhaust" escape completed the project. Also, safety is #1 when I build anything, especially when it comes to working with electricity.

With this build, I can hold my temperatures right on the money. The best part is that I built it all for free! I used all recycled materials from home and construction jobsites (one of the perks from being a construction electrician.) A year later I remodeled my kitchen, which left me with a nice countertop for the top of the chamber. Even if you have to buy some material, you can build this project for a reasonable cost. I recommend a helper for this project.

Safety note: Make sure there are no live un-insulated electrical components exposed while you build this chamber. Also, protect yourself by plugging the dehumidifier into a ground fault interrupter receptacle (GFI). Stay clear of all electrical connections and the compressor fan when you have the cover removed.

> "With this build, I can hold my temperatures right on the money. The best part is that I built it all for free! I used all recycled materials from home and construction jobsites."

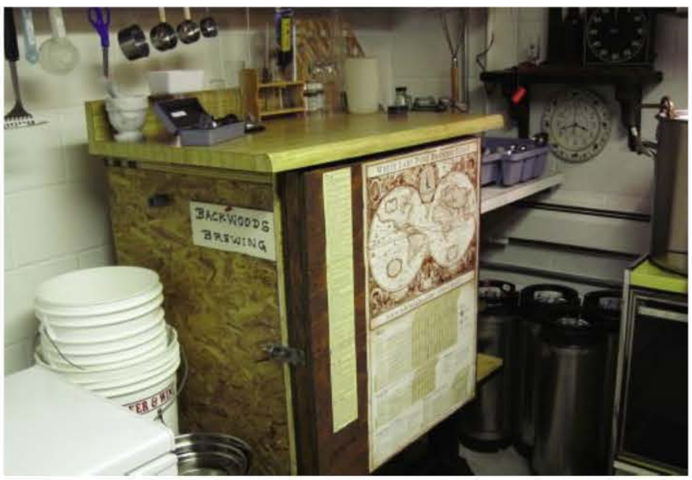
Tools and Materials

Tools
Ruler
Pencil/Sharpie
Tubing bender
Circular saw with wood blade
Sawzall w/wood and metal blades
Drill w/bits and driver tips
Holesaws
Tinsnips
Screwdrivers
Razor knife
Wire strippers/crimpers
Personal safety equipment:
- Safety glasses
- Gloves
- Ear protection
- Dust mask

Materials
Dehumidifier
Plywood/OSB (Oriented strand board)
1-inch Dowfoam insulation board
1 pair of hinges
1 hasp or latch
¼-in. x ¾-in. self-stick gasket material
Framing lumber 2 x 4's etc. (not treated)
3 Conductor 14-gauge SJO cord
Wire nuts and ring terminals
Rubber cord connectors
Unistrut and angle clips
Misc. nuts and bolts, screws
Duct seal/caulking
Computer fan with guard
Temperature controller w/remote sensor
Dial thermometer and bracket
Misc. closed cell insulation
Drip pan
Construction adhesive/glue
Ground fault receptacle (GFI)
Kitchen countertop (optional)
Paint or stain (optional)
Misc. ¾-in. PVC fittings (optional)

1. HARVEST THE COLD COIL

Start the dehumidifier and make sure the Freon coil gets cold and the compressor cooling fan works. Unplug the power and remove the cover. See if you think it is possible to rework the coil so as to bend the tubing out away from the main appliance body. I reworked mine out 180 degrees, but 90 degrees might work too. Do this work outdoors and go slow. If you break the coil's tubing, Freon will be released, which is toxic to inhale and can displace oxygen in enclosed areas. You will also have to start over with another dehumidifier. Do not kink the tubing. Use a tubing bender to help you. Remove the coil support clips and save them for later. Now rework your coil. Remember to keep a temporary support on the coil all times until you add the permanent support back in step 3. Test the operation of the modified dehumidifier. Make sure the coil still gets good and cold.



2. BUILD YOUR INSULATED BOX

My box started out with a piece of galvanized ductwork 24 inches (61 cm) wide x 26 inches (66 cm) high x 24 inches (61 cm) deep (open on both ends). Next, I insulated it with a layer of 1-inch (2.5 cm) thick Dowfoam board insulation, followed by an exterior layer of plywood and OSB board. You could make your box any size, just make sure your fermenter and airlock will fit inside comfortably. My box can hold two fermenters.

Next add an insulated door with a pair of hinges and a hasp or latch. I also used ¼-in. x ¾-in. wide self-stick gasket material to give the door a good seal.

Finally, cut a window in the lower back corner for your Freon coil. Take a little time to figure out exactly where you think it would work best for you. Make it big enough so as not to damage your coil while inserting it later. You will end up insulating this opening anyway.

3. ASSEMBLE AND SUPPORT

I mounted my insulated box and dehumidifier on a common piece of ¼-in. thick plywood. Mine was 26 inches deep x 42 inches wide. First I mounted the box, then carefully inserted the coil into the previously created window in the box. I then fastened the dehumidifier to the base plywood.

Next I made a stand. Mine is 16 inches (41 cm) high. Note that this stand MUST be strong and sturdy as it will have a lot of weight on it when you have full carboys in it. Make sure you fasten this base plywood to the stand securely. Wood screws worked well for me.

Now it is time to support the Freon coil. I used a short 11-inch (28-cm) piece of Unistrut with a 2 x 2 Unistrut angle bracket fastened to the bottom of the box. I then used the coil clips I saved from the original support in the dehumidifier. Be careful not to pinch or clamp the coil too tight so as to cause a leak.

Finish this step by insulating the window at the coil. Soft closed cell packing foam worked well for me.

4. ELECTRICAL CONTROLS AND FAN

SAFETY NOTE: Electrical work should only be done by a qualified person. All electrical components and all metal parts must be properly grounded. Also, proper use of ground fault interrupter receptacles (GFIs) should always be used to prevent electrical shock.

The temperature controller is mounted in a convenient spot outside the box, with clear vision of the set point temperature dial. I drilled a hole into the box near the ceiling and mounted the sensor on the ceiling with a little plastic one-hole strap. Be careful not to kink the capillary tube. Seal the hole with a little duct seal. I used 3-conductor 14-gauge SJO cord from the controller to the compressor junction box. It is wired to have the contacts close on temperature rise. Follow this by mounting a computer fan in front of the Freon coil. I used a little piece of predrilled angle iron and a few nuts and bolts. This fan is also wired with 3-conductor 14-gauge SJO cord. It is wired to run full time, even when the compressor is not running. Make sure your fan has a guard or screen.

5. INSTALL VENT, THERMOMETER AND COVER

To vent the "yeast exhaust," I drilled a 1⅛ inch hole with a holesaw near the top of the box (on the sidewall). I dressed it up with ¾-in. PVC fittings. Location is not critical, so long as it is at the top. I also added a drip pan under the Freon coil to catch any condensate. This pan could be anything lying around the house.

Next I added a dial thermometer. This item, although convenient, is not necessary. A crystal thermometer on your fermenter will work just fine.

Finally, reinstall the original cover for your dehumidifier. I had to modify mine by cutting a section of the side panel off with a Sawzall. Reinstalling this cover will keep your hands away from the compressor fan and the electrical parts. Also, make sure you seal all openings (except the vent) with duct seal, insulation or caulking. This will add to the efficiency of your unit.

6. FINISHING TOUCHES

As mentioned earlier, I added a formica kitchen countertop. It was 25 inches (64 cm) deep x 37 inches (94 cm) long with a backsplash. That worked really well for scales and test equipment. My countertop ended up at 52 inches (132 cm) above the floor. Take time to smooth all edges with a wood or metal file. Paint and stain are optional. Decorations and data sheets are easy and practical.

Finally, test it out. Make any necessary adjustments — there are always a few. If you are like me, you will start making better beers with your next batch! This will also allow you to brew your favorite flagship brews over and over with wonderful results and consistency. BYO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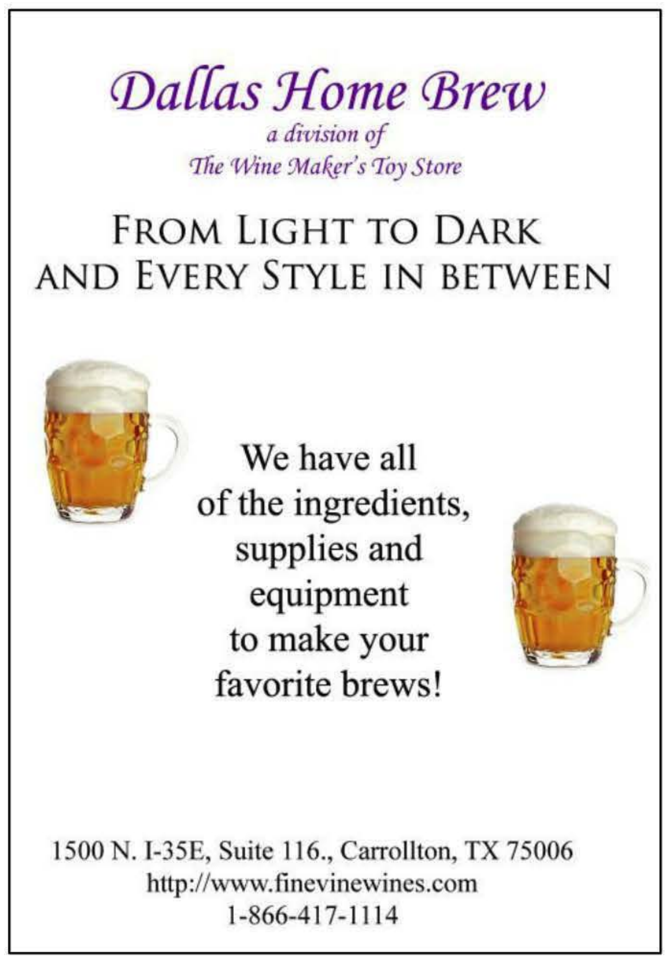
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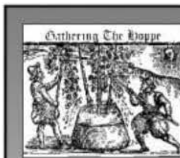

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Two Trails

A homebrewer goes pro

Rob Conery • Worcester, Massachusetts

Brewer Ben Roesch, as they say, came to a fork in the road — and he took it.

Some years back, newly minted forestry degree in hand, Roesch left the University of Massachusetts and returned to Worcester, moved in with some buddies and started scuffling for work. Pickings were slim.

As he mailed resumes, Roesch started boiling batches of beer on the stovetop in his little slacker flop house. He'd picked up homebrewing while away at school and it quickly took hold of his imagination.

Then in one week he got two job offers. One was doing forestry work for the state of Massachusetts — all-but guaranteed lifetime employment with security and a state pension. The other call was from Cambridge Brewing Company, near Boston. This job offered virtually nothing in terms of security; it was part-time with less pay and no retirement plan. Some other guy took the forestry job. Ben chose to follow his dream: brewing.

Part-time pay and a long commute didn't dull his enthusiasm one bit. On the contrary, he flourished, learning to brew on a commercial scale from Cambridge's Head Brewer, Will Meyers.

The next few years saw Roesch move from Cambridge to Wachusett Brewery to Nashoba Valley Winery, who were then expanding into brewing. At each step he basically went to a smaller operation but assumed more responsibilities. Already taking root was Roesch's ultimate dream — his own place.

In 2009 he entered into talks with Tom Oliveri Jr., scion of a Worcester family restaurant business to open a brewery. Negotiations were friendly but tough — Roesch fought to keep possession of his recipes if the business went sour and rejected the first seven contracts he was offered. Finally a deal was struck.

Roesch and Oliveri settled on Wormtown Brewery as a name. Beantown is to Boston as Wormtown is to Worcester. The old nickname was revived by a local music paper from the 70s called Wormtown Punk Punk Press, which celebrated the do-it-yourself ethos of this scrappy industrial city.

Roesch and Oliveri conspired against long odds. Worcester hadn't supported a brewery since 1962. From sourcing materials to getting pieces custom machined at the last moment, the hurdles were many. The only space available to them was in a little used annex in one of Oliveri's restaurants.

The partners cobbled together some startup funding and got busy. All the tanks were custom made. Even with cash on the barrelhead, this proved difficult. Nevertheless, Roesch fought to source locally, even forgoing one Canadian bid that would have delivered working tanks months earlier and for less money.

Wormtown Brewery opened on St. Patrick's Day 2010, just in time for the big Irish parade that careens down Park Ave. They brewed 700 barrels of beer that first year.

Three years operational and growing rapidly, now with one part-time and three full-time employees, Roesch still tries to source locally. Even if it sometimes means a 150% price premium he says, "I want to know my hopsters, I want to know my farmers." Every Wormtown beer contains some local ingredients — their motto is: "A piece of Mass in every glass."

Roesch is happy riding the homebrewer-turned-professional gig as far as it'll take him. The other guy who took the forestry job? Roesch knows the guy, they talk. But he has no regrets. He brews beer for a living. BYO

"Every Wormtown beer contains some local ingredients — their motto is 'A piece of Mass in every glass.'"

Photo Courtesy of Rob Conery


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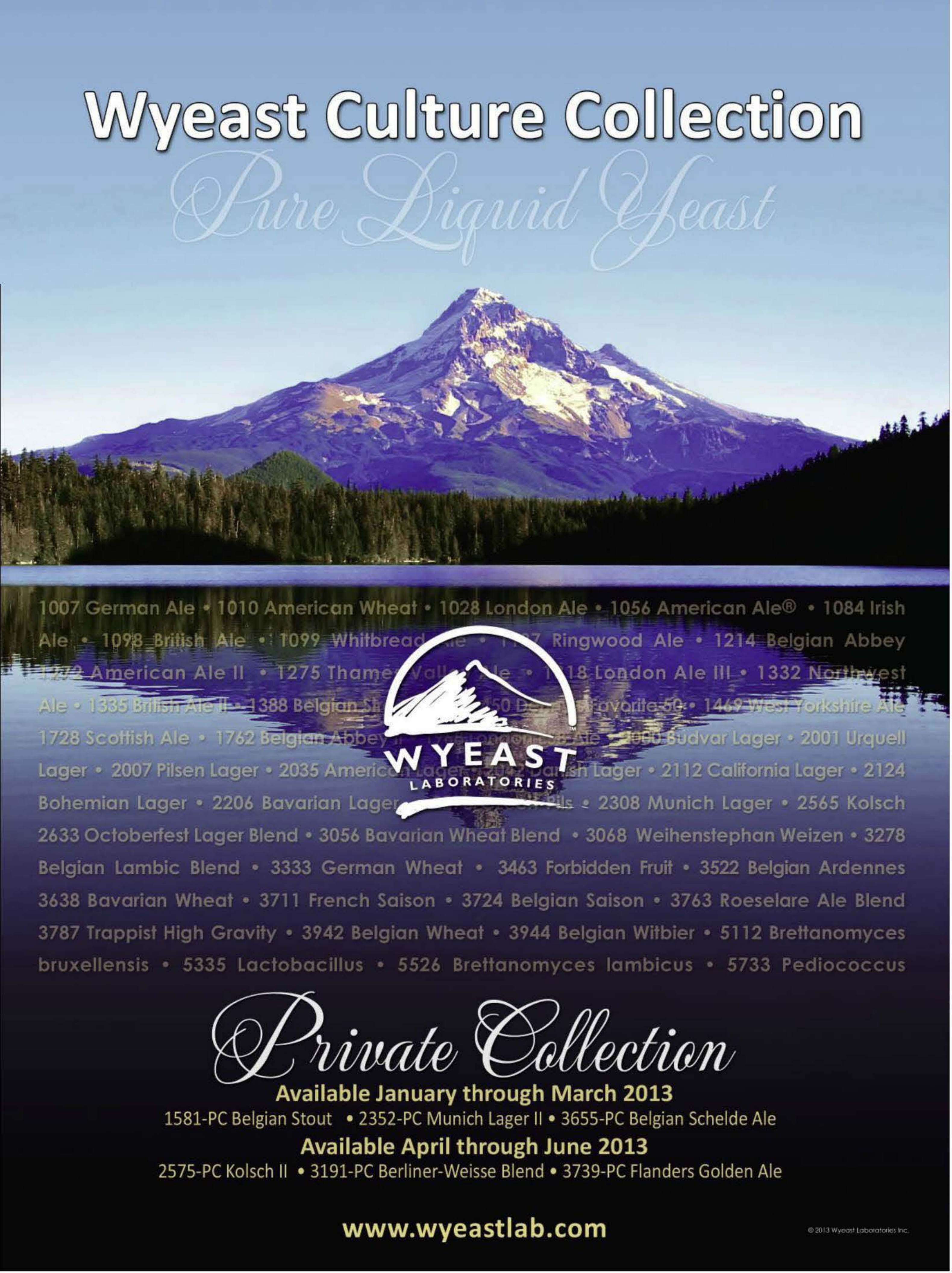
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