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Brew YOUR OWN

THE HOW-TO HOMEBREW BEER MAGAZINE

NOVEMBER 2011, VOL.17, NO.7

BUILD THIS ULTIMATE HOME BAR!

Step-by-step bar plans designed for homebrewers by homebrewers

Mastering Sour Beer Techniques

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make it bigger, easier, better


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savor the moment


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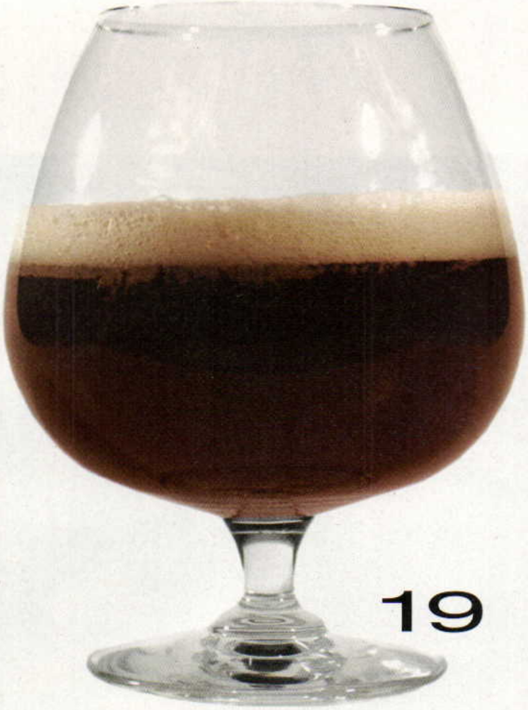

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BYO RECIPE STANDARDIZATION

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.

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

Build a Cast Tap Handle

Wood and chalkboard taps are great for your home bar, but if you are looking for a way to really customize, try making your own custom cast tap handles.
www.byo.com/component/resource/article/357

Build a Pump in a Toolbox

BYO reader Travis Glazier builds the pump in a toolbox project from the October 2009 issue of *Brew Your Own*. Watch how he constructed the project, then visit his blog for more information about Travis at cnybrew.com.
www.byo.com/videos/24-videos/1810

Build More Brewing Equipment

If half the fun of homebrewing is building your own hardware, check out *BYO*'s online directory of DIY projects. You can find instructions for making everything from a mash paddle to a temperature-controlled fermenter!
www.byo.com/stories/projects-and-equipment

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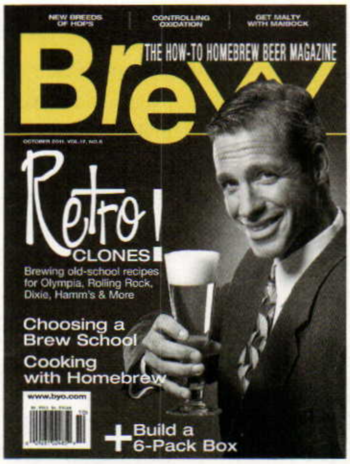

Whose hops?

I'd like to give kudos to Joseph Alonzo's article on new hop varieties in the October 2011 *BYO* magazine. Very interesting and memorable, and cool photos! Looking forward to sampling some of these new varieties some day.

Mike Duppong
Twin Falls, Idaho

Glad you liked the story. To be fair, though, the sidebar on new hop varieties was written by James Spencer (host of the Basic Brewing *podcasts). Joseph Alonzo took the photos and wrote the main story on aroma hop breeding in Oregon.*

Maibock I

I'm reading Jamil's Maibock recipe (October 2011) and I have a quick question on mash temperature. He says that conversion may take 90 minutes at a "low" temp of 154 °F. In my experience, 145 °F is a low temp, not 154 °F. Is this a misprint or is 154 °F the correct mash temp?

Amanda Kertz
via email

The mash temperature (154 °F/68 °C) is correct; the advice that the conversion may take 90 minutes at that "low temperature" was a line inadvertently carried over from a previous recipe. Sorry if this caused any confusion.

Maibock II

15-L starter? I hope the decimal was omitted. Else you have a 4-gallon starter for a 5-gallon batch of beer.

Gordon Maness
via email

It takes a lot of yeast to brew a high-gravity lager. Lagers are generally pitched at about twice the rate of ales and high-gravity beers require higher pitching rates than normal beers to achieve an ordered fermentation that finishes at a reasonable final gravity (FG). Combine these two facts and you get a 4.0-gallon (15-L) yeast starter for a 5.0-gallon (19-L) batch of Maibock, an OG 1.070 lager.

contributors

Christian Lavender is an Austin, Texas area homebrewer and the founder of HomeBrewing.com, a website that helps brewers find the best prices on homebrewing kits and homebrew supplies. He also runs Kegerators.com, a website for those looking for home draft equipment. You can ask him draft-beer related question at the site's "ask an expert" section.

Previously, Lavender has written about building a 10-gallon (38-L) fermenter from a half-barrel keg (July-August 2011) and how to build a kegerator-friendly hop filter (similar to a Randall).

On page 52 of this issue, he describes how to build a bar around a homebrew kegerator. Serve your beers in style from this brewing-inspired bar design.

Michael Tonsmeire is the blogger behind the Mad Fermentationist (www.TheMadFermentationist.com). There, he discusses a wide variety of fermentation-related topics. These include beer, but also include sake, vinegar, cider and cheese. He is a big fan of sour beers and wrote about adding fruit to sour beers in the September 2010 issue of *Brew Your Own*.

This year, in the July-August issue, he wrote about the burgeoning interest in saisons among American craft brewers.

In this issue, on page 32, he gives an overview of the many techniques used for producing sour beers and advice for first-time sour beer brewers.

Ashton Lewis is the Process Engineer for the Paul Mueller Company of Springfield, Missouri, fabricators of stainless steel vessels for a variety of industries, including the brewing industry. He is also Master Brewer at their brewpub, Springfield Brewing Company, a showcase for their brewpub vessels and design.

Ashton has been *Brew Your Own*'s Technical Editor since the first issue of the magazine in 1995. He also writes the "Mr. Wizard" column, something he did anonymously for the first 10 years of *BYO*.

In this issue, Ashton — in the guise of Mr. Wizard — answers questions about dry hopping, IBU calculations and repairing stainless steel that has been pitted by contact with bleach.

A handy resource for calculating pitching rates can be found at mrmalty.com. This is Jamil Zainasheff's website. The pitching rate calculator (found in the Yeast Tools section of the website) allows you to pick the type of beer (ales, lagers, etc.), volume and the type of starter (simple, stirred, continuously aerated, etc.). It then estimates the volume of the yeast starter you would need to make to yield the proper amount of yeast.

Note that, in this case, the size of the starter drops to 6 L, about 1.5 gallons, if you pitch the starter with two packages of commercially-produced liquid yeast instead of one. If you continuously aerate that starter, the required volume further drops to 3.4 L (less than a gallon).

A 1.5-L yeast starter would not raise nearly sufficient yeast for this beer.

Petite problem?

I recently brewed the recipe for the Petit Saison ("The Cult of American Saison," by Michael Tonsmeire, July-August 2011) and before I racked to the secondary fermenter and dry hopped, I asked a guy at my LHBS about the Roeselare blend. He suggested that I let the beer sit in the primary for about a year to avoid having bottle bombs and letting the bacteria have time to fully develop. I posted this concern on the homebrew forum of *Beer Advocate* and the general consensus was to let the beer sit for a year before bottling. The reason behind this email is I wanted to bring this to your attention and also after using that blend your primary fermenter plastic bucket should only be used for sour beers because the bacteria will always come through when using that bucket from now on. I think this information is important for the readers and should be shared.

Cory McArthur
via email

Letting this beer age for a year before bottling is excessive. The Petit Saison is a low-gravity beer, OG 1.036. The wort is made from mashing the grains at 145 °F (63 °C) for 90 minutes, creating a highly fermentable wort. The saison yeast strain is highly attenuative and the fermentation temperature is allowed to rise to the mid 80s °F (around 29 °C). All this leads to a very dry beer, one with few fermentable carbohydrates left. (The projected FG is 1.002.) This beer is meant to be drank fresh and aging it for a year will simply mean that all the hop character, which is an integral part of the beer, will be gone.

Jolly Pumpkin's Bam Biere, a petite saison, is only aged in barrels about two weeks before bottling and we would suggest that this is a reasonable time frame to aim for. As *the recipe states, check that the gravity has stabilized. If it has after being dry hopped, go ahead and package the beer. Since this low-gravity beer is intended to be drank while it is young and fresh, you should be able to tell from drinking it if excessive carbonation is building up in the bottles from the slow, continued action of* Brettanomyces. *(If so, call your friends and have a party. Or, pop the caps on the remaining bottles to release the extra pressure, then quickly recap.)*

Also, the bucket will be fine if it is unscratched and you clean and sanitize it properly.

Blending with booze

In your September 2011 issue, in the "Tips from the Pros" section, you did a thing on beer blending. Blending different beers together to create a unique brew is a great idea. I have also found that blending beers with liqueurs also produces some outstanding brews. Maybe you could do a section on blending beers with liqueurs also. I am a homebrewer and have combined several different beers with different liqueurs. Both family and friends seem to like the combinations.

Jeff Taynor
Mughead Brewing Company

Editor Chris Colby responds: "In winemaking, blending plays a major role. In contrast, few homebrewers practice blending. Commercially, Belgian lambic brewers blend many of their beers. In addition, many large breweries blend different batches of the same beer to achieve a higher level of consistency. (The practice of high-gravity brewing — brewing a strong beer, then diluting it to serving strength after fermentation with deaerated water — is sometimes also called blending.)

"As mentioned in the article, finished beer can also be blended with other beers or beverages to make beer cocktails. (One traditional blend not mentioned in the article is blending small amounts of Woodruff or raspberry syrup into a Berliner weisse.) Beer can be blended at almost any stage in the brewing process. Another possibility — albeit one that has much more to do with me needing to fill this last bit of space in the "Mail" page than being a serious brewing suggestion — would be to experiment with blending different worts prior to fermentation. (This is actually done in some forms of parti-gyle brewing.)

"Blending beer with liquor (or liqueurs) could lead to some interesting mixes. (I suspect that it could also produce some vomitous concoctions in the wrong hands.) I've never mixed beer with hard liquor, but a friend of mine (Joe Walton) once blended whiskey with freshly run off wort on a brew day of ours. It was surprisingly good." BYO

homebrew nation

READER PROFILE

Brewer: Jon Larson

Hometown: Portland, Oregon

Years brewing: Eighteen

Type of brewer: All-grain

Homebrew setup: I am in the process of moving from an insulated cooler 10-gallon (38-L) set up to a fancy Brew Magic system. Efficiencey around 80–85% with the cooler setup (and I attribute much of that to my brew partner Aaron's Rube Goldberg-esque grain mill).

Currently fermenting: 2011 India Ink Imperial Stout (see recipe at right), Revolution/Evolution Imperial IPA with Magnum hops fresh from the garden, a hard cider and a Marionberry melomel.

What's on tap/in the fridge: Belgian Cascadian Dark, Czech Pilsner and Session Bitter. There is also one empty tap waiting to be filled.

How I started brewing: It all began in college as brewing was a source of fine suds for me and my friends, but it quickly became much more. Once I moved to Portland, Oregon, things took off again. Everybody here is into beer — drinking, brewing, experimenting, pairing, you name it. That was when I made the switch from extract to all-grain brewing. Now I have four taps in the basement (thus my brewery's name, Basement Brewing), and every brew day I have around 15 to 20 good friends who are willing to help me out with the arduous task of sampling and draining the kegs. What swell folks, eh? These days my homebrewing has the potential for becoming a nano brewery. So I will keep brewing, refining my recipes and packaging and maybe — just maybe — I will get licensed to share my brews with more people. Because after all, isn't that what it is all about?

My blog/website: www.basementbrewing.com

reader recipe

2010 India Ink Imperial Stout (5 gallons/19 L, all-grain)

OG = 1.083 FG = 1.021
IBU = 100+ ABV = 8.0%

Ingredients

6.5 lbs. (3 kg) American 2-row pale malt
6.5 lbs. (3 kg) Maris Otter malt
2 lbs. (0.9) light Munich malt
0.75 lbs. (0.34 kg) crystal malt (80 °L)
0.75 lbs. (0.34 kg) CaraMunich® malt
0.625 lb. (0.28 kg) roasted barley
0.5 lb. (0.23 kg) chocolate malt
21 AAU Magnum hops (60 min.) (1.5 oz./43 g at 14% alpha acids)
24.5 AAU Magnum hops (20 min.) (1.75 oz./50 g at 14% alpha acids)
12 AAU Cascade hops (knockout) (2 oz./57 g at 6% alpha acids)
1 Tb. gypsum
1 tsp. Irish moss
Wyeast 1056 (American Ale) yeast

Step by step

Single step infusion mash using 5.75 gallons (22 L) water to mash at 150 °F (66 °C) for one hour. Sparge with 170 °F (77 °C) water and collect 7 gallons (26 L) of wort and bring to a boil. The total boil time is 75 minutes with hop additions as listed in the ingredients.

Cool to 68–70 °F (20–21 °C) and pitch a ½-gallon (1.9-L) yeast starter. Ferment two weeks in primary. When fermentation is finished (I racked it at 1.014), rack to secondary fermenter.

Force carbonate and keg or bottle and age.

byo.com brew polls

Do you plan to expand your homebrewery this year?

Yes 78%
I Wish! 17%
No 5%

social homebrews

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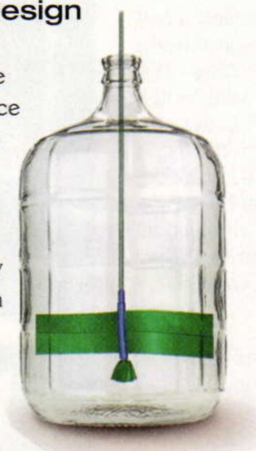
Follow *BYO* on Twitter at: @BrewYourOwn

what's new?

Clean Bottle Express from Third Coast Design Works



The design of Clean Bottle Express™ uses a spiral force to make your bottle cleaning experience quick and painless. All Clean Bottle Express™ bottle washers are designed to fit into any standard cordless drill with 1000 rpm motor. Simply attach to the drill, insert into your bottle and press the trigger of your drill to remove any debris or old deposits from inside your beer, wine or carboy bottle.

www.thirdcoastdesignworks.com/Products.html

Tri Clover Filter Strainer

Place this new strainer from Brewer's Hardware between your kettle outlet and pump and a plate chiller to reduce the amount of debris that makes it into the plate chiller and ultimately into your fermenter. The relatively large pore size still allows some trub through for healthy yeast and fermentation. The large 3-inch (7.6-cm) Tri Clover clamp between the body and the lid allow for easy disassembly and cleaning. If you want or need finer filtration, optional 0.2-mm and 0.3-mm filter nets are also available.

www.brewershardware.com/FILTER1.html

calendar

November 4-5
Goodlettsville, Tennessee
Music City Brew Off

Nashville's Music City Brewers will hold their 16th annual homebrew competition, featuring speaker Gordon Strong, president of the BJCP, Ninkasi award winner and author of the new book, *Brewing Better Beer*. The Brew Off also features the MCB's annual "Club Crawl" where regional clubs can bring their beers to showcase.

Entry Fee: $7 ($10 for entries in the "HopGod" category)
Entry Deadline: October 14
Email: bigjohn3957@gmail.com
Web: www.musiccitybrewers.com/brewoff.php

November 12
Fort Worth, Texas
Spirit of '76 Challenge

The Spirit of '76 Challenge, sponsored by the Horsemen of the Hopocalypse, seeks to acknowledge veterans by celebrating beer styles that are uniquely American. A list of accepted styles can be found at the event website. The competition also includes a special Category 76, which will be judged by a panel of servicemen from each branch of the armed forces, based simply on which they like the best.

Entry Fee: $7
Deadline: October 21
Email: comp_coordinator@hopocalypse.org
Web: http://spiritof76.hopocalypse.org/

November 27
Ocean City, Maryland
West Coast vs. East Coast

The Ocean City Maryland Homebrew Club (OCMHBC) invites all homebrewers to enter the first-ever West Coast versus East Coast brew off. The competition is one of the first in a series of week-long events devoted to beer in Ocean City, Maryland. The best of show will win an engraved tear drop trophy and a certificate for a free entry in the AHA National Homebrew Competition.

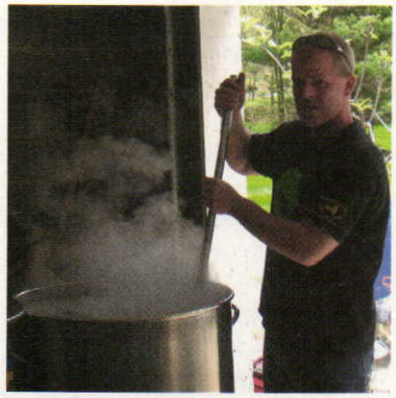
Fee: $5 for the 1st entry, $4 additional entries
Deadline: November 21
Email: sunflowerbrewhouse@comcast.net
Web: http://westcoastvseastcoast.brewcompetition.com/

homebrew drool systems

The Portable System

Ed Elliot • Kingston, Pennsylvania

I have been homebrewing for about three and a half years, the last two of which have been all-grain using my 15-gallon (57-L) gravity fed system. While on a visit to a local scrapyard, I came across what would become the heart of my new 50-gallon (189-L) system: three 54-gallon (204-L) stainless steel pots with lids, in very good condition, which I purchased for scrap price. After about a year of DIY, gathering parts and learning how to weld, I debuted my new system on National Homebrew Day at a gathering of the Wyoming Valley Homebrewers Club in Northeastern Pennsylvania.



On that first big brew day I brewed 44 gallons (167 L) of a fairly standard pale ale, and hit 75% efficiency. My plan for the big brew day was to split up the wort into eight separate 6-gallon (23-L) fermenters (three of which I kept, and the other five I gave away to club members), and give each fermenter a different treatment, including yeast, dry hops, honey, etc. At the July meeting we all brought in samples of the "different beers" for everyone to try.

The system is a single tier, pump driven system with a direct-fired mash tun, capable of doing single infusion and step mashes with full recirculation. The tun features a homemade false bottom made of a sheet of perforated stainless (also a scrapyard find). The same material was used in the standoffs, and the pickup tube is actually underneath the false bottom so it doesn't get knocked around while doughing in.

Two 185,000-BTU burners heat the hot liquor tank (HLT) and boil kettle, and a 55,000-BTU burner heats the mash tun. In the future I want to upgrade with stainless ball valves, bigger pumps and built-in thermometers. I plan on using this system two or three times a year, splitting the batches up like we did for National Homebrew Day.

I look forward to many years of use of this system, as well as many years of brewing with my fellow club members and friends. And the best part of the whole setup is that this system is completely portable, and can fit in an SUV or Minivan — perfect for transporting to club brew days!

beginner's block

YOUR FIRST FERMENTER

by betsy parks

One of the most important pieces of equipment in your brewhouse is the humble fermenter. This is the vessel where your wort becomes beer, so it is important that you select your first fermenter wisely. Choosing a basic fermenter at your local homebrew shop is easy: walk in the door and someone will point you in the direction of a display of buckets and carboys. But although the selection process is simple, you should have your basic brewing needs in mind before you shop.

What you need

A proper fermenter needs to have a few features: it must keep air out while keeping beer in, it should be big enough to hold your batch of wort while allowing some space for foaming during primary fermentation and it needs to be a size and shape that you can move around your homebrewery. The most common first fermenters are food-safe plastic buckets, or glass or food-safe plastic carboys.

Size and style

When choosing a fermenter, consider the volume of your beer and the type of material you prefer.

First, make a mental note of your planned batch size. Fermentation will cause foaming and bubbling, so you will need a vessel with more space than the actual volume of beer. For instance, many homebrewers start out with 5-gallon (19-L) batches, which can produce around a half gallon (1.8 L) or so of kräusen, so it would be wise to choose a 6 or 6.5-gallon (23 or 25-L) fermenter.

Next, decide what type of fermenter would be best for your needs. Fermenters are most often made of plastic, glass or stainless steel, and each has their advantages and disadvantages.

Plastic bucket fermenters and polyethylene terephthalate (PET) carboys are lighter than glass and don't shatter when they are dropped, so they are easy to move around. Plastic buckets are inexpensive, simple to clean because of their wide openings and are often equipped with a spigot, which makes racking easy. However, plastic can be easily scratched, which can make these types of fermenters difficult to sanitize over time. Plastic is also not impermeable to air, which isn't an issue during primary fermentation when there is a lot of CO_2 present to protect the wort, however, if the beer is left for too long in a plastic bucket after primary fermentation it is vulnerable to oxidation.

Glass carboys are impermeable to air, so the beer does not need to be racked to a secondary fermenter after primary (if the beer needs secondary fermentation). Glass cannot be scratched when scrubbed and the surface is easily sanitized. Glass carboys are more expensive than plastic buckets, however, and they and their PET counterparts are more of a challenge to clean because of their small openings. Also, because they don't have spigots, the beer must be racked using a siphon.

There is also the option of using a stainless steel fermenter, although stainless steel is more expensive and might not be in a beginner brewer's budget. Stainless steel conical fermenters can cost around $500 for a basic model and increase in price up into the thousands of dollars based on size and specifications. However, for those just starting out, stick to a budget with plastic or glass, then move up to stainless steel when you're ready to grow.

by marc martin

DEAR REPLICATOR, ONE OF MY FAVORITE BEERS IS MOOSE DROOL FROM BIG SKY BREWING IN MISSOULA, MONTANA. I HAVE LOVED THIS BEER FROM THE FIRST TIME THE NAME OF IT CAUGHT MY ATTENTION. WHILE IT IS AVAILABLE IN MY AREA, I WOULD LOVE TO BE ABLE TO HAVE THE RECIPE SO I COULD REPLICATE IT AND PUT IT ON TAP FOR MY FRIENDS TO ENJOY. THIS BROWN ALE IS WONDERFULLY BALANCED AND THOSE THAT ARE OUTSIDE OF THEIR DISTRIBUTION AREA ARE REALLY MISSING OUT.

CHRISTIAN BOEHIKE
CHEYENNE, WYOMING

Homebrewing roots run deep at Big Sky as co-owners Neal Leathers and Brad Robinson began making 5-gallon (19-L) batches in the mid 1980s. Neal fondly remembers his first effort with the "Wise Ass Red Bitter" from Charlie Papazian's book *The New Complete Joy of Homebrewing*. This recipe evolved into their first commercially-brewed beer, Whistle Pig Red Ale.

To gain recognition in the community when they first started out, the two created and hosted a show called "Beer Talk" on the Missoula cable access television station. This gained the attention of Bjorn Nabozney, a local college student finishing his BA degree in finance. He offered to write a business plan for their brewery and the three were on their way.

After acquiring a suitable building and a 30-barrel system, they produced their first batch of Whistle Pig in mid June of 1995. Moose Drool Brown and Scape Goat Pale followed a couple of months later.

Soon they needed a head brewer, so thankfully Matt Long, another local college student studying microbiology was following his dream of taking his homebrewing hobby to the next level at the time. He completed the American Brewers Guild remote study program and was hired by the Lost Coast Brewery in Eureka, California. After a year he wanted to get back to Montana and in the fall of 1996 began brewing at Big Sky.

These days Big Sky boasts sales that are expected to top 38,000 barrels this year, and distribution has expanded to include 24 states. Their flagship beer, Moose Drool, accounts for almost 55% of total production.

A dense, light tan head tops this dark mahogany colored ale. It is a decidedly malt forward beer with hints of chocolate. Hop aroma is very subdued and bitterness is just enough to offset the low residual sweetness.

Christian, you can enjoy Moose Drool anytime now because you can "Brew Your Own." For more about Big Sky Brewing visit the website www.bigskybrewing.com or call them at 406-549-2777. BYO

BIG SKY BREWING COMPANY, MOOSE DROOL BROWN ALE

(5 gallons/19 L, extract with grain)

OG = 1.052 FG = 1.012 IBU = 26 SRM = 22 ABV = 5.3%

Ingredients

3.3 lbs. (1.5 kg) Muntons light, unhopped, malt extract
2 lbs. (0.9 kg) dried malt extract
1 lb. (0.45 kg) 2-row pale malt
18 oz. (0.5 kg) crystal malt (75 °L)
6 oz. (0.17 kg) chocolate malt (350 °L)
0.5 oz. (14 g) black barley (450 °L)
5.7 AAU east Kent golding hop pellets (1.2 oz./34 g of 4.75% alpha acid) (60 min.)
2 AAU liberty hop pellets (0.5 oz /14 g at 4% alpha acids) (30 min.)
2.5 AAU Willamette hop pellets (0.5 oz /14 g at 5% alpha acids) (0 min.)
½ tsp. yeast nutrient (last 15 min.)
½ tsp. Irish moss (last 30 min.)
White Labs WLP 013 (London Ale) or Wyeast 1028 (London Ale) yeast
0.75 cup (150 g) of corn sugar for priming (if bottling)

Step by step

Steep the crushed grain in 2 gallons (7.6 L) of water at 154 °F (68 °C) for 30 minutes. Remove grains from the wort and rinse with 2 quarts (1.8 L) of hot water. Add the liquid malt extract and boil for 60 minutes. While boiling, add the hops, Irish moss and yeast nutrient as per the schedule. Now add the wort to 2 gallons (7.6 L) of cold water in the 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 68 °F (20 °C) until fermentation is complete. Transfer to a carboy, avoiding any splashing. Allow the beer to condition for one week and then bottle or keg. Allow the beer to carbonate, age for two weeks and enjoy.

All-grain option:

This is a single step infusion mash using an additional 8.75 lbs. (4 kg) 2-row pale malt to replace the liquid and dried malt extracts. Mix the crushed grains with 3.75 gallons (14 L) of 172 °F (78 °C) water to stabilize at 154 °F (68 °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 hop addition to 0.9 oz. (26 g) east Kent golding hop pellets (4.3 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 grain recipe.

Growing Goals

Expanding your homebrewery

by Betsy Parks

IT IS ONE THING TO DAYDREAM OVER A STORE DISPLAY OR HOMEBREW CATALOG FILLED WITH STAINLESS STEEL, GADGETS AND GIZMOS, AND QUITE ANOTHER TO FILL OUT YOUR HOMEBREWERY WITH NEW EQUIPMENT. IN THIS ISSUE, TWO HOMEBREW HARDWARE EXPERTS DISCUSS THE RIGHT WAYS TO EXPAND YOUR BREWERY.

The biggest benefit to expanding your homebrewery, aside from increasing volume, is reducing work.

For extract brewers looking to upgrade basic setups, there are several things that you can do to expand your homebrew setup while still using extract.

First, get a kettle large enough to boil your entire wort at once instead of topping up with water at the end. The flavor impact mainly comes from not boiling with such concentrated sugars. From our experience at MoreBeer! helping thousands of homebrewers get started, this was by far the biggest single improvement people have reported back that made their beer better. This is generally a slippery slope in cost, however, as a new kettle often means buying an outdoor burner.

Next, to perform a full boil, you will need a way of getting the wort chilled down quickly, so you will want a chiller. This reduces your risk of added wild yeast and bacteria infection as well as other off flavors that can occur if you don't chill down quickly.

For all-grain brewers, I would recommend a brewing sculpture to streamline the brew day. After that, I would look at adding a refractometer for fast, easy gravity readings. It is also a good idea to look seriously into some kind of brewing software (BeerSmith is my choice, although there are many. Read Forrest Whitesides' story on brewing software in the May-June 2011 issue of *BYO* for more choices). Finally, a pump to move your liquids around is very helpful, and you should always have a good mash paddle and good thermometers.

Fermentation temperature control is also important for all homebrewers, extract or all-grain. This is really where the most flavor impact can be made on the beer as well as repeatability, so if you can afford either a fermentation chamber (like a chest freezer) or a temperature-controlled fermenter, I would recommend it.

In addition to controlling fermentation temperatures, every homebrewery could benefit from adding a water filter — it's hard to make great beer with bad water. Also, an oxygen system is handy. It is so easy to do and the yeast really benefits.

Some of the downfalls of expanding can be a problem, though, so be aware of the changes in your brewhouse. For example, things don't always multiply correctly when you scale up. Let's say you are moving from 5-gallon (19-L) to 20-gallon (75-L) batches and you have a killer 5-gallon (19-L) recipe you want to brew on your new setup. You may find that you get different hop bitterness extractions as you increase your boil kettle size.

Other expansion issues I've noticed happen when homebrewers try to add too much at once, then don't know what change made a difference in their homebrews. I am a big fan of adding one thing at a time to a brewery then waiting to see what the impact of it is. That way if something goes well you know what caused it; but better yet if something goes wrong you know what to investigate. Also, I find that adding slowly gives you something to look forward to on future brews and trips to the homebrew shop.

> "Fermentation temperature control is also important for all homebrewers, extract or all-grain."

Chris Graham, Chief Operating Officer of MoreBeer! in Concord, California. Chris has been homebrewing for more than 15 years, and has since gotten into meadmaking, winemaking, and coffee roasting. Each year he teaches the Advanced Homebrewing class at the Siebel Brewing School in Colorado. He also sits on the Brewers Association's Board of Directors and the American Homebrewers Association's Governing Council.

John Blichmann, Owner and Founder of Blichmann Engineering. John has a Bachelor of Science degree in engineering from Iowa State University and worked for Caterpillar's engine division for fifteen years. He "retired" from an engineering supervisor position to start Blichmann Engineering in 2002. He is a BJCP judge and has been homebrewing for 17 years.

My best move in my twenty years of homebrewing was moving off the stove and into full-wort boils with a larger pot and a propane burner. This not only saved my stove (and my marriage) from all too frequent boil-overs, it also allowed me to make light-colored beers like Kölsch and Pilsners that concentrated wort boils just didn't do justice to.

Full-wort boiling does necessitate moving outdoors, but a propane burner will bring your water up to temperature much more quickly than your stovetop. Buy a quality pot you can keep forever, and don't skimp on size. I always recommend a volume of about two times your batch size for a boil kettle so that you can accommodate your starting wort volume and have adequate clearance for boil-over protection. About 8 to 10 gallons (30 to 38 L) for a 5-gallon (19-L) batch is about right. And if time is your nemesis, as it is for my busy family schedule, look into high efficiency burners.

Before you delve into building your dream homebrew system dripping with stainless steel and sexy digital controls, develop a well thought out, long-term plan. Not a plan for a year down the road, but for the next five to ten years. You're about to invest in expensive equipment that you don't want to replace after a couple of years because it no longer fits into your plans. The most important decision is whether or not you eventually want to move into all-grain brewing, and if so, what batch sizes you want to brew. Keep in mind that making 10 gallons (38 L) of all-grain beer doesn't take much longer than 5 gallons (19 L). However, if you brew frequently 10-gallon (38-L) batches may tax your storage facilities.

Also, I did a presentation at the 2010 National Homebrew Conference discussing the organization and efficient layout of your home brewery, which you can read at this link: www.ahaconference.org/conference-information/presentations/2010-presentations/. Without a good brewery layout, you'll waste a ton of time searching for things. BYO

Dry Hopping

Continual hopping, stainless steel

by Ashton Lewis

Q I AM AN AVID BREWER AND ALSO AM A BIG FAN OF THE HOPPY BEERS BREWED BY SO MANY US CRAFT BREWERS. WHEN I TRY BREWING THESE STYLES, HOWEVER, I AM DISAPPOINTED WITH THE HOP AROMA IN MY BEERS AND AM A BIT LEERY TO USE DRY HOPPING. WHAT SUGGESTIONS DO YOU OFFER?

DAN DOLAN
HANNIBAL, MISSOURI

A The envelope of hoppiness has been pushed and pushed by US craft brewers over the last thirty years, and the most common trait of these very hoppy brews is the lovely aroma of fresh hops. The preferred technique in making these beers is dry hopping.

I have stated many times in the past that dry hopping does not introduce spoilage organisms to beer and I think the popularity of dry hopping today is good anecdotal evidence in validating the method. There are certainly different schools of thought about how to go about dry hopping, however. Many brewers use pellet hops and others swear by cone hops.

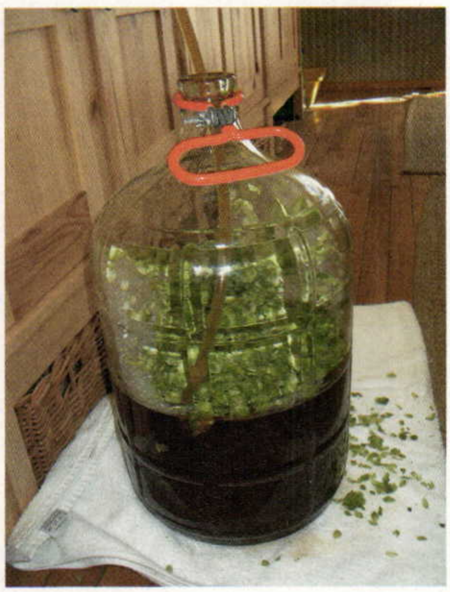
Brewing large volumes of dry hopped beer presents production challenges, both for those brewers using pellets and those using cone hops. If you use pellets, the hops are typically added to the top of the fermenter. This is not a big deal for pub brewers, but breweries with bigger tanks have logistical challenges, such as humping relatively large quantities of hops to the top of the tank. Then there is the issue of gas break out, which is when the beer sometimes begins to fountain out of the tank as the hop pellets dissolve and act as gas nucleation sites for gas release.

Some brewers who use pellets have adopted methods to dissolve the hop pellets in beer or water and then to pump the hop preparation into the beer to be dry hopped. Others have developed hop conveyors to deliver hop pellets to the top of the tank.

Then there are the brewers who only use cones. The method many craft brewers prefer is to use a hop bag to hold the whole cones during the dry hopping process. Some brewers toss the bag through the side of the tank, some hoist big bags up through cone bottom manways and others add them from the top of the tank. This makes hop addition and removal easier than simply dumping in a bunch of loose hops and then having to remove them from the tank after racking. I've brewed beers using this method and I can assure you that the cleanup is a major pain in the backside. Several years ago Sierra Nevada started experimenting with ways to sequester hops in a container that beer could be pumped through without having the hops in the fermenter and along came the hop torpedo.

The bottom line is that the hoppiest monsters on the planet use some form of post-kettle hop addition for aroma, and dry hopping seems to be the most common method. I suggest brewing an IPA with a moderate OG, 14.5 °Plato (1.059 SG) is a happy medium between session beer gravity and high gravity beers with more alcohol and esters, a firm bitterness in the 50-60 IBU range and a color somewhere between golden and amber. Dry hop the beer with about 0.4 ounces of hops per gallon of beer (11 g per 3.8 L). It is best to add hops after fermentation is complete, but before the beer has been chilled for any cold aging period that you may use.

> "The bottom line is that the hoppiest monsters on the planet use some form of post-kettle hop addition for the aroma . . ."



Q

WHAT IS THE BEST WAY TO CALCULATE IBU CONTRIBUTIONS FROM CONTINUAL HOPPING?

BRIAN S GIBSON
MANCHESTER, NEW HAMPSHIRE

A

There is a basic formula that can be used to calculate the weight of hops added to wort during boiling, which is:

Hop weight (grams) = ((liters wort) * (IBU contribution of addition) * (0.001)) ÷ ((% utilization) * (% alpha acids of hop addition))

There are certain calculations that simply do not make sense converting to English units, and hop calculations are one example. The IBU (International Bitterness Unit) is expressed as milligrams iso-alpha acids/liter beer, so the calculations using IBUs are metric by nature. When crunching numbers with this equation it is important to convert the utilization and alpha acid percentages to decimals; for example, 30% utilization should be input as 0.30, not 30.

Hop utilization is the key to bitterness estimation through hop calculations. This value numerically defines the amount of iso-alpha acids in the finished beer compared to the amount of alpha acids added to the wort during boiling. If you have a beer with 20 IBUs that was made by adding only one hop addition during boiling and the hop utilization was determined to be 25%, you can determine that 80 mg of alpha acids/liter of wort (post boil volume) must have been added.

Hop utilization is not an easy value to know unless you analyze your finished beer and back-calculate utilization based on the brew. Most small craft brewers do not have the labs required for this analysis and those who do actually measure beer bitterness use outside labs. Since this analysis is not exactly cheap, most small craft brewers, and the majority of homebrewers, do not really know their hop utilizations for the various beers brewed.

Most small brewers rely on tables and equations developed by others to estimate utilization. In general terms utilization increases as wort gravity goes down and increases as exposure to hot wort increases. The hop preparation also influences utilization, with pellets usually yielding higher values than cones. And pH, kettle design, fermenter design, yeast strain and clarification method can also affect utilization.

In my experience, utilization varies between 2–35% for pellet hops added to 12 °Plato during the boil. The maximum utilization of this range occurs after about 60 minutes of boiling and the minimum is obtained when hops are added to the whirlpool after the boil. The increase in utilization with boil time is linear over the normal range of what most brewers do in the brewhouse. This means that you could approximate the results of "continuous" hopping one of two ways.

The easiest method is also the most realistic, and that is to approach the problem as a bunch of discrete additions over the course of the boil since you probably will be using pellets and not a liquid hop preparation.

For the sake of discussion purposes, I am going to assume that a batch of wort is prepared by boiling for 60 minutes, during which time 120 individual hop pellets are added to the kettle. Furthermore, let's assume that the brewer has decided on a form of self-abuse for the brew and has decided to use a timer as a reminder to add 1 hop pellet every 30 seconds for the hour boil. The math is pretty simple. Step one is to develop a regression equation based on data from others (Malowicki and Shellhammer, for example). You can easily write a formula to provide the expected utilization for each of the 120 additions. After this you calculate the IBU contribution of each addition, sum the 120 additions and now you have an educated guess about the predicted bitterness of the finished beer.

I wish I knew more about what I do today when I took calculus during my freshman and sophomore years of college. I don't remember how to use calculus, but do know its applications and there are many to be found in a brewery. For all the math whizzes out there in *BYO*-land, now is your chance to apply your integration skills to brewing. If you go all out and solve this problem by integration you really need to use a liquid hop extract preparation and design a system to deliver a constant flow rate of hop extract to the kettle. And now the problem becomes fun! You cannot simply put the extract in a burette, for example, and open the outlet valve to a set point because the flow of extract will change as the container is emptied (variable static head). I am imagining some pretty cool projects coming from this discussion.

Q IF STAINLESS STEEL HAS BEEN CORRODED BY CONTACT WITH CHLORINE BLEACH, WHAT IS THE BEST METHOD TO CLEAN AND RE-SANITIZE THE STAINLESS STEEL?

BRIAN S GIBSON
MANCHESTER, NEW HAMPSHIRE

A Another question, Brian? Stainless steel is a general term to describe a wide range of alloys that do not rust like ordinary carbon steel. The most common alloys used to make food processing equipment are types 304 and 316 stainless. Type 304 is by far the most common alloy used in the manufacture of brewing and food processing equipment. This type of steel has good resistance against corrosion when used for normal brewing and cooking applications. Type 316 stainless contains 2% molybdenum and "Molly" adds some level of protection against pitting corrosion caused by chlorides. Chlorides are present in foodstuffs that have salt as an ingredient, so if you are in the business of making pasta sauce you may want vessels made from type 316 stainless. Both 304 and 316 alloys are available as "L" grades, for example type 316L; the "L" designates low carbon and for certain applications low carbon is desired because of welding concerns.

Although types 304, 304L, 316 and 316L are well suited for brewing and cooking applications, they all can be damaged by chlorine sanitizers like bleach. Normally the pH of bleach is about 11, making bleach a strong alkaline solution. In this pH range bleach does not corrode stainless. However, if the pH is lowered, for example by adding an acid to the bleach solution, the chlorine solution can release chlorine gas. This is not only dangerous, but it also causes problems for the stainless steel surface being sanitized Bleach is usually added accidentally when an acid cleaning step is followed by a rinse and then bleach sanitizing; if the rinse is too short the pH at the vessel wall will be acidic.

What often happens is that the chlorine gas released from the bleach reacts with water vapor and the result is hydrochloric acid drops on the surface of the steel; this is especially common in closed vessels.

Hydrochloric acid is a strong acid, meaning that it completely dissociates into hydrogen and chloride ions, and chloride when concentrated is very corrosive to stainless steel, even type 316. Molly is no match for this assault. The result is pitting corrosion. If the contact time is long enough the active corrosion cell will continue chewing through the steel until the pit turns into a hole. This does actually happen and is pretty common when chloride-containing solutions, such as corn syrup, are held for prolonged time periods in stainless steel vessels.

So that is the background behind the damage you wish to repair. The good news for you is that you do not have a Swiss cheese keg or brew kettle. If the pits are small the best fix is to use a fine abrasive and polish the surface of the steel. Use a 150-grit abrasive intended for use on stainless steel. If the area is isolated you can tape it off and use a round wheel to polish the surface. Make sure you polish with the grain of the steel. If the pit is deeper you may need to use a coarser abrasive to remove more material and then follow up the treatment with 150-grit to polish the surface. Exercise great caution if you do this because it is entirely possible to grind a hole in your vessel.

When this procedure is complete, thoroughly clean the surface of the steel. After the cleaning process is complete, oxygen in the air will react with chromium atoms at the surface of the steel to form a very thin layer, literally only a few atoms deep, of chromium oxide. This layer is called the passive film that makes stainless steel resistant to certain types of corrosion.

The key to avoiding this procedure is pretty simple; do not use chlorine sanitizers. Although bleach can be successfully used on stainless steel it does cause problems. I work for a stainless steel fabrication company and we, like many of our competitors, have corrosion disclaimers in our standard terms and conditions of sales. I prefer using hot water (>180 °F/82 °C for at least 20 minutes) or peroxyacetic acid for transfer pipes and vessels because these products do not cause problems like bleach. BYO

English Barleywine

Made better with age

by Jamil Zainasheff

One of the classic examples of English barleywine is Thomas Hardy's Ale. Some years ago a friend invited me to a vertical tasting of Thomas Hardy's Ale. He had been purchasing and cellaring each vintage since 1988. More than a dozen years later, he was ready to see how each had matured over time.

The barleywine was a 12% ABV, bottle-conditioned beer, and many people claimed that it should be laid down for five to ten years or more before drinking. I was thrilled at the opportunity to taste it, since the beers were, at that time, already quite rare. Some of the later vintages were very good, showing the complexity that develops as the alcohols and malts oxidize and chemically change over the years. The older samples had already become Madeira-like with heavy oxidation and some of the oldest had some sour notes. I found the experience very educational, learning that some beers age better than others and it has almost as much to do with the brewer and the ingredients as it does the storage conditions. It also made me appreciate English barleywine and how complex it can become with a little age.

English barleywine is rich and strong, with a focus on malty richness and complex fermentation and aging flavors. Young examples start out with more bready or biscuit characteristics, with moderate hop character and young fruity esters. As they age, the malt character takes on more sweet caramel notes and the ester profile takes on some dried and dark fruit notes. While alcohol is present and warming, it is never hot or harsh. The same could be said about the hop bittering and hop character. While the bittering is firm enough to balance any malt sweetness, it is never sharp or biting. Hop character can be moderate in younger examples, but as the beer ages, much of the character fades to a background note. The color should range from rich gold to very dark amber and the mouthfeel should be full and rich, with a smooth texture.

To brew a great example of this style, start with British pale ale malt as the base. It provides that background biscuit-like 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 American two-row or pale malt (1.5 to 2.5 °L) and this higher level of kilning brings out the malt's biscuity flavors. Some brewers use domestic pale ale malt or domestic two-row with the addition of 5 to 10% Munich malt when they cannot source British pale ale malt. This will not produce the same beer as using British pale ale malt, but it can produce a pleasant malt background.

Extract brewers should make the effort to source an extract made from British pale ale malt. If you use domestic two-row malt extract, you must compensate by partial mashing some additional specialty malts such as Munich, biscuit or Victory®. For a 5-gallon (19-L) batch, use about 5 to 10% of the total base malt.

All-grain brewers should use an infusion mash. A temperature in the range of 149 to 154 °F (65 to 68 °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. A great starting point is 152 °F (67 °C).

While English barleywine is a rich, malty beer, much of that comes from the base malt and extended boiling times. Do not overload your beer with lots of crystal malts: 5% is a good amount and 10% is about the maximum. I prefer to use darker color crystal malts (60 to 150° L), which add rich color, as well as some dark caramel, toasty, roasted, and raisin flavors. Lighter color crystal malts (10

Continued on page 21

English Barleywine by the numbers

OG:	1.080–1.120 (19.3–28.1°P)
FG:	1.018–1.030 (4.6–7.6 °P)
SRM:	8–22
IBU:	35–70
ABV:	8.0–12.0%

English Barleywine
(5 gallons/19 L, all-grain)
OG = 1.100 (23.8 °P)
FG = 1.024 (6.0 °P)
IBU = 63 SRM = 16
ABV = 10.2%

Ingredients
- 19.3 lb. (8.75 kg) Crisp English pale ale malt (or similar)
- 8.8 oz. (250 g) Franco-Belges caramel Munich malt (60 °L) (or similar)
- 8.8 oz. (250 g) Great Western crystal malt (120 °L) (or similar)
- 13.75 AAU Target pellet hops (1.25 oz./36 g at 11% alpha acids) (60 min.)
- 2.5 AAU Kent Goldings pellet hops (0.5 oz./14 g) at 5% alpha acids) (15 min.)
- 2.5 AAU Kent Goldings pellet hops (0.5 oz./14 g at 5% alpha acids) (0 min.)
- White Labs WLP013 (London Ale), Wyeast 1028 (London Ale) or Danstar Nottingham yeast

Step by Step
Mill the grains 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 150 °F (66 °C). Hold the mash at 150 °F (66 °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 7.1 gallons (27 L) and the gravity is 1.070 (17.1 °P). If you should come up short on the pre-boil gravity, top it off with some pale malt extract.

The total wort boil time is 120 minutes. This helps concentrate the wort and aids in the development of flavor compounds. The first hop addition comes with 60 minutes remaining in the boil. Add the Irish moss or other kettle finings and the second hop addition with 15 minutes left in the boil. Add the last hop addition at flame out.

Chill the wort to 68 °F (20 °C) and aerate thoroughly. The proper pitch rate is 17 grams of properly rehydrated dry yeast, three packages of liquid yeast, or one package of liquid yeast in a 6-liter starter. Ferment at 68 °F (20 °C) to start, raising the temperature gradually to 70 °F (21 °C) for the last ⅓ of fermentation. When finished, carbonate the beer to approximately 1.5 to 2 volumes.

English Barleywine
(5 gallons/19 L, extract with grains)
OG = 1.100 (23.8 °P)
FG = 1.024 (6.0 °P)
IBU = 63 SRM = 16
ABV = 10.2%

Ingredients
- 12.8 lb. (5.82 kg) Muntons English pale liquid malt extract
- 8.8 oz. (250 g) Franco-Belges caramel Munich malt (60 °L) (or similar)
- 8.8 oz. (250 g) Great Western crystal malt (120 °L) (or similar)
- 13.75 AAU Target pellet hops (1.25 oz./36 g at 11% alpha acids) (60 min.)
- 2.5 AAU Kent Goldings pellet hops (0.5 oz./14 g) at 5% alpha acids) (15 min.)
- 2.5 AAU Kent Goldings pellet hops (0.5 oz./14 g at 5% alpha acids) (0 min.)
- White Labs WLP013 (London Ale), Wyeast 1028 (London Ale) or Danstar Nottingham yeast

Step by Step
I use an English pale liquid malt extract. If you can't get fresh liquid malt extract, use an appropriate amount of dried malt extract (DME) instead.

Mill or coarsely crack 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 for a few minutes while you add the malt extract. Do not squeeze the bags. Add enough water to the steeping liquor and malt extract to make a pre-boil volume of 7.1 gallons (27 liters) and a gravity of 1.070 (17.1 °P). Stir thoroughly to help dissolve the extract and bring to a boil.

The total wort boil time is 120 minutes. This helps concentrate the wort and aids in the development of flavor compounds. The first hop addition comes with 60 minutes remaining in the boil. Add the Irish moss or other kettle finings and the second hop addition with 15 minutes left in the boil. Add the last hop addition at flame out. Chill the wort to 68 °F (20 °C) and aerate thoroughly.

Chill the wort to 68 °F (20 °C) and aerate thoroughly. The proper pitch rate is 17 grams of properly rehydrated dry yeast, three packages of liquid yeast, or one package of liquid yeast in a 6-liter starter. Ferment at 68 °F (20 °C) to start, raising the temperature gradually to 70 °F (21 °C) for the last ⅓ of fermentation. When finished, carbonate the beer to approximately 1.5 to 2 volumes.

English-Style Barleywine Commercial Examples

Abacus
Firestone Walker Brewing Co.
Paso Robles, California
www.firestonebeer.com

Arctic Devil Barley Wine
Midnight Sun Brewing Co.
Anchorage, Alaska
http://midnightsunbrewing.com/

Blithering Idiot
Weyerbacher Brewing Co.
Easton, Pennsylvania
http://weyerbacher.com/

Dominion Millennium Ale
Old Dominion Brewing Co.
Dover, Delaware
www.olddominion.com

Gold Label
Whitbread PLC
London, England
www.whitbread.co.uk

Golden Pride
Fuller Smith & Turner PLC
Chiswick, London, England
www.fullers.co.uk

Monster Ale
Brooklyn Brewery
Brooklyn, New York
www.brooklynbrewery.com

Old Nick
Wells & Young's Ltd
Bedford, England
www.wellsandyoungs.co.uk

Old Numbskull
AleSmith Brewing Co.
San Diego, California
http://alesmith.com/

Thomas Sykes Old Ale
Burton Bridge Brewery
Burton Upon Trent,
Staffordshire, England
www.burtonbridgebrewery.co.uk

Vintage Harvest Ale
J.W. Lees & Co.
Manchester, England
www.jwlees.co.uk

to 40 °L) add sweeter caramel notes, which can make a big beer seem more candy-like.

If you are looking for more complexity or increased head retention, you can add other malts as well. Wheat malt, Victory®, biscuit and others are common additions in many recipes, but restraint is important so that the beer does not become saturated with non-fermentable dextrins and cloying flavors. In general, keep the total of all specialty grain additions to less than 15% of an all-grain grist. Avoid more than small additions of highly kilned malts, as roasted flavors are not appropriate. Color in this style comes mainly from crystal malts and longer boil times. If you want to develop more color and more melanoidin-based flavors and aromas, start with a larger pre-boil volume so

> "English-style beer is best brewed with English hops, such as East Kent Goldings, Fuggles, Target, Northdown or Challenger. The bittering level for English barleywine is in the range of 35 to 70 IBU."

you can boil the wort for two hours or more. This develops a certain character that is not possible by using grain additions alone.

English-style beer is best brewed with English hops, such as East Kent Goldings, Fuggles, Target, Northdown or Challenger. The bittering level for English barleywine is in the range of 35 to 70 IBU. You want enough hop bitterness to balance any residual sweetness, without overwhelming the malt background. There are many factors at play in the final impression of bitterness for the drinker. The starting and final gravities, the character malts selected, the type of base malt, the yeast strain, the pitching rate, and even the yeast cell size all have an impact on the perceived bittering. One additional factor is the amount of time before drinking. You may want to shoot a tiny bit higher on bittering if your expected drinking date is a year or more out. A bitterness-to-starting gravity ratio (IBU divided by OG) between 0.4 and 0.8, should be close. I tend to target around 0.6 to 0.7, because I expect to drink the beer after a period of aging. As a general rule of thumb in determining late hop amounts, include an amount equal to the amount of bittering hops. This is just a generalization, since using very low or high alpha acid hops makes the equation faulty. One or two late hop additions, totaling around 1 to 2 oz (28 to 57 g) for a 5 gallon (19 L) batch at 20 minutes or later, should be about right. Keep in mind hop flavor and aroma should not overwhelm the malt character even when the beer is young.

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 a bitter beer. Many English yeasts tend to attenuate on the lower side (< 70%), but for an English barleywine you want to choose one of the more attenuative English yeasts (> 70%). While you should expect some malt sweetness in the finish, using a low-attenuating yeast in a big beer will result in a beer that is too heavy and sweet. My favorites for this style are White Labs WLP013 (London Ale) and Wyeast 1028 (London Ale) yeast. They both provide a wonderful ester profile without being excessively fruity, and they attenuate a little more than most English yeasts. If you like to experiment with different yeasts, try to select English yeasts that attenuate in the mid 70s percent or higher. If you prefer dry yeast, Danstar Nottingham should produce acceptable results.

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, slowly 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. If your situation restricts you to using less attenuative yeast, you will need to take steps to ensure enough attenuation. For barleywine you can lower the mash temperature or replace a portion of the base malt with simple sugar to help dry out the final beer.

> “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 a bitter beer.”

Serving English barleywine at cellar temperature, around 52 to 55 °F (11 to 13 °C), allows the character of the beer to come out and can improve drinkability. Colder temperatures prevent the drinker from picking up the interesting fermentation and malt flavors and aromas of this style, so do not go below 50 °F (10 °C). Target a carbonation level around 1.5 to 2 volumes of CO_2. Once this beer is finished fermenting, a long aging period does wonderful things for the beer. Yes, you might be tempted to drink it after just a couple weeks, but try to set aside some bottles in a cool place and enjoy them over the years. BYO

Jamil Zainasheff is an award-winning homebrewer, author and writes "Style Profile" for every issue of Brew Your Own.

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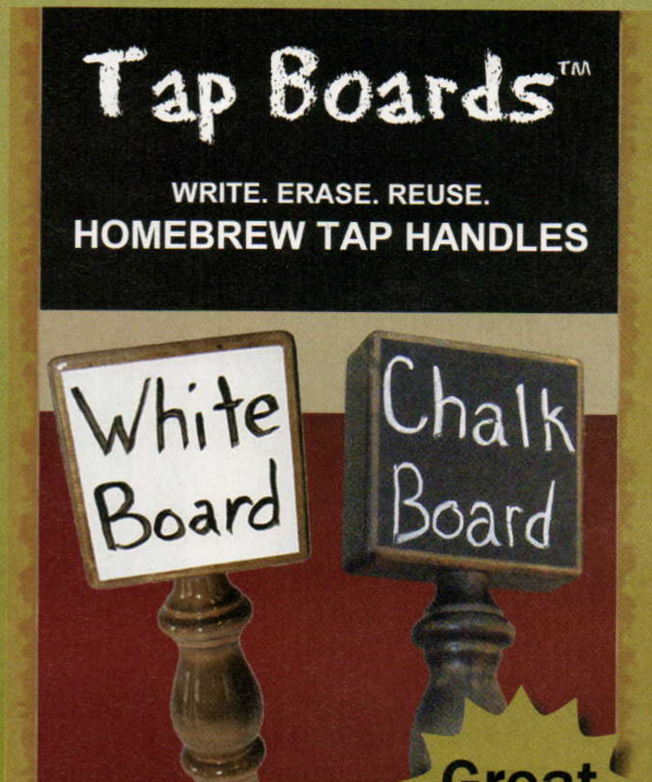

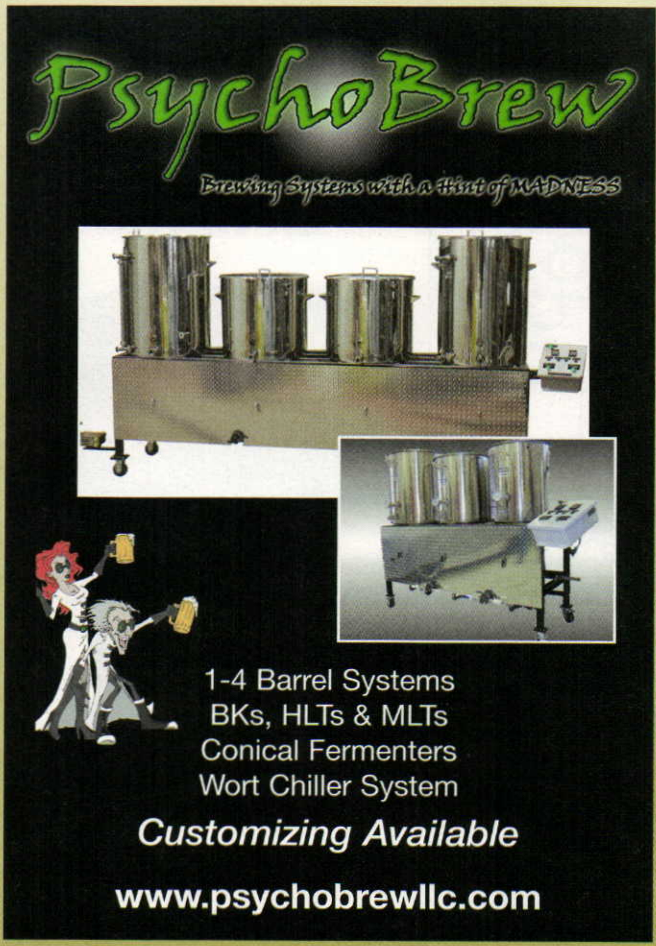
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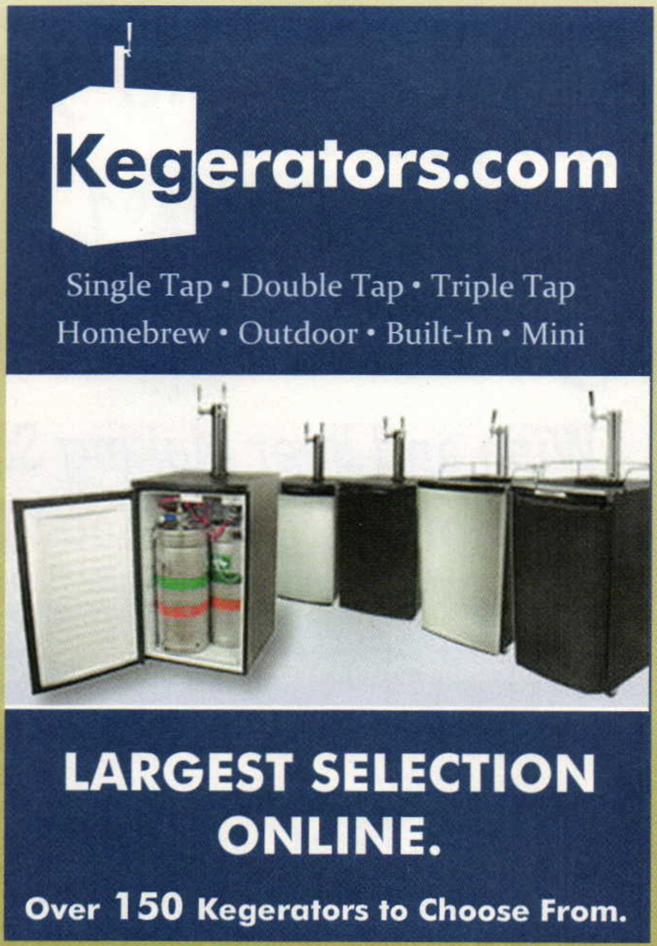
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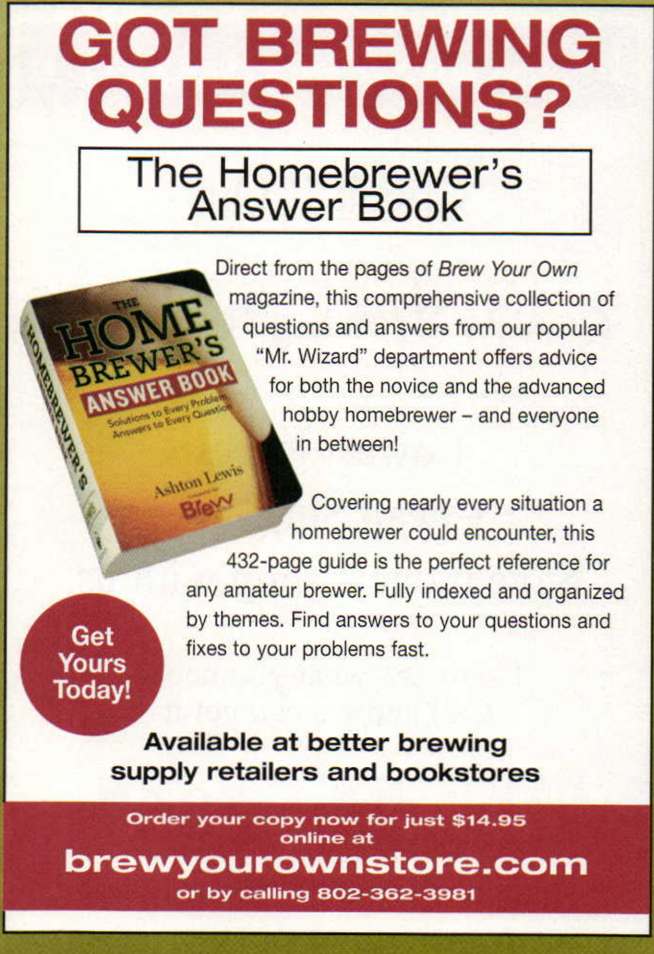
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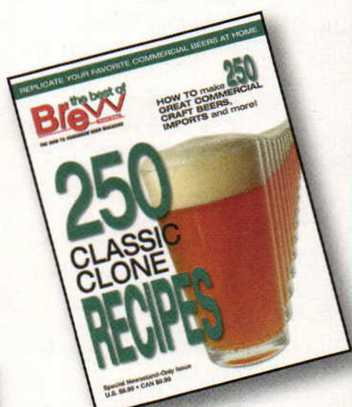

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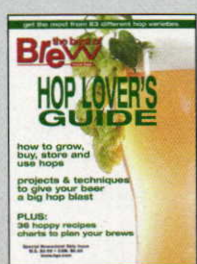

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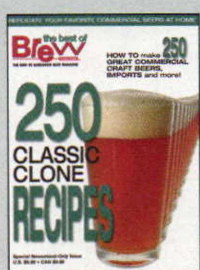

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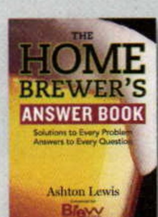

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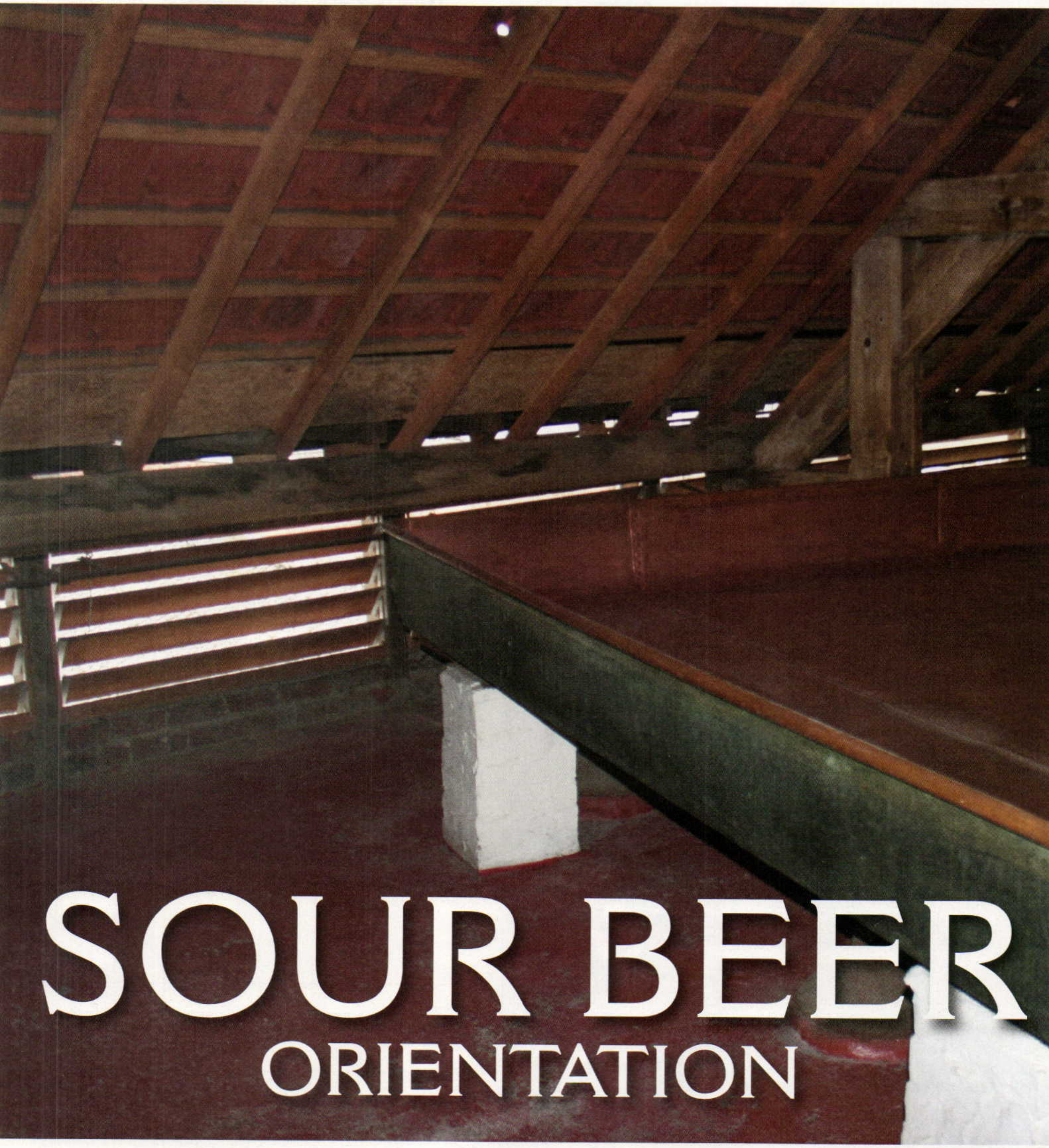


SOUR BEER
ORIENTATION

The coolship at Cantillon Brewery in Brussels, Belgium, where the cooling wort is intentionally exposed to airborne souring microorganisms. In most homebrewed sour beers, microbes are added directly to the wort.

Many homebrewers are wary about brewing sour beers at home. Common questions from brewers include, "Will brewing one turn my other beers sour?"

"Where does the acid come from?"

"Are aged hops required?"

This article attempts to demystify the art of brewing sour beers at home.

Story by **Michael Tonsmeire**

Keeping Your Clean Beers Clean

What seems to make brewers nervous about brewing their first sour beer isn't the time, or even the risk of bad beer — it is the fear that the "wild" microbes will ruin one of their other beers. I won't lie, if you add microbes other than brewer's yeast to your fermenter, this is a legitimate concern. Over my five years of brewing sour beers, I have lost two batches to unintentional souring, but I haven't had any problems since I started following a few simple rules for sanitizing and separating my "clean" equipment from my "sour."

There is no need to purchase duplicates of any of your equipment that touches your wort through the boil. Likewise, you can share equipment that comes in contact with wort between sour and non-sour beers if it can be sanitized.

Chemical sanitizers work best on impermeable, scratch-free surfaces that are clear of deposits. Glass, stainless steel and scratch-free plastic surfaces can all be sanitized adequately. Soaking your equipment in hot tap water and a cleaner such as PBW, TSP or OxyClean Free before sanitizing will remove buildup left from previous fermentations. Follow the guidelines for sanitizer concentration, time and temperature. Adding more sanitizer than recommended may be less effective than sanitizer at the proper concentration and can lead to off flavors if you exceed the no-rinse concentration. On the other hand, longer contact times than the recommended minimum will kill a higher percentage of microbes.

You can safely share most of your gear between clean and sour beers if you are diligent with sanitation and replacement. However, soft plastic has a tendency to scratch and some equipment provides places for detritus to build up unnoticed, so I keep two sets of cool side plastic equipment (tubing, auto-siphon, bottling wand, bottling bucket and thief). I "hand down" my clean beer gear to my sours about once a year; this way it doesn't even cost more money because I continue using the equipment long after I would have replaced it.

Be sure to mark your sour beer equipment with tape or permanent marker to ensure you don't accidentally use it for a clean beer. There is no sanitation reason to segregate your clean and sour beer fermentations, but to avoid mix-ups I keep them on opposite sides of the same room.

Wort Production

For many homebrewers, their first sour beer is an accident, but Scott Vaccaro of Captain Lawrence Brewing Company suggests, "Start with a clean slate, don't turn an off batch into a sour beer. I think you should treat it like any other beer you are making." Brew day for an intentionally sour beer is often indistinguishable from any other. If, however, you are souring the wort before primary fermentation or employing a more complex mash schedule, there will be a few twists to the process. Even so in most cases the steps are the same: grains are crushed and mashed (or steeped), wort is collected (or extract is added) and then boiled with hops before it is chilled and pitched. These steps can be accomplished using whatever processes work best for you.

Hopping

Bitter and sour do not taste good together. As a result, it is rare that I add more than 20 IBUs to a sour beer. Hops also inhibit lactic acid bacteria and some other strains of bacteria, so high hopping rates are counterproductive to souring. I have not found aged hops — as are used in some commercial lambics — to be of benefit for any style of sour beer.

A hoppy aroma can complement a sour beer beautifully (I especially like citrusy American hops), but skip the late boil addition (which will fade before the beer is ready to drink) in favor of adding dry hops a few weeks before packaging.

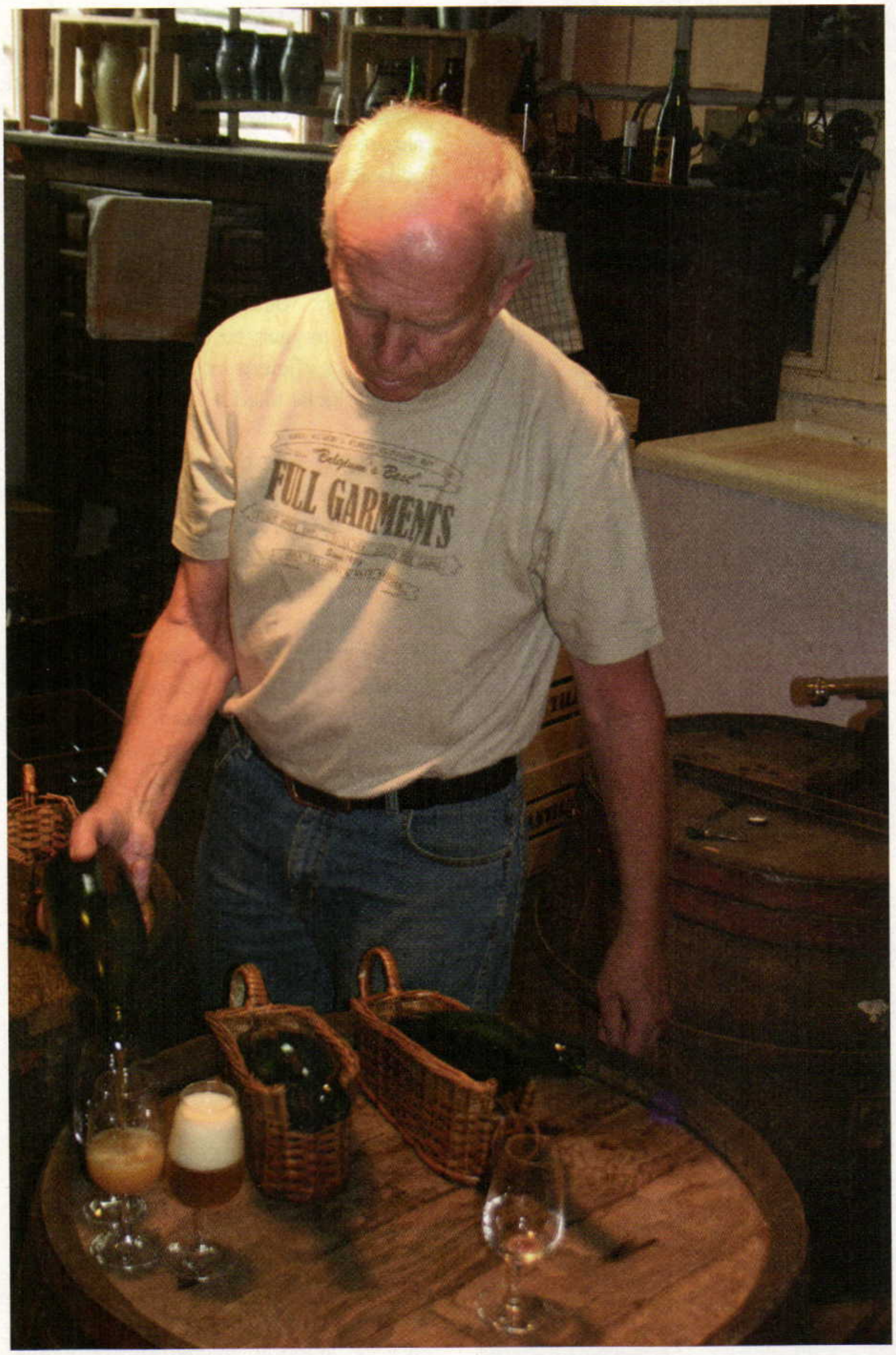
Microbial Players

There are five main actors in the microbial menagerie that goes into producing sour beers: two yeasts and three bacteria.

Saccharomyces The only organism responsive for fermenting a clean beer, brewer's yeast (*Saccharomyces cerevisiae*) does most of the fermentation for sour beers as well. You can literally use any strain of brewer's yeast to accomplish the primary fermentation of a sour beer. While some of the byproducts produced by the *Saccharomyces* will remain in the finished beer, many will be destroyed by the microorganisms that follow.

***Brettanomyces* (Brett)** *Brettanomyces* (*B. lambicus*, *B. bruxellensis*, and *B. claussenii*) is the king of the wild yeasts in the sour brewing world, responsible for much of their complexity. These strains help to break down dextrins (chains of sugar molecules too long for *Saccharomyces* to ferment) and add a wide range of characteristic ester (fruity) and phenol (spicy/smoky) characters. Their impact can range from pleasant aromas like pineapple, hay, juicy-fruit and pear; to others appreciated in low levels like horse blanket, farmhouse, and barnyard; to the vile smoky, Band-Aid, and fecal batch ruiners. *Brettanomyces* can produce acidity under certain conditions, but not enough to make a truly sour beer.

***Lactobacillus* (Lacto)** *Lactobacillus delbrueckii* produces the acidity in Berliner weisses, but in most other worts the hopping levels are high enough to prevent it from producing



Jean-Pierre Van Roy — former brewmaster at Cantillon Brewery in Brussels, Belgium and father of the current brewmaster — pours some lambics for brewery visitors.

much lactic acid. *Lactobacillus* (including *delbrueckii* and other species) likes warm temperatures and can sour a beer within days or weeks if the concentration of bacteria is high enough. *Lactobacillus* is also responsible for the tang produced by a sour mash.

Pediococcus (Pedio) *Pediococcus damnosus* produces the majority of the lactic acid in most sour beers. Some brewers describe the acid character from *Pediococcus* as being more aggressive and sharp than *Lactobacillus*. *Pediococcus* takes several months to dramatically lower the pH of a beer, but it is more hop and acid tolerant than *Lactobacillus*. Some strains of *Pedio* produce diacetyl, thus making it an ideal complement to *Brett*, which reduces the diacetyl.

Acetobacter The role of *Acetobacter* is kept to a minimum in most sour beers because it consumes ethanol and oxygen to produce acetic acid (the signature acid of vinegar). Acetic acid is occasionally present in Flemish reds, but all of the brewers I talked to mentioned that avoiding acetic acid is one of their top priorities. Unlike the other microbes described, *Acetobacter* requires oxygen to thrive. This should provide sufficient motivation to keep your airlocks filled.

Souring Methods

"There really is no right or wrong way to make (sour beers) — that is what makes these beers so fun and personal." says Vinnie Cilurzo of Russian River Brewing Company. The possible methods fall into two categories — quick (where the acid is produced before primary fermentation) and long (where the acid is mainly produced after primary fermentation). The quick methods tend to create less complexity because they rely on *Lactobacillus* alone rather than on the combination of *Pediococcus* and *Brettanomyces*.

Sour Mash

There are many ways to create a sour mash, but the most common way is to cool the converted mash down to 110-120 °F (43–49 °C) and then add a small amount of fresh malt. Malt is naturally covered with *Lactobacillus*, which is allowed to work on the sugars in the warm mash for anywhere from 12 to 72 hours. The key to a successful sour mash is to keep oxygen out (by either flushing the mash tun's headspace with CO_2 or laying an oxygen impermeable covering, such as plastic wrap, over the surface of the mash). Once the desired acidity is reached, the wort is run off, boiled, hopped and fermented just like any other beer. The drawback is that sour mashes are variable because the wild microbes sometimes produce unpleasant byproducts.

Sour Worting

This is a variation on a sour mash that avoids some of the associated issues. It also works for extract brewers. After the wort is brought to a sanitizing boil, it is cooled and inoculated either with an active pitch of commercial *Lactobacillus* or a starter made from the wild *Lactobacillus* living on malt. The *Lactobacillus* is allowed to work until it produces the desired sourness. (As with sour mashes, limit the exposure to oxygen.) Once the desired acidity is reached, the wort is boiled, hopped, and fermented as with any other beer. Sour worting is a great candidate for fermentation with a large pitch of *Brettanomyces* alone because it is more acid tolerant than *Saccharomyces* and thrives in a low pH wort.

Acid Malt

The mash can be soured almost instantly with a large (5–15%) addition of acidulated malt (sauermalz). The acid content of this malt can vary depending on the brand and batch so dialing in the appropriate amount may take some experimentation. The problem with this method is that it will drop the pH of the mash far enough to inhibit efficient starch conversion. Unfermentability is not a problem if *Brettanomyces* is added to the beer, but if fermenting with only *Saccharomyces* the brewer should mash the rest of the grain bill and wait for it to convert before adding the acid malt.

Food Grade Acid

There are food grade acids — such as lactic, acetic (as vinegar), citric, malic, tartaric and winemaking acid blends — that are available to add directly to beer. Using one of these is quick, easy, and controllable, but I have never been happy with their one dimensional character when added to a cleanly fermented beer. In my experience, adding acid is only a viable method to boost the acidity of beers that already have some sourness.

Long Aging Methods

There are three camps when it comes to long-aged sour beers, those brewers who add all of the souring microbes together along with the *Saccharomyces*, those who wait until after primary fermentation to add the microbes and those who stagger the microbe additions even further. I've found that, when fermenting sour beers in carboys or Better Bottles, I don't get enough acid production for my tastes unless I add all of the microbes along with the brewer's yeast to the cooled wort. When souring beers in wine and spirit barrels, we have had good luck with a clean primary fermentation followed by adding the microbes when the beer is racked into the barrel. Some breweries, like Russian River, take an even more staggered approach, by pitching *Brett* after the end of primary fermentation when the beer is transferred to the barrel, but waiting a few more weeks or months longer before pitching the *Lacto* and *Pedio*. This method allows the *Brett* to establish itself before the pH drops too far. (This seems like a lot of work, but it is hard to argue with their results.) Raccoon Lodge and Captain Lawrence each make complex sour beers that have won a GABF gold medal, but they take completely different approaches to microbe selection. Raccoon Lodge is known for making sour beers that are missing the horsy aromatics of *Brettanomyces*, they do this by pitching a house culture of *Lactobacillus* when they move their beers into barrels. On the other hand, Captain Lawrence pitches only a variety of *Brettanomyces* strains into most of their barrels.

Whatever your pitching schedule and microbe selection, once all of the microbes are added, the beer ages for months or years until the acid is at the desired level and the gravity of the beer is stable. (You do not need to wait for the pellicle, the floating mat of microorganisms, to drop.) Ideally I would like to keep the temperature of the aging beer in the 60s °F (16–21 °C), but this is unrealistic because the temperature in my cellar climbs into the high 70s °F (over 24 °C) during summer. Warmer temperatures lead to faster lactic acid production, but they can also encourage *Acetobacter*. I find the flavors of beers utilizing long souring techniques to far exceed other methods, but it takes longer and allows less control over the finished character of the beer.

Sources of Microbes

The microbes you select will have a profound impact on the levels of acidity and funk in your finished beer, so pick carefully.

Commercial Suppliers

There are currently three yeast labs producing pitchable cultures of *Lactobacillus*, *Pediococcus* and *Brettanomyces* for homebrewers. Two of the labs, Wyeast and White Labs, are available at most North American homebrew stores. They sell strains both individually and in blends (which is cheaper, but takes some of the control out of your hands). The third, East Coast Yeast, is a recent startup up with limited distribution.

Bottle Dregs

I've soured beers using many different microbe sources, but I've had my best results with beers where I pitched the bottle dregs (sediment) from unpasteurized commercial sour beers.

Fresh, lower-alcohol beers are your best bet for harvesting dregs. Let the bottle sit upright somewhere cool to allow most of the cells to settle on the bottom. Decant the beer into a glass with a slow pour, stop when you see sediment flowing towards the neck. If you have a batch ready to be soured (or already souring) then swirl the bottle and pour the dregs directly into the wort or beer. I like to add the dregs at the same time as the *Saccharomyces* to give the microbes time to grow. If you do not have a beer ready, you can pitch the dregs into a small volume of low gravity wort. I suggest leaving the starter covered in the refrigerator until you are ready to use it. Propagating a mixed culture can be difficult because the various microbes have different growth rates and requirements for oxygen, pH and temperature.

> "The microbes you select will have a profound impact on the levels of acidity and funk in your finished beer, so pick carefully."

Unpasteurized Sour Beers

The following list contains examples of beers that have harvestable dregs including bacteria and in many cases *Brett*. This is by no means a complete list, there are many one-off or limited distribution beers not included.

- Bavik (Petrus Oud Bruin, Petrus Aged Pale)
- Boon (Oude series)
- Bruery (Hottenroth, Oude Tart)
- Cantillon (Anything)
- Captain Lawrence (Cuvee de Castleton, Rosso e Marrone, Flaming Fury, Little

Sour Beer Recipes

Flemish Pale Session Ale

OG = 1.046 FG = 1.006
IBU = 18 SRM = 4 ABV = 5.3%

Pale version of a Flemish Red. Similarly sour, but lacking the dark fruit character. A lower gravity beer that is mashed cool, so it makes a good session sour ale since it is low in alcohol and not aggressively sour.

Ingredients

5.25 lbs. (2.4 kg) Pilsener malt
2.25 lbs. (1.0 kg) wheat malt
0.50 lbs. (0.23 kg) CaraHell® malt
7 AAU Mt. Hood hops (100 mins)
(1.4 oz./40 g of 5% alpha acids)
Wyeast 3522 (Belgian Ardennes) yeast
Wyeast 3763 (Roeselare Blend) yeast
4.25 oz. (120 g) table sugar (for priming)

Step by Step

Mash at 135 °F (57 °C) for 25 minutes, raise temperature to 146 °F (63 °C) for 60 minutes, then 158 °F (70 °C) for 15 minutes. Boil for 115 minutes, adding hops as indicated. Start fermentation around 65 °F (18 °C) and allow to rise to 70 °F (21 °C) over the course of fermentation. When primary fermentation is complete (2–3 weeks), rack to secondary onto 1.0 oz (28 g) of medium toast French oak cubes (boiled for five minutes and drained first). Allow the gravity to stabilize before bottling.

Extract Option: Steep CaraHell®, and replace the Pilsener malt and wheat malt with 3.0 lbs (1.4 kg) wheat dried malt extract and 2.0 lbs (0.91 kg) Pilsener dried malt extract.

Nieuwe Bruin

OG = 1.056 FG = 1.013
IBU = 22 SRM = 18 ABV = 5.7%

Sour ale that uses the new technique of sour worting to mimic some of the flavors of Oud Bruins without the long aging period. The sourness comes off as a clean tartness that gives depth to the dark malt character.

Ingredients

9.0 lbs. (4.1 kg) Golden Promise malt
0.50 lbs. (0.23 kg) Amber malt
0.50 lbs. (0.23 kg) Golden Naked Oats
5.0 oz. (0.14 kg) American roasted barley (~300 L)
4.0 oz. (0.11 kg) dark English crystal malt (60 °L)
6 AAU Galena hops (60 mins)
(0.50 oz./14 g of 12% alpha acids)
Safale S-04 (English Ale) yeast
Lactobacillus culture
4.25 oz. (120 g) table sugar (for priming)

Step by Step

Mash at 154 °F (68 °C) for 60 minutes. Bring to a boil briefly, then cool to 90 °F (32 °C) and pitch a 1.0 qt. (1.0 L) starter of *Lactobacillus* (either started from a commercial culture or ½ cup of malt). Hold the wort above 80 °F (27 °C) for 2–3 days. Once the desired level of acidity is reached, boil for 90 minutes adding hops as indicated. Chill to 65 °F (18 °C) and pitch the ale yeast. When primary fermentation is complete, rack the beer onto 0.75 oz. (21 g) medium toast French oak cubes. Allow the beer to extract the desired oak character (1–2 months) before bottling.

Extract Option: Steep Golden Naked Oats, roasted barley, and dark English crystal malt. Swap Golden Promise and amber malt for 5.0 lbs (2.25 kg) English pale dried malt extract and 0.75 lbs (0.34 kg) Munich liquid malt extract.

Wallonian Buckwheat Amber

OG = 1.056 FG = 1.008
IBU = 17 SRM = 14.5 ABV = 6.3%

This beer adds the rustic charm of buckwheat to an amber sour base. The high mash temperature and crystal malt mean this beer needs extended aging before packaging.

Ingredients

5.0 lbs. (2.3 kg) German Pilsener malt
2.25 lbs. (1.0 kg) German Vienna malt
2.0 lbs. (0.91 kg) buckwheat
1.0 lb. (0.45 kg) crystal malt (40 °L)
2.5 oz. (71 g) Carafa® Special III malt
5 AAU Styrian Goldings hops (60 mins)
(1.0 oz./28 g of 5% alpha acids)
Safbrew T-58 dried yeast
Dregs from two bottles of Jolly Pumpkin
(or other unpasteurized sour beer)
4.25 oz. (120 g) table sugar (for priming)

Step by Step

Boil the crushed buckwheat in 7 qts. (6.6 L) of water for 20 minutes. Mash the rest of the grains at 125 °F (52 °C) for 15 minutes then combine with the buckwheat "porridge" and additional boiling water to stabilize at 156 °F (69 °C) for 45 minutes. Boil for 90 minutes, adding hops as indicated. Start fermentation with both the ale yeast and dregs around 68 °F (20 °C) and allow to rise to 75 °F (24 °C) over the course of fermentation. When primary fermentation is complete (2–3 weeks), rack and add 1.0 oz (28 g) of red wine soaked French oak cubes. Allow the gravity to stabilize before bottling. (If the dregs of your sour beer contain *Brett*, it may take weeks to months for the gravity to stabilize. Take gravity readings and only bottle when they stop dropping.)

Linda's Liquid)
- Cisco (Woods series)
- De Ranke (Cuvée De Ranke, Kriek De Ranke)
- Drie Fonteinen (Anything except Beersel Lager)
- Fantôme (Anything)
- Girardin (1882 Gueuze Black Label)
- Hanssens (Anything)
- Jolly Pumpkin (Anything)
- Lindemans (Cuvée René Oude Gueuze)
- Lost Abbey (Red Poppy, Cuvee de Tomme, Duck Duck Gooze, Framboise de Amorosa)
- Mort Subite (Oude series)
- Oud Beersel (Oude Series)
- Panil (Barriquée)
- Professor Fritz Briem (1809 Berliner Style Weisse*)
- Raccoon Lodge (Any Cascade*)
- Russian River (Supplication, Temptation, Beatification, Consecration, Sanctification)
- St. Louis (Gueuze Fond Tradition)
- Van Steenberge (Monk's Cafe Flemish Sour Red Ale)

An asterisk (*) denotes sour beers that contain only bacterial strains (no *Brettanomyces*).

Other Sources

There are many other sources of microbes worth considering: sourdough starters, dried bread yeast (see "Kvass Revival" in the December 2010 issue of *BYO*), kombucha, wild microbes, yogurt and your previous batches of sour beer. However, I recommend waiting to try these alternatives until after you have successfully brewed a few batches using more predictable microbe sources.

Wood Aging and Fruit

While oak barrels and sour beer are frequent partners, you can make great sour beers without one. Oak cubes, staves, or spirals are reasonable replacements, but even these are not necessary. For more information on using oak, see "Professional Barrel Aging" and "Oak Alternatives" in the January-February 2008 issue of *BYO*. Fruit too has a historical relationship with sour beer, as I wrote about in "Adding Fruit to Sour Beers" in the September 2010 issue of *BYO*.

Blending

If there is a secret to making great sour beer, it is the art of blending. Despite your best efforts some batches will be too funky, not sour enough or overly oaky. Get a few friends together, and pull samples of the beers you have aging. Ron Gansberg of Raccoon Lodge & Brew Pub lent some advice, "Tasting is key, taste for different characters (less acidic, lemony) and use them to build a sum that is greater than the individual parts." Sample each beer before you start blending, and always start with a clean glass (adjusting a blend after taking a sip will make it hard to replicate). Once you settle on a ratio, scale it up to create your finished beer. If you are blending in any beer that had not finished souring, then leave the blend in a fermenter for a few weeks to ensure the gravity does not drop. Any beer left out of the blend can be bottled straight, or saved for another blending session.

Packaging

Sour beers can be either kegged or bottled, just like any other beer. If you rely on natural carbonation from an addition of sugar there may be a period of a few weeks or months where the beer develops odd flavors. Fortunately, given time these flavors will dissipate. For a long-aged sour beer, it is a good idea to pitch fresh yeast to ensure carbonation. I prefer to use dried wine and Champagne strains because they are inexpensive and acid and alcohol tolerant. When using dried yeast, it is important to rehydrate the cells in warm water because the low pH and high alcohol of a beer would kill many of the dehydrated organisms.

Carbonation calculations can be derived in the same way as for any beer, except in the case of barrel aged beers which tend to lose most of the residual carbonation while aging. Before bottling, taste the beer to judge carbonation deficits and adjust the amount of priming sugar accordingly. Force carbonation via a kegging system evades some of these packaging issues, but reduces the potential for long-term flavor development.

Sour Beer Tips

Split batches to produce multiple beers. The simplest way is to sour a portion of the wort from a non-sour beer. Once you have a batch of sour beer, you can add fruits, spices, dry hops, liquor/wine, or other flavoring to a portion while leaving the remainder as is.

Make friends with other homebrewers who brew sours, try their beers and have them try yours. Some of the best sours I have tasted were fermented in the basements and closets of fellow homebrewers.

Try as many commercial sour beers as you can (for inspiration and microbes) and ask questions of the brewer, if possible.

Take copious notes on the process and flavor of your beers at each step. This information will help you avoid mistakes and recreate successes.

Do not be discouraged if your first batch does not taste as good as Russian River Supplication, Captain Lawrence Cuvee de Castleton, or Cascade Bourbonic Plague — it takes experience to consistently make sour beers that good.

The methods for producing sour beers are almost as diverse as the results. Pick a method that fits your palate and brewing style and give sour beer brewing a shot. BYO

Michael Tonsmeire is a frequent contributor to BYO *magazine.*

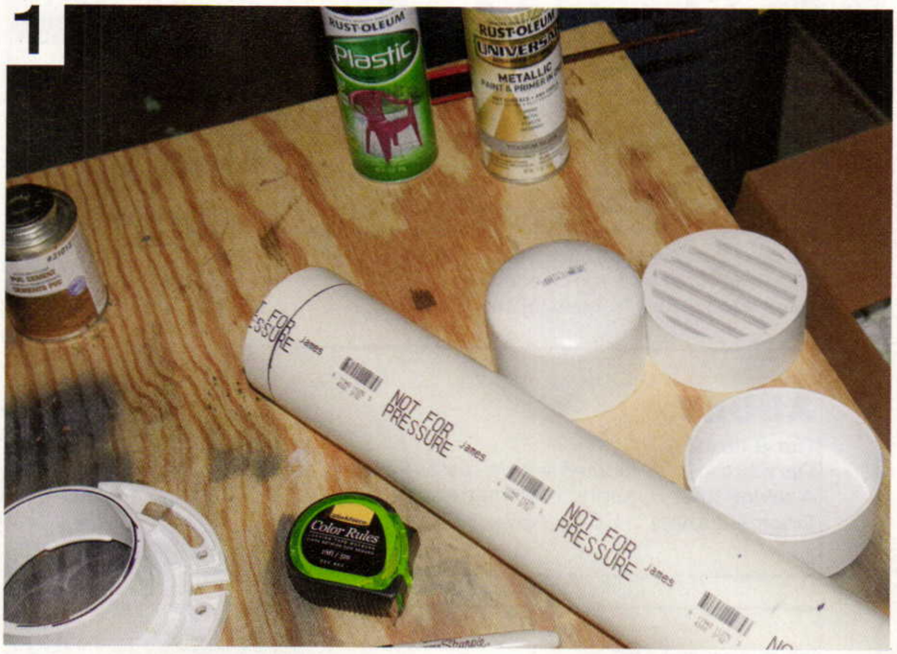
BUILD A DRAFT TOWER

Story and photos by **Forrest Whitesides**

Getting a kegging system up and running at home is a worthwhile project for any homebrewer. However, assembling all the necessary components is rarely an inexpensive venture. If you decide to go with a mini-fridge or chest freezer as the base for your kegerator, one major cost center is the draft tower, which is the fancy-looking chrome pipe to which the dispensing faucets are mounted. A tower with a single faucet costs an average of about $75–$100 for a new "economy" unit, and the price goes up from there for fancier hardware and multiple faucet options.

But don't let that deter you, because you can build your own draft tower from PVC for a fraction of the cost of a new metal tower. The prime directive for this project is to get your system up and running as inexpensively as possible; you can always upgrade the hardware at a later date as finances allow. And with PVC, it's trivial and cheap to add additional faucets, unlike with a traditional metal draft tower. You can even make your own per-faucet drip trays for less than $5 each.

1



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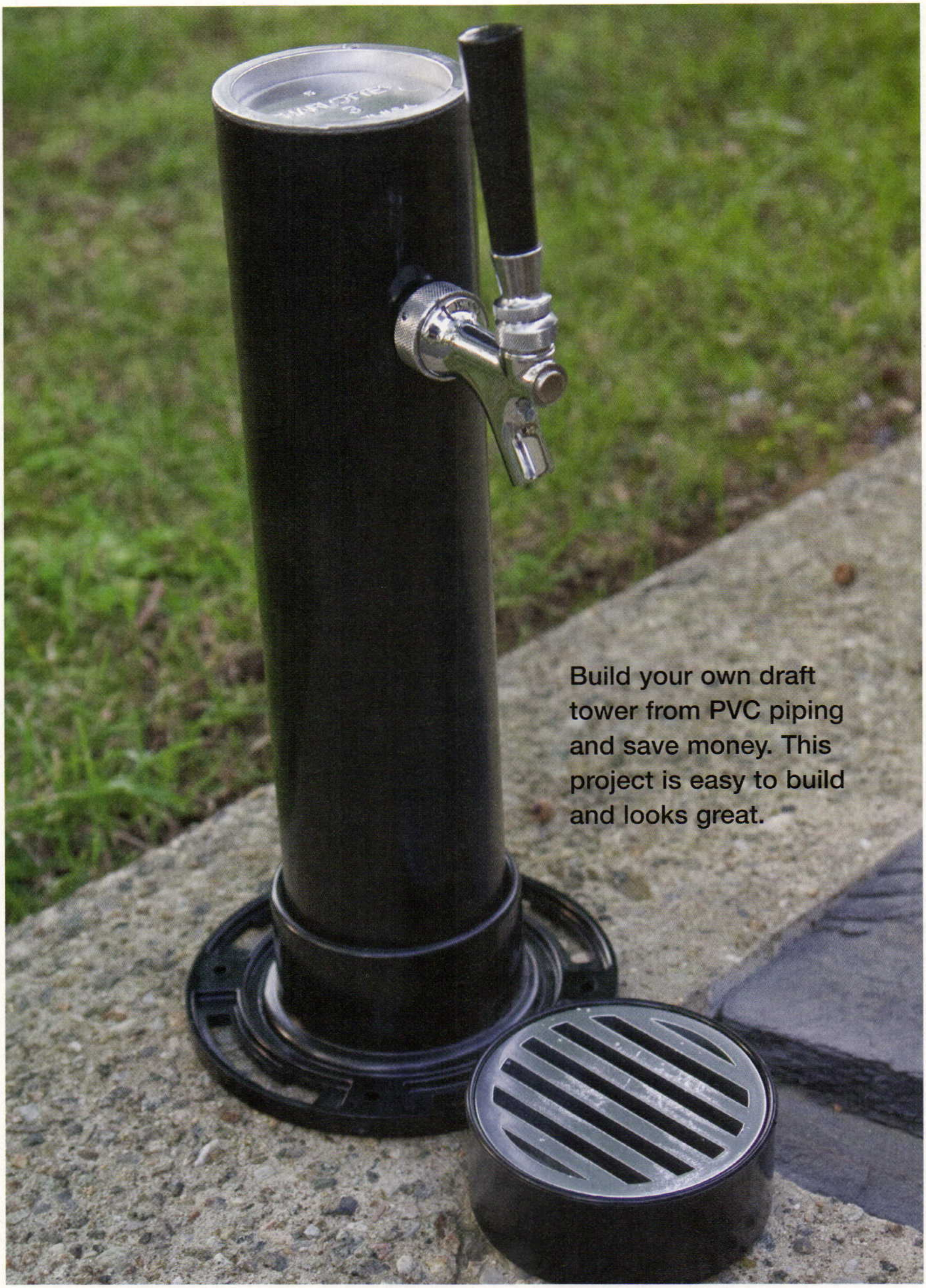


Build your own draft tower from PVC piping and save money. This project is easy to build and looks great.

3

4

5

Materials, Parts and Tools

For the Tower:

- 3-inch (7.6 cm) diameter PVC pipe (commonly sold in 2-foot/61 cm lengths)
- 3-inch (7.6 cm) PVC end cap (slip fitting)
- U.S. standard floor-mount toilet flange (4-inch exterior/3-inch interior diameter) (10 cm/7.6 cm)
- Mounting bolts, washers, and nuts (¼-inch bolts are standard)
- PVC cement
- Paint (optional)
- Foam insulation (optional)

For the faucet:

- Short faucet shank (3 inches/7.6 cm or less), or a dedicated right-angle tower shank
- Dispensing faucet and tap handle
- Shank hookup hardware (depends on shank type)
- Beverage tubing.

Tools:

- Drill with ½-inch (1.3-cm) hole saw bit
- PVC pipe cutter tool (or a hack saw or hand saw)
- Angle grinder, RotoZip or hack saw with metal-cutting blade (for straight shanks)
- Hand file (optional)

Tower Pieces

The body of the tower is composed of a PVC pipe, a flange and a pipe cap (photo 1). There are quite a few options for capping the draft tower (photo 2). The default option is to use a 3-inch (7.6 cm) rounded PVC pipe cap ("slip fit," which means it's not threaded and just slips on the pipe). There are also 3-inch (7.6 cm) flat-top slip-fit pipe caps, 3-inch female adapters (one side is slip fit and the other is female pipe thread) and 3-inch (7.6 cm) threaded flush-fitting drain plugs. And of course there are also similar drain plugs with the square nipple on top. You can also opt for a "test cap," which fits directly into the end of the pipe and sits perfectly flush. There are other options, but the above are more than adequate and all are relatively cheap (under $5).

Measure, Cut and Fit

Draft towers come in a range of heights

and widths, with 12 inches (30 cm) from mounting flange to the top cap and about 3 inches (7.6 cm) around being typical. You can build your tower shorter or taller than this, depending on your specific situation.

Keep in mind that the flange will elevate the pipe between 1 and 2 inches (2.5 and 5.1 cm) above the kegerator, but will also require about 1 inch (2.5 cm) pipe insertion for a snug and sturdy fit. So make sure you measure and mark the pipe height with one end fully inserted in the flange. Also, all but the "test cap" pipe fitting will add to the overall height.

Use hacksaw or PVC cutting tool to cut the pipe to length. If the cut isn't perfectly even and level, don't worry because both ends of the pipe will be hidden from view by the flange and the end cap (unless you opt for the test cap, in which case you will need to be a little more careful when cutting). You can also file down higher edges to make the cut more level, if desired.

Drill, Baby, Drill

With the three tower components fit together snugly, consider where you want the faucet to be mounted. If you plan to do multiple faucets, figure out how you want them arranged and experiment with the shanks to make sure everything will fit as you have imagined it. Many single-faucet towers have the mounting holes about 1 to 2 inches (2.5–5.1 cm) below the bottom of the cap.

Typically, with two or three faucets, the mounting holes are put at different heights to make sure there is not an internal space conflict with the shanks, fittings, and tubing. With most types of the smaller right-angle shanks, you have the option to fit two faucets side by side at the same height.

Mark the hole(s) center with a Sharpie or similar marker (photo 3), and drill a pilot hole. A ⅛-inch bit is fine for this. The pilot hole gives the hole saw's guide bit something to grab onto. This is not necessary, but it only takes a few seconds, and helps to keep the guide bit from wandering when drilling starts. The hole saw will make a nice ½-inch (1.3 cm) hole that is a snug fit for

Make your own cheap drip tray

While you're at the store picking up the parts for your new draft tower, you might as well spend an extra $4 and get the parts for a nice drip tray. There are a few different ways you could go, but the easiest, cheapest, and best-looking option I've found is a combination of two parts: a 4" PVC flat-top drain cap (slip fit) and a 4" PVC drain grate. At my local big-box, both the cap and the drain grate were $1.75. Simply turn the cap upside down and set the grate into it. Done! It's a nice round drip tray that not only is easy to clean, it can also serve as a pint glass holder while pouring.

For bonus points, paint the drip tray for a nice finished look. I painted the cap black and the grate metallic silver (see the photo on page 43). Make sure the paint is fully cured before using.

straight shanks (photo 4). If you intend to use the more compact right-angle shanks that are designed specifically for draft towers, check the diameter, as some of them require a larger hole.

Shank It Up

By far, it is much easier to go with a shank that was designed for a round draft tower. Just pop it through the hole and tighten the nut on the inside or follow the mounting instructions that come with it (photo 5). But you can save about $15 if you go with a standard 3-inch (7.6-cm) shank designed for mounting on flat surfaces.

The 3-inch (7.6-cm) shank is a little too long to accommodate a tail piece, wing nut and tubing. So I cut mine down with my trusty RotoZip and a metal cutting wheel. You could also use an angle grinder, a Dremel with an EZ-Lock metal cutoff wheel or even a hack saw with the right blade. Be sure to wear safety goggles when cutting metal.

After cutting the shank to size, you may need to use a ½-inch washer as a spacer to allow the shank nut to tighten fully against the inside of the tower. If you go the cheaper route, save yourself a lot of time and frustration by using a tailpiece with a 90-degree hose barb. A straight tailpiece is going to make for a much tighter fit in an already cramped space. Whatever type of shank you use, do a full fitting to make sure everything is spaced properly before painting.

To Glue, Or Not To Glue

The top cap should not be glued to the tower. You will need to remove it to gain access to the shank to change tubing in the future, or perhaps you will want to add another faucet at some point. A properly seated cap will have a snug fit and will not come off during typical usage.

You may, however, want to glue the tower to the flange base. Depending on which brand or type of flange you end up with, the fit may not be tight enough without glue to hold it steady during use. If you decide to glue the tower to the flange, follow the instructions on the PVC cement can to ensure a nice strong joint. Cement the pieces together before you paint.

Paint It Black

Adding a little paint to the tower is optional, but is also a cheap and easy way to class it up a bit, or make it match your serving area better. The most obvious color that comes to mind is silver or some sort of metallic finish. However, I have found that most metallic paints that work with plastic do not look very realistic once applied. Of the brands that I tested, the one that looks the most realistic is Valspar's "Brilliant Metal" series (I tested 66010 Silver). Therefore, I chose to go with lightly-glossed black paint for the majority of the finish, instead. I used Rust-Oleum "Specialty Plastic" paint (211338 Black).

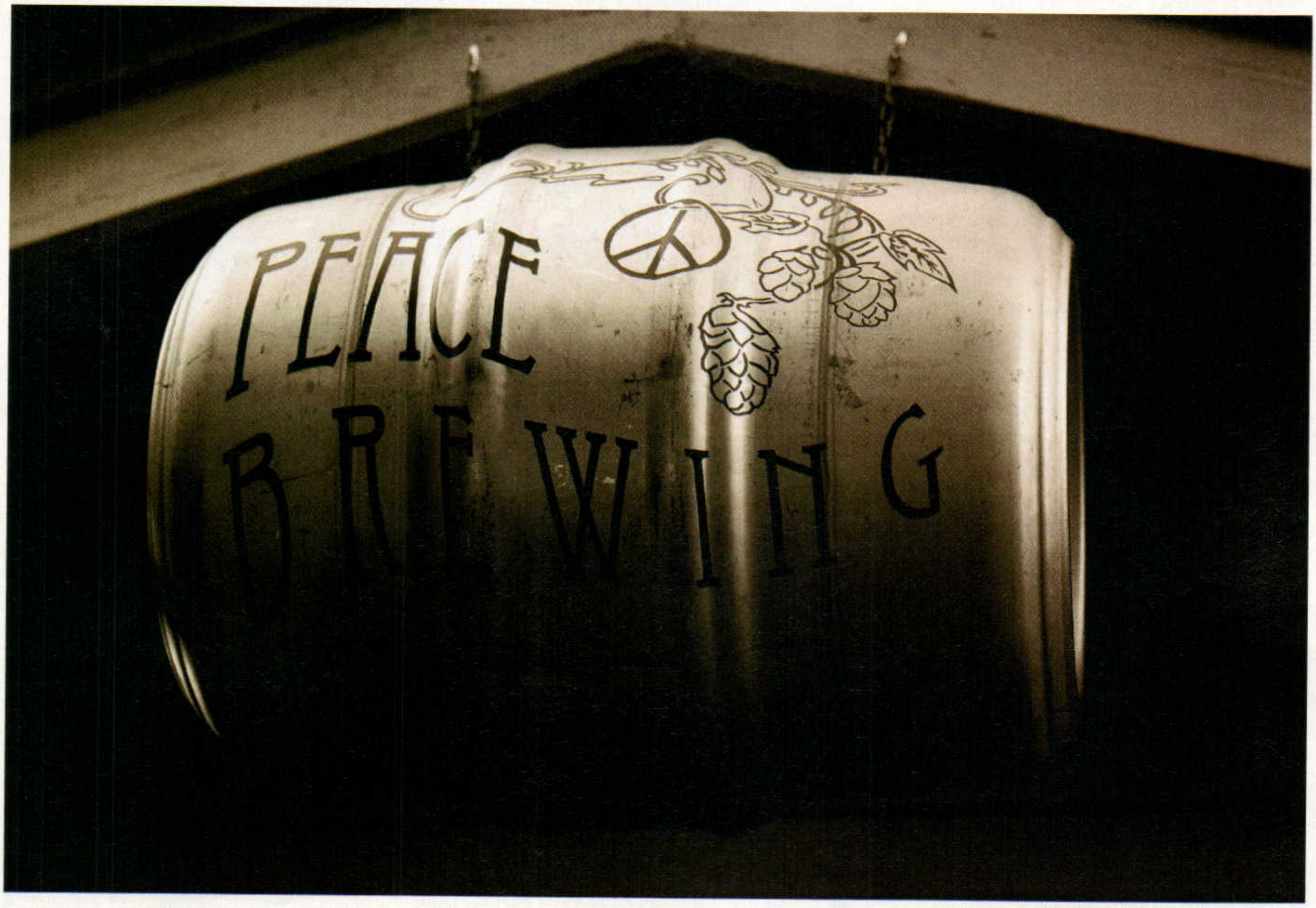
Clean all parts to be painted prior to spraying. You may or may not need to prime the PVC first (check the label on your paint). Two coats, at least, is a good idea (photo 6). The paint may take some time to dry enough to be handled for reassembly. If the tower or any fittings feel tacky to the touch at all, give it some more time (sometimes a few days) to fully cure.

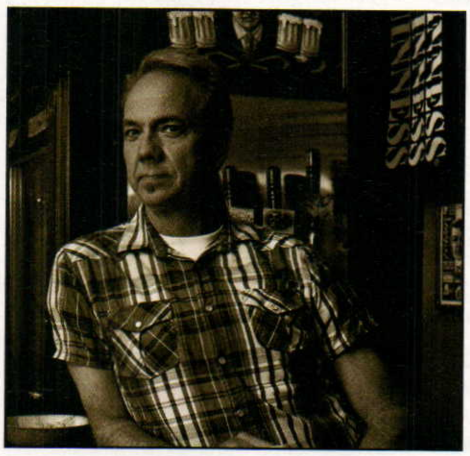
Now to reassemble. Refit your dispensing hardware first (photo 7). Then connect the pipe, flange and cap. Your new draft tower is now ready to be secured to your kegerator. (The process for this will vary greatly depending on the kegerator type and size.) When you purchase your PVC flange, take it over to the nuts-and-bolts section of the store and size out some proper fastening hardware. BYO

Forrest Whitesides is a regular contributor on the Final Gravity Podcast.

HOME BREWPUB

Photos by **Brian Evans**

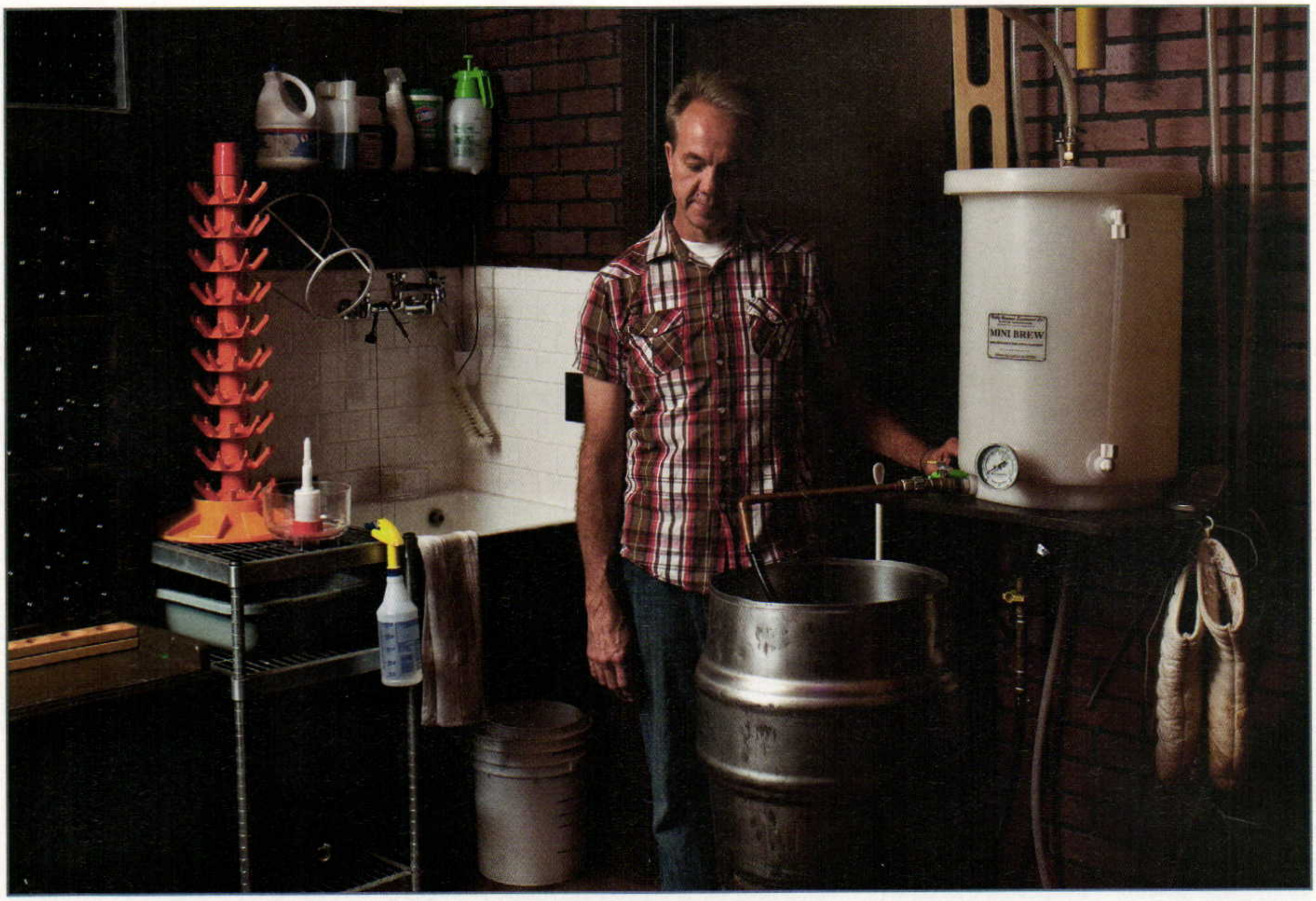


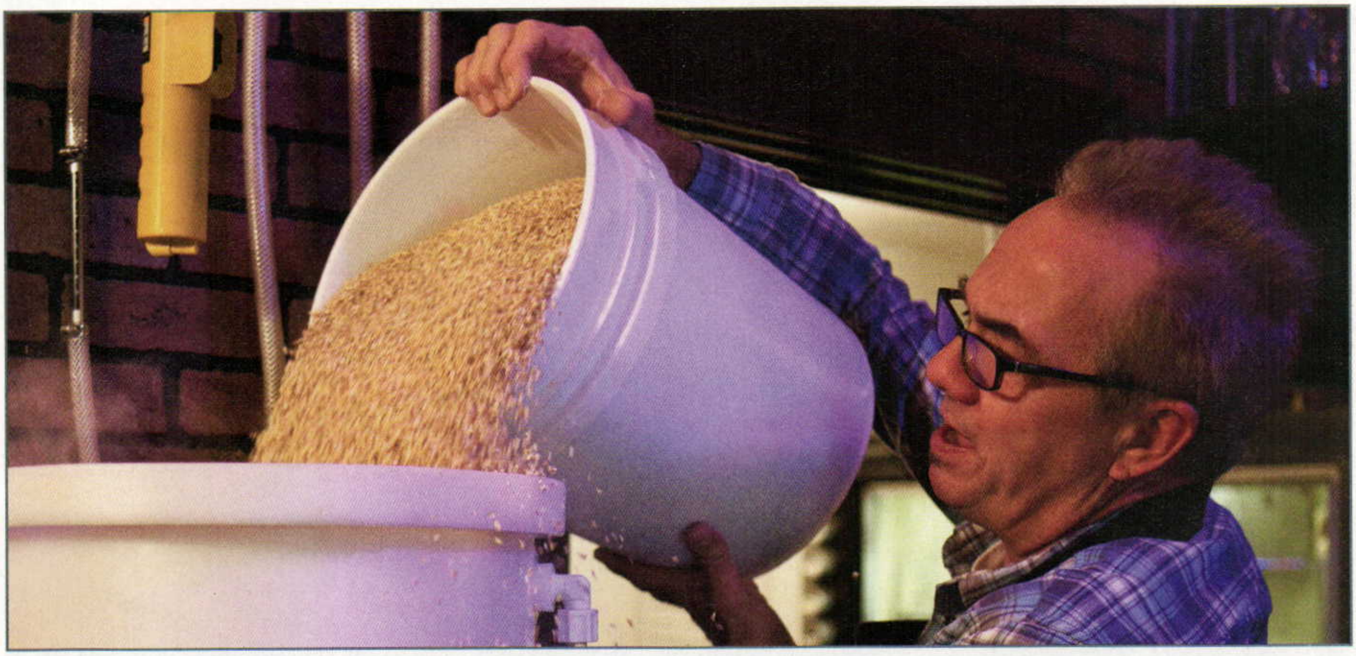


Every homebrewer dreams of their own dedicated space for brewing and entertaining. For Anaheim, California homebrewer Bradley Daniels, that dream came true in a big way three years ago when he and his wife bought a circa-1924 home in the historic district of the city with plans to restore it. The garage was inaccessible to a car due to a large stone wall built through the middle of the driveway, so the space was up for grabs — as a brewery.

"I had always dreamed of having a space to brew my homebrew and this was the perfect opportunity. After lots of visions we finally settled on our design," he said, which features a tap room, a fermentation refrigeration room and even a small gentleman's room (bathroom).

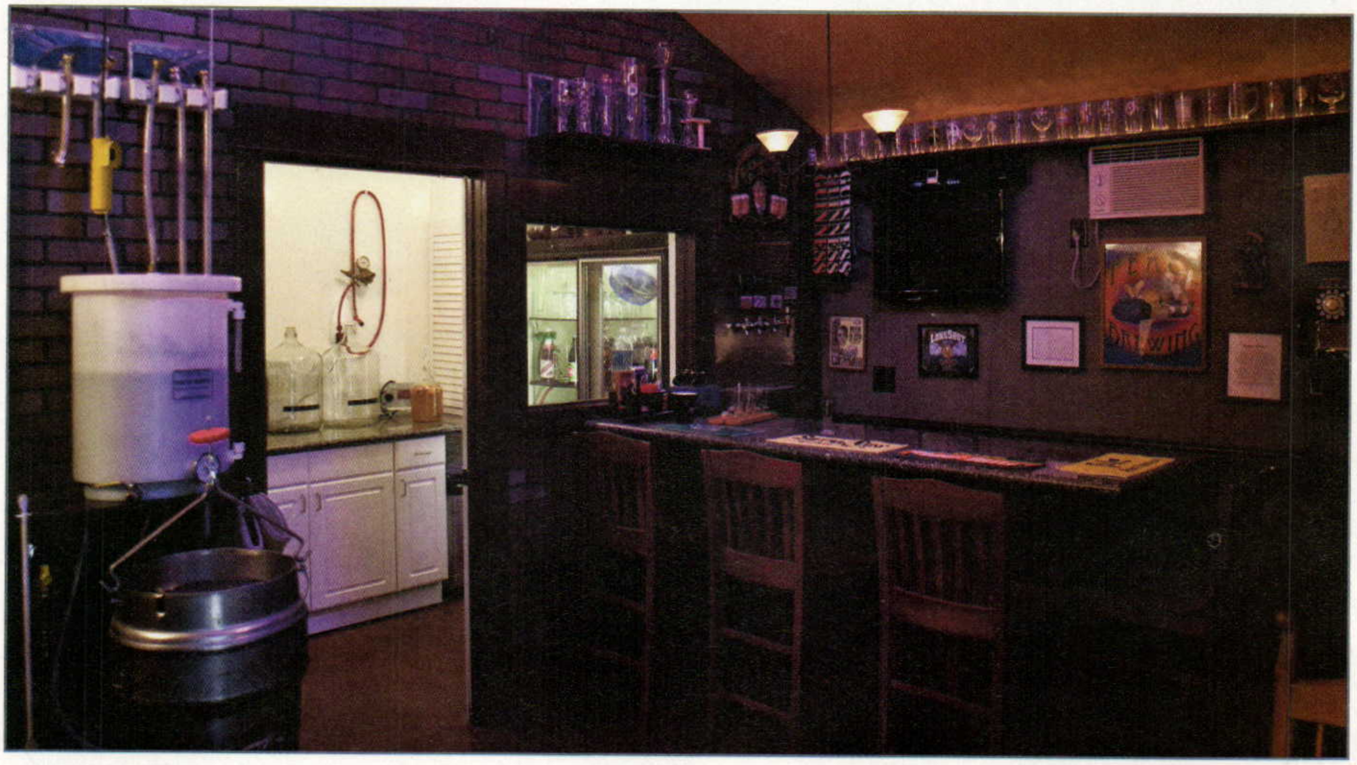
"I'm not a beer geek by any means," he claims. "I consider myself more of a beer ambassador. I'm all for promoting the hobby, no matter how big or how small — it's a blast." Homebrewers, welcome to Peace Brewing!





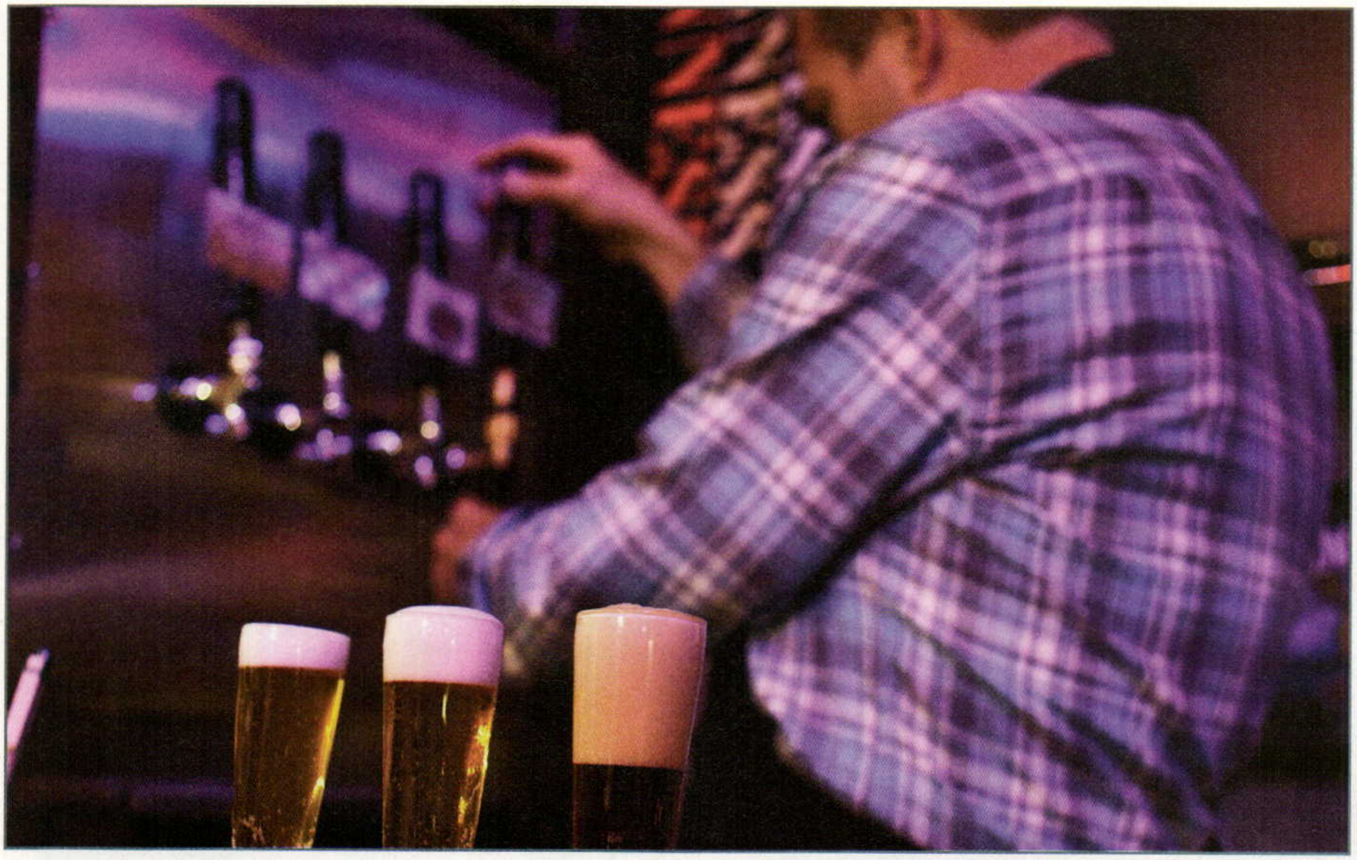
TOP: Bradley designed his 10-gallon (38-L) brewing setup to be easy to use while eliminating as much extra space as possible. He rigged his lauter tun up to an electric hoist, which moves the tank up and down at the push of a button, to eliminate the need for two burners. The brew kettle that he is standing in front of in this photo fits under the shelf beneath the white mash tun when not in use — leaving more space in the brewery/tap room for welcoming guests.

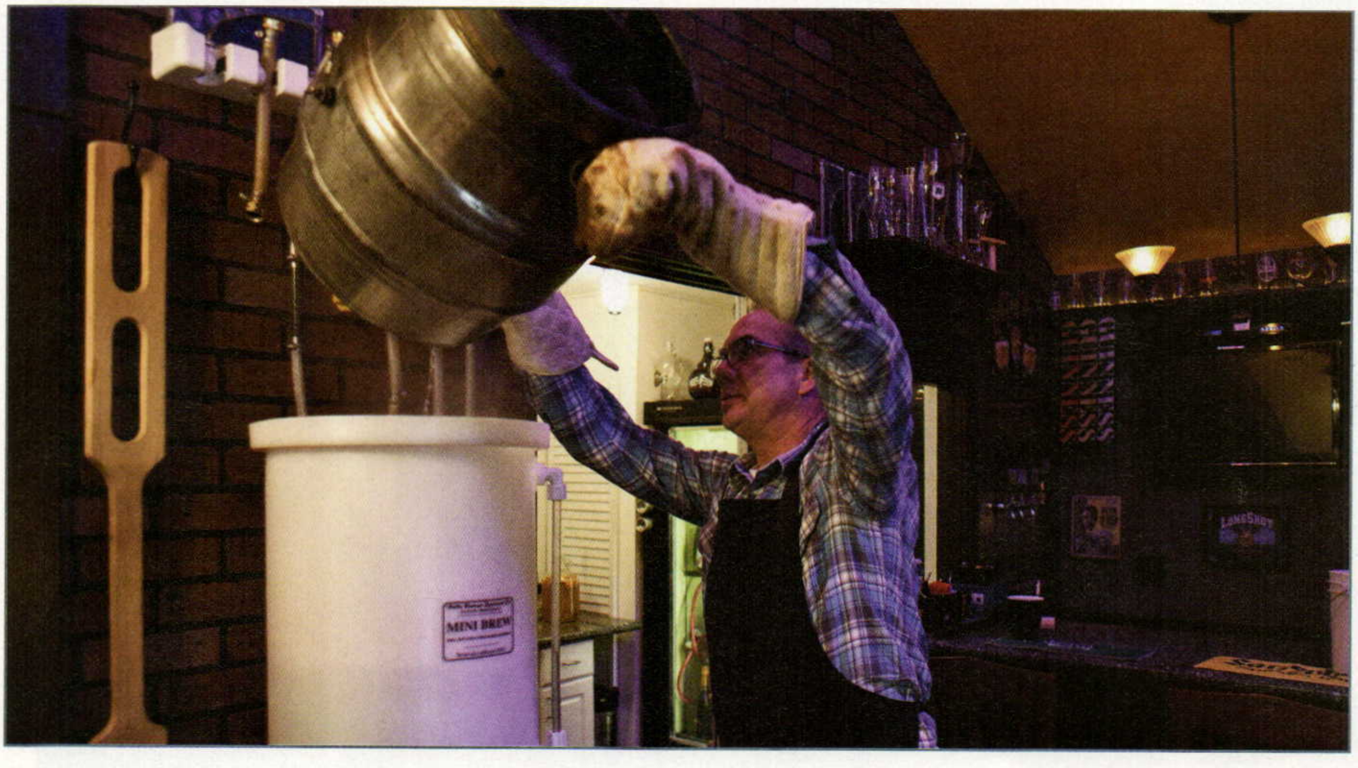
BOTTOM: Bradley has been brewing for more than 20 years. He is mostly an ale brewer, as he doesn't yet have the facility to lager, although he is considering adding a chest freezer to the homebrewery. But that doesn't mean there's any lack of beer. He estimates that he's brewed about 24 times in the past year and is constantly out of beer — although that's because he likes to entertain. He has welcomed many people to his homebrewery, including local homebrew clubs, who of course drink all the beer.



TOP: Behind the taproom/brewery is a fermentation room, which Bradley keeps at around 70 °F (21 °C) year round with a small air conditioner. This room also houses all of his grains, a rack for aging bottles with caged corks and most importantly a reach-in refrigerator with the kegs for the taproom kegerator (beer and soda) as well as glassware and miscellaneous bottles.

BOTTOM: In this photo, you can see the taproom with the bar, as well as the brewing setup and the fermentation room. The window between the fermentation room and the taproom is double glazed for better temperature regulation in the cool room. There is a flatscreen TV behind the bar and the walls are decorated with antiques and beer memorabilia from the 30s, 40s and 50s — including the lamp over the bar that was originally a gas lamp, restored and then wired for electricity.





TOP: Bradley keeps four beers on draft in the taproom at all times, including a stout that is dispensed on nitrogen (far right tap). Deceivingly streamlined and uncluttered, Peace Brewing also boasts features that only homebrewers can appreciate. For example, his draft system is run on a central CO_2 system with two regulators — one for charging kegs and the other for the beer gun. The brewery also has its own hot water tank, which he keeps at 150 °F (66 °C) to make heating water faster and cleaning up easy.

BOTTOM: There's lots of room to hang out, homebrew and enjoy a beer at Peace Brewing if you're in Anaheim. Between space in the taproom and a big backyard, he has been able to host groups with as many as 60 and 80 people at a time. Want a personal tour but can't stop by? Check out Peace Brewing on YouTube: www.youtube.com/watch?v=h3CzYqWRAhs BYO

BUILD A HOME BAR

Story and photos by **Christian Lavender**

As homebrewers, we put so much time, effort and care into making our beer — shouldn't we put the same into serving it? Serving beer in bottles lets you get creative with labels and names, but what about those of us who want beer on draft in our home? Home bars can run the gamut from a simple and easy construction project to an elaborate and intricate one. I chose the latter, taking the opportunity to kick it up a level and build the ultimate homebrewer's bar.

Barstorming

I wanted my home bar to cater to my homebrewing needs. I wanted it to seat at least four people, have cold storage for hops and yeast and a triple tap draft system — plus tons of storage for glassware, brewing books and bottled beer. Finally, it needed some sort of additional wow factor. I chose to display the beer color range in rows of grains on the front side of the bar and have a bar top pictograph explaining how to brew. I knew I shouldn't rush into the build without a little research, so I hit the internet, which is flooded with woodworking forums and bar plan websites. After looking at multiple styles and weighing my options, I decided on a simple straight style bar about 6 x 2 x 3.75 feet (1.8 x 0.61 x 1.1 m). The bar would need armrests and foot rails. An assortment of wood would be needed for framing, moulding and shelving. Adding the draft system, refrigerators and epoxy bar top, I could see this was a huge project already, but it was for a good cause — a place for homebrew worship.

Frame

Looking at all of the raw materials lying on my garage floor, I realized this project's success was going to be largely based on my measuring and woodworking abilities. I started with some 2x4s to lay out a base frame for the bar. I cut them using my compound miter saw — although a regular chop saw would work here, too — to the following lengths:

Four 6-foot/1.8-m 2x4s
Twelve 25-inch/0.64-m 2x4s
Eight 43½-inch/1.1-m 2x4s

I set up a pilot screw jig on a folding table and started drilling holes in pairs for the small interior framing 2x4s (25-inch/0.64-m). Only eight of the twelve boards needed the two sets of pilot holes on each end. I continued with pilot screw holes in the four 6-foot (1.8-m) 2x4s, drilling the same pair of holes on each end. Now I was ready to start putting the frame together. I laid out two of the 6-foot (1.8-m) 2x4s parallel and two of the small interior framing 2x4s (2-inch x 4-inch x 25-inch) with no drilled holes on the ends and screwed the pieces together. I used a small amount of wood glue on all joints just as additional support.

I next measured out the dimensions for the kegerator and shelve sections. The kegerator would need 25⅞ inches (0.66 m) of width clearance and the rest would be the shelve sections divided equally on either side. I dropped in my smaller 2x4 supports with pre-drilled pilot holes with the interior 43½-inch (1.1-m) 2x4s sandwiched in between. The width of the inside edges of these 43½-inch (1.1-m) 2x4s was measured out to give me my necessary kegerator clearance width of 25⅞ inches (0.66 m). I screwed everything down and moved on to the exterior 43½-inch (1.1-m) 2x4s. Making sure the boards were level and square, I screwed the boards on from the outside of the frame with 2½-inch construction screws and some glue. I clamped the ends and let the glue dry for a few hours. Once dry, I flipped the frame over and repeated the same steps for an identical frame on the bottom of the bar (photo 1).

The next step was to add bottom boards and interior backer boards. I used a skill saw, tape measure, L-square and a pencil to take my measurements and make my cuts. Right and left bottom boards were cut to 28 x 22 inches (0.71 x 0.56 m) and the center bottom board was cut to 28 x 25 inches (0.71 x 0.64 m). I tacked them in using a finishing nail gun and 1.5" brad finishing nails.

Interior side walls came next, and I made my cuts for the six panels needed. Left and right interior wall boards were cut 36 x 28 inches (0.91 x 0.71 m) and because the inner wall support beams are not set as wide as the outer

The frame of the bar is constructed from 6-foot, 25-inch and 43½-inch 2x4s.

To avoid a surprise later, be sure to test fit the kegerator early in the construction.

The interior walls and shelves are made of medium density fiberboard (MDF).

Victorian-style baseboards add a touch of class to the homebrew bar.

Supply List

Supply List	QTY
Triple Faucet Built-in Stainless Steel Kegerator	1
1⅔-Cubic-Foot Built-In Refrigerator	1
Traditional Wooden Bar Arm Rest Moulding (Oak) — 8 feet (2.4 m)	2
Base Moulding (Back) — 7 feet (2.1 m)	1
Base Moulding (Front/ Sides) —14 feet (4.3 m)	1
Grain Frame Moulding — 8 feet (2.4 m)	4
Panel Moulding	1
2x4s — 8 feet (2.4 m)	14
Embossed Moulding — 8 feet x 2 inches x 9⁄16 inches (2.4 m x 5.1 cm x 1.4 cm)	1
¾-inch Medium Density Fiberboard — ¾ inch x 49 inches x 97 inches (1.9 cm x 1.2 m x 2.5 m)	1
½-inch Medium Density Fiberboard (Shelves) — ½ inch x 2 feet x 4 feet (1.3 cm x 61 cm x 1.2 m)	3
Hardboard — 2 feet x 4 feet (0.61 m x 1.2 m)	1
Hardboard — 3⁄16 inch x 48 inches x 96 inches (5.6 cm x 1.2 m x 2.4 m)	1
Glass — 24 inches x 36 inches (61 cm x 91 cm)	2
Brushed Stainless Steel Bar Foot Rail Tubing — 2 inches x 2 feet (5.1 cm x 0.61 m)	1
Brushed Stainless Steel Bar Foot Rail Tubing — 2 inches x 4 feet (5.1 cm x 1.2 m)	1
Bar Rail Bracket – Brushed Stainless Steel	3
Flush Flat End Cap – Brushed Stainless	2
Steel Internal Splicing Sleeve	1
Custom Vinyl Graphics — 6 feet x 2 feet (1.8 m x 0.61 m) (BuildASign.com)	1
Stain (Dark Walnut)	1
Pipe Insulation	1
1½-inch diameter PVC – 12 inches (30 cm)	1
1½-inch Flanges	2
Fasteners, Screws, Nails	Various
Surge Protector	1
Shelf Supports	12
Kleer Koat Bar Top Epoxy (2 Gallons)	1
Tap Boards	3

Tools

- Compound Miter Saw
- Skill Saw w/ Fine Finish Circular Saw Blade
- Dremel w/ Rotary Tool WorkCenter
- Finishing Nail/Staple Gun
- Power Drill
- Drill Bits
- Biscuit Joiner
- Pilot Hole Jig
- Glass Cutter
- Sander
- Squeegee
- Foam Brushes
- Staining Pads
- Graduated Mixing Tubs
- Stir Sticks
- Propane Torch
- Striker
- Protective Eyewear
- Gloves
- Mask
- Wood Glue
- Bar Clamps
- Painter's Masking Tape
- Hammer
- Hack Saw (Door Jam Saw)
- Tape Measure
- L-Square Ruler
- Level
- Scraper
- Folding Tables (or Saw Horses)
- Wood Filler
- Sandpaper
- Pencil
- Silicone

boards, I cut four boards to 36 x 25 inches (0.91 x 0.64 m). I tacked the boards in using the nail gun.

At this stage, make sure the draft refrigerator fits with adequate clearance (photo 2). My kegerator is built for under-counter use and requires adequate space and ventilation, so I designed the bar to allow the kegerator to expel hot air around and through the shelf sections. The center support beams and interior walls leave a two inch space to allow great circulation of air to keep the refrigerator cool.

Trim and Moulding

Next, it was time to add the exterior panels and trim with cutouts for the grain frames. I had the guys at the hardware store cut my panels into 4-foot x 4-foot (1.2-m x 1.2-m) sections, which made them easier to handle. With my skill saw, I cut two panels for the sides to 43½ x 28 inches (1.1 x 0.71 m). My front panel was split into two sections both measuring 37½ x 44 inches (0.95 x 1.1 m). I added a support 2x4 behind where the two panels meet. This gave me something to nail the panel into and make an unnoticeable seam.

On each panel, I measured down 10 inches (25 cm) from the top and then 4 inches (10 cm) from the right side on the right panel, and 4 inches (10 cm) from the left side on the left panel to make my jig saw cuts for the frames. The openings measured 21 x 27 inches (0.53 x 0.68 m). When the cuts were completed, I nailed the panels down with the finishing nail gun and the 1½" brad nails.

Shelves were needed next, so I measured three shelves at 25 x 21½ inches (0.64 x 0.55 m) using the medium density fiber board (MDF) and cut using the skill saw (photo 3). I had some decorative moulding for the front side of these shelves, so I nailed them on. I didn't get very precise with my shelf heights, but I did use a level when mounting the shelving brackets. (You can always come back and punch out a few new holes if you need to raise or lower them in the future.)

The same moulding I used for the fronts of the shelves was used for the

A jig for the Dremel is used to router the grain frame to accept the glass panes.

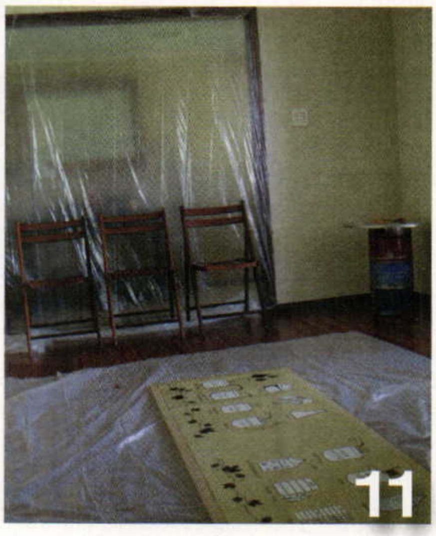
The two slots are spaced far enough apart that one layer of grain will fit between.

Before staining the wood, the glass is test fit into the grain frame.

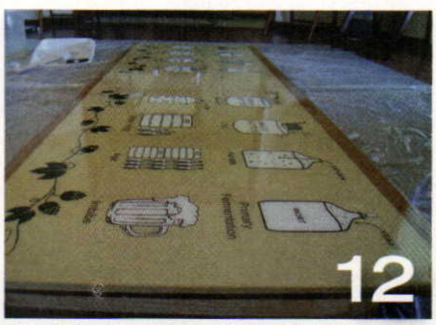
The grains were slid between the glass panes using rolled paper as a funnel.

One of the finished grain frames, showing a range of malt colors.

A biscuit joiner was used to join the mouldings used as the armrest on the bar.



A makeshift clean room was prepared for applying epoxy to the bar top.



The finished surface, clear and free from bubbles, after 24 hours of curing.

corners of the bar to cover where the decorative panels met. These mouldings were in the shape of an L and were cut to 36½ inches (0.93 m). I chose some Victorian style baseboards (photo 4) for the front and sides of the bar due to their height. I would be adding a foot rail later in the build and needed a baseboard with at least 6 inches (15 cm) height for mounting the foot rail brackets. Here's where you really need a compound miter saw. I measured out a 77-inch (2.0 m) section and two 28.5-inch (0.72 m) sections. I made some 45 degree cuts using my measurements as the long side of the cuts and glued/nailed them into place. To get a nice smooth corner, I used stainable wood filler, let it dry and then sanded it.

Grain Frames

Now I needed to get started on the grain frames. I wanted four vertical columns of different colored grains in each frame between two layers of glass. I chose to do this, so I could light up the grains from the inside at some point if I wanted to. Otherwise you can just create a top layer of glass and a solid backboard.

I took some of the decorative grain frame moulding and measured out enough wood for two 30 x 24 inch (76 x 61 cm) frames. These are the long side measurements after you make your 45 degree cuts using the compound miter saw. Not having a router, I set up a Dremel tool in a rotary workstation (photo 5). This let me use the Dremel as a router with a special ⅛-inch wood routing bit. I wanted to groove out two channels in each piece on the inner side of the frame to allow the glass to slide in, but leave enough room in between for one layer of grain (photo 6). I set the Dremel bit height for a 1⁄16-inch (1.6 mm) deep groove and started my routing. (You may need to tweak this measurement depending on your glass cutting precision.)

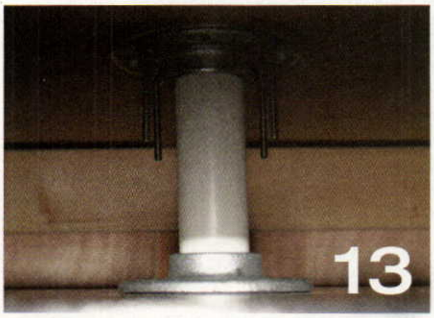
I bought some glass panels and a glass cutting kit that had a wax pen, glass cutter and cutting oil. Handling glass is never one of my favorite activities. I wore protective eyewear, gloves and made sure to take off my flip flops and put shoes on. I never thought cutting glass was going to be a big deal, but boy was I wrong. I needed four 18 x 24 inch (45 x 61 cm) panes of glass, which meant all I needed to do was cut my 36 x 24 inch (91 x 61 cm) panes in half. Sounds easy right? Wrong. I spoke with a guy at the hardware store and he mentioned that the heat (111 °F/ 44 °C that day) was going to make cutting glass with a clean edge almost impossible. After four botched attempts, I really took my time and made sure to clean the glass front and back with window cleaner where I was going to make the cut. Finally I snapped the correct sizes and victory was mine.

I sized the glass in the frames before connecting all the frame pieces (photo 7). Using a biscuit joiner, I made cuts on all the frame ends with #10 biscuits and started constructing a framing jig. I threw some 2x4s together, so I could glue my frame together and slide it into the jig to dry. (You can also use a framing clamp or regular bar clamps for this.) I left off a side piece of the frame, so I could slide in the glass and grains after the three sides finished drying.

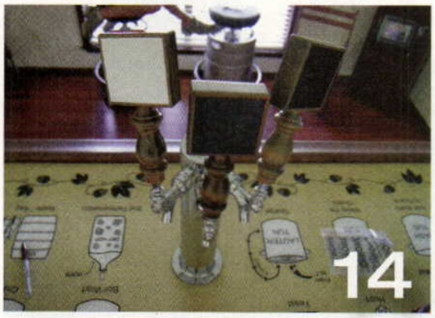
Next, I stained all of the frame wood, so I wouldn't need to mask it off later. Once the stain dried, I slid in my glass and measured out four 6" sections with tape. I started to add in my grains. Rolling up a piece of paper to make a small funnel seemed to work well navigating the grains down into their final resting place (photo 8). This was time consuming. After the last grain fell in I was able to glue down the last frame side to seal everything together (photo 9). (I had help picking out the right colored grains from Dave, Luke and Christian over at Austin Homebrew Supply. Thanks guys!)

Bar Top

For the bar top, I took a piece of ¾-inch MDF and cut it to 71¾ x 27 inches (182 x 69 cm) using my skill saw. Next, I cut my front side arm rest at 45 degree angles to measure 77¾ inches (197 cm) on the long side. I made matching 45 degree cuts for the left and right side arm rails and cut them to 30¾ (78 cm). The biscuit joiner came in handy again for cutting nice slots out



Insulated PVC pipe between the kegerator and draft tower keeps the beer cold.



Erasable tap handles make labeling the beers on tap a snap.

A stainless steel footrest is screwed into the frame 2x4s for adequate support.

The bar stores a variety of homebrew essentials — from ingredients to books.

for #20 biscuits (photo 10). I lined up the armrests on the bar top, glued and clamped the pieces together.

You may have to use shims (I used biscuits) to level out your bar top and align your arm rails. I used stainable wood filler on the corner joints, let it dry and then sanded.

I wanted the bar top to have some sort of teaching element, so I mocked up some step-by-step brewing graphics, had them printed out by a local company (Austin Graphics), and I was able to pick up a 6 x 2 foot (1.8 x 0.61 m) adhesive vinyl banner within a few days. The top needed to be covered in an epoxy coat to seal in the graphics and protect the bar top from spills. I had to construct a clean room using plastic tarps and also had to shut off the air conditioning vents to limit particulates in the air (photo 11). Layering epoxy on the bar is a long multiple step process, but anything with a blow torch as a required tool seemed fun.

Any dust, hair, insects, etc. that hit the epoxy will stay in the epoxy forever, so I had to clean the room thoroughly before I started. I gathered my tools which included the Kleer Koat resin and hardener, measuring buckets, squeegee, sponge brush, stir stick and propane blow torch, and headed into the clean room. The first layer of epoxy is called the seal coat and only required a small amount. I poured together equal parts of resin and hardener and waited four hours for this to dry. This coat is just to seal everything and pull out any small oxygen bubbles on the surface of the graphic and wood top.

The next coat is called the flood coat. Use the same mixing ratio of resin to hardener depending on your square footage and mix, mix, mix. Mixing for this took around ten minutes using a painting stir stick. Your wrists get tired, but this is the most important part of the job. You have to slowly mix the epoxy without whipping the mixture. Air bubbles at this point are bad things. (The propane torch is to get rid of small bubbles after the epoxy is poured.) The mixture has a haze in the beginning, but after about ten minutes of mixing, it clears up, indicating that it is ready. After just one flood coat and 24 hours to cure, the bar top looked great (photo 12).

During this drying time, I started staining the rest of the bar. I used a combination of staining pads and sponge brushes to get into small places. When it was time to put the bar top pieces together, a buddy and I placed the bar arm rest on the ground upside down and placed the bar top in. I nailed the bar top into the arm rest from underneath so you could not see any nail marks on the top side. Once this was completed, we put the bar top back onto the bar frame and I drilled a hole for the tower. The hole diameter measured 2⅛ inch (5.4 cm) and was centered using the instructions in the kegerator manual — 12 inches (30 cm) from left to midpoint, 12 inches (30 cm) from right to midpoint and 12.5 inches (32 cm) from front to midpoint.

Tower

From the draft tower down to the kegerator is a 7–8 inch (18–20 cm) gap, so I mounted a couple 1½-inch flanges, one on the kegerator and one on the underside of the bar top. (I already had a few of these and they were cast iron, but if you can find plastic that would probably work better.) These are most commonly used in sprinkler irrigation systems and pool pumps. Between these two flanges I ran a piece of 1½-inch PVC pipe and insulated it with HVAC insulation (photo 13). Next I slid the beer lines down the PVC and into the kegerator, aligning the tower on the bar top. I marked the tower holes and drilled some pilot holes for the bolts that came with the draft tower assembly. The bolts went into the tower through the bar top and flange and were secured with a washer and hex bolt. Unfortunately, the pre-drilled holes in my flange did not align with the pre-drilled holes in my tower, so I had to drill new holes. I used a little WD40 as lube and drilled down through the cast iron with a metal bit, roughly the same diameter as the bolts. I used plastic gaskets with the flanges and on the bar top tower to seal everything together. The final touch to the tower was three Tap Boards: chalkboard, white and black dry erase (photo 14). These let me write and erase my homebrew names as needed.

Final Touches

A bar just isn't complete without a footrest, so I ordered 6 feet (1.8 m) of brushed stainless steel tube, rail brackets and end caps. The rail brackets required a few pilot holes to secure the footrest to the bottom of the bar. I drilled through the moulding and framing, tightened the brackets, slid in the tube and capped the ends (photo 15).

The kegerator I purchased came with an air tank, 3-way air distribution valve, and beer and gas line fittings to dispense beer out of three kegs. This means all of the kegs are under equal pressure. I like to keep my air system simple, but you could purchase two or three valve regulators that would allow you to control the amount of pressure in each keg. I have a few other systems in my garage that I use for force carbonating, so the CO_2 saturation is set before the kegs enter the house.

My hops and yeast went into the mini-fridge and the temperature was set to 33–38 °F (0.5–3.3 °C). Avoid freezing the yeast as ice crystals will rupture the yeast cell walls. The mini fridge is a great place to store your harvested yeast, starters and any bugs you happen to be culturing.

Under the mini-fridge, I used the shelf space to store my grains. I was able to fit a full bag of 2-row and a few other bags of mixed grains. Enough grain to brew around 25 gallons (95 L) of beer. On the remaining shelves I stored some brewing books and magazines, an assortment of glassware and other brewing equipment that never had a good home until now (photo 16).

The bar has reached completion and is ready to enjoy. I pushed my woodworking skills to their limit, but this project was a lot of fun. I already have a wish list of additional features I will add in the future like a built-in yeast stir plate, hop scale and under-counter lighting. BYO

Christian Lavender is a frequent contributor to Brew Your Own. *He is the founder of homebrewing.com and lives in Austin, Texas.*

My quest to brew a flavorful but quaffable session ale was coming up short. I was getting wonderfully high extract efficiencies, near 90%, but my ordinary bitters, milds and Scottish ales were coming out watery and bland.

Then, in the spring of 2008, I had a homebrew-life-changing experience with an ordinary bitter I judged in the first round of the National Homebrew Competition (NHC). The depth of malt character far surpassed anything I had been able to achieve, while the beer remained dry and highly drinkable. It was clear this was not just crammed with crystal malt. There was something I was missing.

I later found out that the beer won first place and was brewed by none other than Jamil Zainasheff (*BYO*'s "Style Profile" columnist and coauthor, along with John Palmer, of "Brewing Classic Styles" (2007, Brewers Association).) This was extremely fortunate because I had brewed his exact recipe several times, so it meant there was either something different with his technique or ingredient sources. Ultimately, through an email exchange, I narrowed it down

Story by **Dave Louw**

NO SPARGE BREWING

to a significant efficiency difference. In his book, Zainasheff did not just pick a 70% efficiency target to provide a common standard; he felt the beers were noticeably better compared to those brewed with extract efficiencies in the mid-80% range and higher.

Hearing one of my homebrew idols poo-poo the common practice of chasing high efficiency totally changed my approach. In the following year I researched, experimented with, and refined my technique to consistently hit around 70% efficiency. Ultimately I settled on no-sparge lautering as the key. Everything came together for NHC 2009 when I entered my vastly improved ordinary bitter and won first place in the Southwest region. Since then I have used this technique on nearly all my beers and seen a significant increase in malt aroma and flavor complexity.

What Is No-Sparge Lautering?

Lautering is simply the process of separating the wort from the grains after mashing. Historically, commercial brewers discovered that if they sparged (rinsed) the grain bed with additional water during the lauter, they were able to get a higher yield of fermentable sugar from the same amount of

No sparge brewing simplifies your all-grain brew day by just draining a mash similar to this photo all at once into your boil kettle with no additional step of rinsing grains with more water, as in batch and fly sparging.

grains. This increased efficiency improved profits and so became standard practice for the vast majority of breweries.

Fast forward to recent times and you will see that homebrewers commonly use either continuous or batch sparging when brewing all-grain beers. Continuous sparging directly scales down the commercial practice of adding water to the top of the grain bed while simultaneously draining wort from the bottom. It can be tricky to do consistently as matching flow rates, avoiding channeling and repeating the process identically batch after batch requires practice and/or specialized equipment. The pragmatic alternative of batch sparging instead involves adding water and draining the grain bed two or more times in sequence.

No-sparge brewing is just what it sounds like. You entirely skip the sparging step and just drain the wort from the mash into the boil kettle. While that sounds simple — perhaps even lazy — the benefits are numerous.

Why No-Sparge?

The primary reason I switched to no-sparge lautering was the flavor difference, especially in lower-gravity beers. When compared side by side, I perceive a greater intensity of fresh malt character from beers I brew without sparging. By that I mean that the beer has an aroma and flavor that matches the aroma you experience when you open a new sack of malted grain. Surprisingly, this comes without the beer being perceptibly sweeter or more viscous, as you would get from adding large amounts of specialty grains.

I have yet to see a good explanation for why this is the case. Perhaps the uniformly higher gravity of the wort prevents some level of tannin extraction that comes from sparging. Maybe there is some difference about the first compounds that are extracted compared to those extracted during the tail end of rinsing. I just know what my taste buds and other drinkers tell me they perceive in the finished beer. Despite the added ingredient cost, there is at least one commercial beer produced this way — Kirin Ichiban.

Beyond the improvements to the beer, there are several practical benefits to no-sparge brewing. No-sparge brewing is simpler — you don't need to worry about matching the inflow rate of your sparge water with the outflow rate of your wort. No-sparge brewing also requires less equipment — you don't need a separate hot liquor tank (or HLT) or a sparge arm to deliver the sparge water.

This approach can save time too. While there are ways to speed up continuous sparging, it often takes 30–60 minutes depending on your target volume. With batch sparging you need to add water, stir and recirculate for each "batch" (usually there are two). No-sparge lautering skips all of this in that you simply recirculate and then drain as quickly as you possibly can without sticking the mash. Of course, if your burner takes a while to heat up your runoff to boiling, this time saving may be moot.

In terms of difficulty, no-sparge is easy to do consistently and correctly. When I first started brewing all-grain, I was overwhelmed with all the variables in the process. Did I miss my gravity because I was having channeling? Was I sparging too quickly? With no-sparge brewing there is one less step to go wrong. With fewer variables in the process, there is subsequently less variability in the output. I consistently get 68–72% efficiency with beers in the 1.032 to 1.050 SG range. As the gravity goes up, the efficiency drops in a very predictable way.

From an equipment standpoint, no-sparge brewing means that you can skip the hot liquor tank and associated burner. Because you do not need to store sparge liquor while draining from the mash, the boil kettle is the only heatable vessel you really need. Additionally, the fluid mechanics of no-sparge brewing mean that, as with batch sparging, you can use a simple slotted manifold or braided hose rather than a more costly false bottom. In fact, an ideal setup is a large cooler with hose braid or manifold, a boil kettle and a burner. Set up the vessels on two levels so you can use gravity to transfer the wort.

Step by Step

Applying the no-sparge technique couldn't be easier. Start off by calculating how much water you need. While some homebrew sources warn against using a thin mash, there are actually some benefits. My experience matches what Kai Troester's experiments (seen at braukaiser.com) have shown: a thinner mash of 2.5 quarts of water per pound of grain (5.2 L/kg) or higher results in better conversion with no real drawbacks. In the interest of simplifying the process, add all your brewing liquor up front during the dough in.

There is no mystery or magic in figuring out how much water you need. Water added to the mash tun ends up in one of three places: in the boil kettle, pooled in the dead space in the tun or absorbed in the grain. To determine your total, you simply add up each part. My target pre-boil volume for a sixty-minute boil is 7.25 gallons (27 L). My mash tun has a dead space of about 1 quart (~1 L). That just leaves the water absorbed by the grain bed. An approximation that has served me well is that one pound of grain absorbs one half of a quart of water (roughly one liter of water per kilogram of grain.) So, for a beer recipe with 12 pounds (5.4 kg) of grain, I expect 6 quarts (5.7 L) of water to be absorbed and lost. Adding that all up for the theoretical batch on my system totals 9 gallons (34 L) of water.

Heat the entire volume of water to the desired strike temperature and transfer to your mash tun (or heat directly in your mash tun if possible.) Dough in and mash as usual. For my setup, I mash in a stainless kettle and so I need to heat and stir a few times to maintain my desired temperature, regardless of mashing technique. Doing this has the side effect of evenly dissolving the sugars throughout the brewing liquor. If you do not normally stir, you will want to do so at least once at the end of the mash to get the sugars mixed evenly. Recirculate a few quarts as usual until the wort runs clear.

Now comes the easiest part. Simply open the drain valve on your mash tun and let it transfer as fast as you want without getting a stuck mash. Just as in batch sparging, the actual speed is irrelevant because you are not rinsing, you are simply separating the wort from the spent grains. At this point, you should have the desired pre-boil volume and you can proceed with the rest of your process as usual.

Since your entire pre-boil wort volume is in the mash tun, you can easily check to see if you hit your target specific gravity by sampling wort from the mash tun. Once you get a negative iodine test, stir the mash and let it sit for a minute (to let the grain solids settle out a bit), then take a specific gravity reading. Your pre-boil gravity should be $C_p=(C_tV_t)/V_p$ (where C_p is pre-boil specific gravity, C_t is target specific gravity, V_t is target post-boil volume and V_p is pre-boil volume). If you have not reached your pre-boil gravity, let the mash sit and sample again after 5 minutes. You may be able to save extra time by not needing to mash for a typial 60 minutes.

One variant on this procedure is to retain enough water from your total water volume to perform a mash out. Before running off the wort, transfer the last bit of (boiling) water from your kettle to the mash tun. Stir the mash,

then recirculate after about 5 minutes. In addition to the usual benefits of a mashout, this can save you even more time, as you will be heating your wort from 170 °F (77 °C) to boiling instead of mash temperature to boiling.

The Drawbacks

Of course, if no-sparge brewing had no downside, brewers would never have developed the techniques and equipment to sparge, nor would they invest the time and energy on each batch. The obvious drawback is lowered extract efficiency. On a commercial scale, a 70% efficiency would be a big hit to profitability in what is a very competitive industry. A jump to 90% efficiency means a brewer can use roughly ¼ less grain. This is true on the homebrew scale as well, but in the grand scheme of things our costs are often less critical.

Since you need to use more grain and because you will put all your brewing liquor into the mash tun up front, your mash tun capacity can be an issue. A 10-gallon (38-L) cooler at 70% efficiency is able to make a 6-gallon (23-L) batch at 1.052 gravity when filled to its maximum. To increase the gravity, you can decrease your batch size to 5 gallons (19 L) and get closer to a 1.076 batch. Or, if you upgrade to a 15-gallon (57-L) mash tun, your possibilities are practically limitless for six gallon batch sizes (a back of the napkin calculation shows something around 1.115 using 35 lbs./16 kg of grain.)

Another problem with having all the water in your mash up front is that if you like to do step mashes you have got more thermal mass to deal with. This will require either more heat or time to bring the mash up to the next step. I personally do not do step mashes, so this has not slowed me down.

The final drawback is a bit more subjective. Brewers typically fine tune recipes without the effects of no-sparge brewing in mind. Skipping the sparge can lead to a beer that is out of balance. For example, I have had trouble getting that slightly tannic roasty character that I like in dry stouts. Instead, the subtly nutty and biscuit-like Maris Otter base malt masks. The solution is to adjust the amounts or types of grains. Consider switching some or all of your Maris Otter base malt for a domestic two-row, perhaps. Dial back crystal malts. Or, simply brew these beers using either continuous or batch sparging.

Conclusion

Whether or not you decide to switch all your beers to no-sparge lautering, this can be a useful trick to have in your brewing repertoire. Consider pulling it out when you want to make a tasty beer that doesn't knock you over with an alcohol punch or weigh you down with excess calories. Or, try it to save time and simplify your process. BYO

This is Dave Louw's second article for Brew Your Own *magazine.*

Homemade Malts

Make your own amber and brown malt

by Terry Foster

Many homebrewers have probably wondered about making their own malt. After all, we don't have to brew at home to get good beer these days, so we do it because we like the reality of drinking the results of our own efforts. What great satisfaction it is to be able to enjoy a great, perhaps unique beer, with your friends that you have put together with your own two hands. If you've already brewed beer with purchased ingredients you may want to go a step or two further down the self-made path, such as growing your own hops. Many homebrewers grow their own hops, and one or two commercial brewers, such as Sierra Nevada and Anheuser-Busch, do too. It's not too difficult if you have a little in the way of growing skills and a reasonable patch of ground available. But if you've done that, too, what about trying your own malting?

I know some of you out there have tried malting at home, and I applaud those who have. But malting isn't for everybody, for it is quite a complicated procedure. To malt at home you need access to a source of barley of a suitable quality for malting and brewing, and also the ability to follow a process that requires constant attention for a few weeks. You need a fair bit of space to set up the malting "couch," as well as some skill to design and build a kiln, which will permit drying of the green malt so that the final malt comes somewhere near to that available commercially. If you want to have a go at this process, read the article "Malt your Own" in the "Techniques" section of the March-April 2007 issue of *Brew Your Own*.

Yet that story covers malting pale malt, the basic raw material of most beers. So what about specialty malts, which are as important as pale malt, hops and yeast when it comes to producing a quality, flavorful and distinctive beer? There's a huge range of specialty malts available these days, and since by definition they are only used in relatively small amounts you won't want to make all of them. And some specialty malts are more difficult to make than others. Caramel/crystal malts require roasting green malt (to which you may not have access), and heating it in a closed system so as to stew the wet malt. A brief description of a method for this is given in the "Malt Your Own" article referred to earlier. High roast malts such as chocolate and black malt require quite high temperatures, usually in the range of 420–450 °F (215–232 °C). Acrid, unpleasant fumes are created during the process, and the final temperatures are close to the combustion point of the grain, so that there is a significant fire hazard in this process (the malt is quenched with water as soon as the required color has been obtained).

In between those two extremes of malting are amber and brown malts, which can be produced quite simply at home by moderately roasting pale malt. These are not as common today as other specialty malts, although they are available from homebrewing suppliers. In fact, my information is that whatever the name on the label may say, they are likely made at only one English plant, which lies right in the heart of the area where brown malt was originally made for the London porter brewers back in the 18th century. Amber and brown malts fell out of favor with English brewers, especially the larger ones, and maltsters generally stopped producing them. Fortunately, the craft brewing revival here and in Britain has seen an increase in the popularity of porters and stouts and a consequent upsurge in the demand for amber and brown malts. Indeed, when I visited that plant a couple of years ago they were just completing installation of a brand new, state-of-the-art brown malt kiln.

Porter and stout are the styles where these malts are most suited and

"The craft brewing revival here and in Britain has seen an increase in the popularity of porters and stouts and a consequent upsurge in the demand for amber and brown malts."

Photo courtesy of Briess Malts

most commonly used, although they can be employed to good effect in mild and brown ales as well. I (and others such as The Durden Park Beer Circle) have used them successfully in re-creating 18th and 19th century stouts and porters, a never-ending quest on my part! Of course, you should not assume that these modern malts exactly match the original brown malt used in porter brewing, for the roasting process today is quite different from that used earlier. Nevertheless they are as close as brewers can get in trying to work out how porter and stout once tasted.

But if amber and brown malt are commercially available, why should we bother to make our own? Well, first of all there's the satisfaction of doing it yourself. Then there is the fact that because the commercial supply is limited we can expand the range of flavors available to us. In other words we can adjust the degree of roasting to produce a range of color (and therefore flavor) around the specification of the commercial malts. Finally, and perhaps most importantly, is that freshly-roasted amber and brown malts have a fuller flavor and aroma than other malts stored for a lengthy period after aging.

Let's do it

This method owes something to the book *Old British Beers And How To Make Them*, published by The Durden Park Beer Circle. Note that the temperature settings given are those recorded on a thermometer (thermocouple type). Settings on the cooker dial may not be as accurate, but should be close enough for practical purposes. However, it would be wise before you start to do a check against a thermometer for at least one setting, say 250 °F (121 °C), just to be sure.

Amber malt procedure

Set the oven to 185 °F (85 °C), then take 5 lb. (2.3 kg) of pale malt (preferably malted from Maris Otter barley) and place it in a shallow pan. Spread it as evenly as possible in the pan to a depth of about 1 inch (2.5 cm); use a smaller amount if necessary so that you do not exceed this depth. Place it in the oven for 25 minutes, then set the temperature to 190 °F (88 °C) and leave for 30 minutes. Raise settings in steps at 200 °F (93 °C), 220 °F (104 °C), 230 °F (110 °C), and 250 °F (121 °C), allowing a 25-30 minute rest at each setting. At this point take a number of corns (15-20) and break or cut them; they should have a very pale brown or buff color, when compared to a sample of the starting pale malt. This is then the lowest color level for amber malt, and can be used as such in a brew. In order to develop the full color continue at 250 °F (121 °C) for 45 minutes or so, until the grain samples show a definite pale brown color, which is about the maximum color for amber malt. If you have a few grains of commercial amber malt

Continued on page 68

AMBER AND BROWN MALT BEER RECIPES

1822 Porter

(5 gallons/19 L, all-grain)

OG = 1.052 (12.9 °P)
FG = 1.021 (5.3 °P)
ABV = 4.0% IBU = 40 SRM = 50-60

Ingredients

3.8 lb (1.7 kg) 2-row pale malt
3.8 lb (1.7 kg) your own amber malt
3.8 lb (1.7 kg) your own brown malt
10.6 AAU Simcoe hop pellets (0.9 oz./25 g, at 12% alpha-acids) (90 min.)
1 oz. (28 g) Simcoe hop pellets, (0 min.)
White Labs WLP002 (English Ale) or Wyeast 1098 (British Ale) yeast

Step by Step

Mash the grains at 148 to 150 °F (64 to 66 °C) for 90 minutes. Run off and sparge to collect 5.5 to 6 gallons (21 to 23 L) of wort. Boil for 90 minutes adding bittering hops at start, and finishing hops as heat is turned off. Cool and pitch yeast (preferably as 1 quart/1L starter prepared in advance), ferment about one week, rack to secondary and one additional week bottle or keg.

Pale Porter

(5 gallons/19 L, extract with grains)

OG = 1.071 (17.3 °P)
FG: 1.022 (5.6 °P)
ABV = 6.4% IBU = 45 SRM = 30-40

Ingredients

6 lb. (2.7 kg) amber liquid malt extract
3 lb. (1.4 kg) amber dried malt extract
1 lb. (0.45 kg) 2-row pale malt
1 lb. (0.45 kg) your own brown malt
12 AAU Columbus hop pellets (1 oz./28 g at 12% alpha-acids) (60 min.)
White Labs WLP005 (British Ale) or Wyeast 1968 (London ESB) yeast

Step by Step

Steep the crushed grains (in grain bag) in 3 qt. (2.8 L) water at 145 to 155 °F (63 to 68 °C) for 45 minutes. Strain liquid into boil pot, and rinse grains with further 2 qt. (2 L) hot water. Add 3 gallons (11 L) to collected liquors, and carefully dissolve syrup, then dried malt extract. Adjust to 5 gallons (19 L) with water, and bring to boil. Add bittering hops and boil 60 minutes. Cool to 65 to 70 °F (18 to 21 °C), and pitch yeast, preferably as a 1 qt. (1 L) active starter. Ferment five to seven days, then rack into secondary for up to one to two weeks. Rack the beer into bottles, priming with 1.5 to 2 oz. (42 to 57 g) corn sugar depending upon the residual carbonation level of the beer, or force carbonate and keg.

use these for color comparison rather than pale malt. Let cool and store in an airtight container until use.

Brown malt procedure

Proceed exactly as you would in the amber malt procedure, making a color comparison only after reaching the final amber malt stage. Raise the setting to 300 °F (149 °C) and maintain it for 30 minutes. Then raise the setting to 350 °F (177 °C) for 20 minutes, and check for color as above, preferably against grains of commercial brown malt. If the color has reached a definite brown (but light as in "brown bag"), you're done. If it seems still too pale continue heating for another 20 minutes, but no more. Allow the malt to cool and store in an airtight container until you are ready to brew.

Brewing with amber and brown malts

I've included two porter recipes with this story on page 67 to showcase amber and brown malts. For this column I chose a classic recipe for porter from the late 18th/early 19th century. It uses a ratio of 1:1:1 of pale:amber:brown malt, which is a similar recipe to one adapted from an 1822 English brewing book. After that is an extract with grains brew, which is rather different than this classic, but still shows the virtues of brown malt. Of course, there are other beer styles in which you could use your homemade malts. For example, pale ales, ESB, Baltic porters and any other beer with a full malty palate, where the nutty, biscuit characters of these malts add something extra to the beer's character.

These malts contain significant amounts of starch but no enzymes. They cannot therefore be used directly in extract brewing, but must be mini-mashed with about the same quantity of pale malt. They are fine in all-grain brewing, again using pale malt as a base. The pale amber malt as prepared above does have significant diastatic power according to British Beers, and I have used it to brew a porter where it made up almost 68% of the total grist, along with 15% brown malt, and only 17% pale malt. Extract yield was about normal, but finishing gravity was a little high with an apparent degree of fermentation of 60%.

Experiment a little with the degree of roasting to optimize the flavor and color for a particular beer when making these malts, and know that when you use them in your homebrew that you are brewing something truly unique. If you are even more inventive, you might want to look into devising a system so that you can produce your own crystal malt. Perhaps one day you will even grow your own hops, malt your own barley, kiln all your own specialty malts, and brew beers which are completely your own. BYO

Terry Foster writes "Techniques" for every issue of BYO.

Beer Aroma

The effect of temperature

by Chris Bible

Serving temperature plays an important role in the overall organoleptic experience of a beer. Temperature of beer is a very important variable that effects perception of intensity of both taste and aroma in beer. In general, beer that is served at a higher temperature will be perceived as having a greater intensity of both taste and aroma. In contrast, colder beer is generally viewed as more refreshing.

Ideal serving temperatures vary between different beer styles, but a temperature range of 48–52 °F (9–11 °C) is generally considered ideal for most lagers, wheat beers and lambics, while a slightly warmer temperature range of 50–60 °F (10–16 °C) is ideal for most other ales. The cooler serving temperature range for lagers is in-line with the typical "clean" flavor and aroma profile that is desirable for lagers; cooler temperature means less overall flavor and aroma intensity. Conversely, the higher ideal serving temperature for ales is appropriate because higher temperature will enhance the perception of the complexity of the flavor and aroma profile and produce an overall flavor and aroma intensity that is generally desirable in ales.

Aroma compounds in beer

Beer contains over five hundred different volatile compounds and many of these compounds contribute to the aroma perception in the beer. Categories of aroma compounds include esters, alcohols, vicinal diketones, sulfur compounds and hop constituents. Table 1 (page 71) presents various aroma compounds found in beer with the corresponding aroma or flavor descriptor.

Important aroma variables

Three things greatly affect the concentration of aroma compounds in the vapor phase above a liquid: concentration of the aroma compound in the liquid phase, vapor pressure of the aroma compound and molecular interactions (non-ideal solution interactions) between the aroma compound and the other molecular species.

The concentration of aroma compounds contained in the liquid phase directly affects the concentration of the aroma compounds in the vapor phase above the liquid. A higher concentration of a compound in the liquid phase causes a higher concentration in the vapor phase.

The vapor pressure — also known as saturation pressure — of a compound affects the vapor phase concentration. A compound with a higher vapor pressure will have a higher concentration of the compound in the vapor phase.

Molecular interactions between the aroma compounds and the other compounds dissolved in the beer also affect vapor phase concentration. If there is a strong, attractive interaction between the aroma compound in question and the other compounds in solution, then the concentration of the aroma compound in the vapor phase will be lower than expected under conditions when this interaction is not present. It will be "held in" somewhat by the attractive forces of the other compounds in the solution. Conversely, if there are strong, repulsive interactions, then the concentration of aroma compounds in the vapor phase will be higher than when this interaction is not present.

This is all expressed succinctly by Raoult's Law:

$$y_i = \frac{\gamma_i x_i P_i^{sat}}{P}$$

Where:

y_i = mole fraction of species i in the vapor phase

γ_i = activity coefficient of species i. (Equals 1 in an ideal solution.)

x_i = mole fraction of species i in the liquid phase

"In general, beer that is served at a higher temperature will be perceived as having a greater intensity of both taste and aroma."

Photo by Charles A. Parker/Images Plus

P_i^{sat} = saturation pressure or vapor pressure of species i
P = absolute pressure

The vapor pressure term, P_i^{sat}, in the numerator of the equation is strongly temperature dependent. Increasing the temperature increases the vapor pressure of aroma compounds and causes them to have a higher concentration in the vapor phase. The relationship between temperature and vapor pressure has been studied for many different compounds, and empirical equations that describe the relationship are available. One of these equations is Antoine's equation:

$$\log p = A - \frac{B}{t + C}$$

Where:
log p = base 10 logarithm of pressure
(p = pressure in mmHg)
A, B, C = Constants that are determined experimentally
t = temperature (in °C)

Researchers Hrivňák, Šmogrovičová, Lakatošová and Nádasky have used solid-phase microcolumn extraction and gas chromatography to evaluate the compounds found within the gas-phase headspace over beer. They found that increasing temperature lead to higher vapor pressure over the beer for all the compounds they studied. However, some compounds were affected by by temperature more than others. The vapor pressure of butanol and hexanol increased greatly with pressure, while temperature's effect on acetaldehyde was comparatively small.

Conclusions and practical considerations

Temperature greatly affects the perception of aroma compounds in beer. A relatively slight increase in serving temperature can cause a very dramatic increase in the perception of aroma compounds, both good and bad, in beer.

If you are trying to detect the presence or absence of certain aroma compounds in beer, allow some time during the process to let the beer warm. This will allow the beer to "open up" and will cause otherwise concealed aroma compounds that may only be present in the beer in very low concentrations to volatilize and perhaps be more easily detected during the evaluation.

In contrast, if you have brewed a beer that is showing some faults, serving it at a lower temperature may help you enjoy the beer more as you plan your next brew day to address the problems of that batch. BYO

Chris Bible is an engineer and writes the "Advanced Brewing" column in every issue of BYO.

Table 1: Common Aroma Compounds in Beer

Compound	Typical Concentrations in Beer (mg/liter or ppm by weight)	Aroma or Flavor Descriptor
Esters		
Ethyl Acetate	10 - 60	Solvent-like, Sweet
Isoamyl acetate	0.5 – 5.0	Banana, Estery, Solvent
Ethyl hexanoate	0.1 – 0.5	Apple, Fruity, Sweet
Ethyl Octanoate	0.1 – 1.5	Apple, Tropical Fruit, Sweet
2-Phenylethyl acetate	0.05 – 2.0	Roses, Honey, Apple, Sweet
Ethyl Nicotinate	1.0 – 1.5	Grainy, Perfume
Alcohols		
Methanol	0.5 – 3.0	Alcoholic, Solvent
Ethanol	20,000 – 80,000	Alcoholic, Strong
1-Propanol	3 – 16	Alcoholic
2-Propanol	3 – 6	Alcoholic
2-Methylbutanol	8 – 30	Alcoholic, Vinous, Banana
3-Methylbutanol	30 – 70	Alcoholic, Vinous, Banana
2-Phenylethanol	8 – 35	Roses, Bitter, Perfume
1-Octen-3-ol	0.03	Fresh-cut-grass, Perfume
2-Decanol	0.005	Coconut, Aniseed
Glycerol	1200 - 2000	Sweetish, Viscous
Tyrosol	3 – 40	Bitter, Chemical
Vicinal Diketones (or reduced compounds)		
2,3-Butadione	0.01 – 0.4	Butterscotch
3-Hydroxy-2-butanone	1 – 10	Fruity, Moldy, Woody
2,3-Butanediol	50 – 150	Rubber, Sweet
2,3-Pentanedione	0.01 – 0.15	Butterscotch, Fruity
Sulfur Compounds		
Hydrogen Sulfide	1 – 20*	Sulfidic, Rotten Eggs
Sulfur dioxide	200 – 20,000*	Sulfidic, Burnt Match
Carbon disulfide	0.01 – 0.3	---
Methanethiol	0.2 – 15	Putrefied
Ethylene sulfide	0.3 – 2.0	---
Ethanethiol	0 –20	Putrefied
Propanethiol	0.1 – 0.2	Putrefied, Rubber
Dimethyl sulfide	10 –100	Cooked Corn, Canned Tomatoes
Diethyl sulfide	0.1 – 1.0	Cooked Vegetables
Dimethyl disulfide	0.1 – 3.0	Rotten Vegetables
Diethyl disulfide	0 – 0.01	Garlic, Burnt Rubber
Dimethyl trisulfide	0.01 – 0.8	Rotten Vegetables, Onion
Methyl thioacetate	5 – 20	Cabbage
Ethyl thioacetate	0 – 2	Cabbage
Methionol	50 – 1300	Raw Potatoes
Methional	20 – 50	Mashed Potatoes, Soup-like
3-Methyl-2-butene-1-thiol	0.001 – 0.1	Skunky, Catty, Lightstruck

Paintball and Homebrew

Build a portable CO_2 regulator

by Kevin Verratti

I play for an internationally recognized paintball team — aptly named "Pub Crawling." Our schedule takes us all over the world to compete in events, and nothing goes down quite as good as a homebrewed beer after an event. Because we spend so much time on the road, our team needed a simple carbonation system that is both mobile and easily field repairable.

Playing paintball and brewing beer are actually great companion hobbies because transferring CO_2 through a paintball marker is fundamentally no different than transferring CO_2 through a kegging system. This means that many of the fittings used in paintball can be easily adapted to dispense or even carbonate beer. For an added bonus, paintball fittings are already pressure rated for use with CO_2, which equals less guesswork for you.

While there are adapters available to attach a beer regulator directly to a paintball CO_2 tank, that does not solve the issue of having readily available replacement parts for the regulator. These adapters also require you to already have a beer regulator, which makes up the majority of the costs in the regulator system. Another problem is that beer regulators are not easily serviced when they fail, however the Planet Eclipse inline high pressure regulator is designed for easy disassembly and is fixed quickly and easily.

CO_2, like all gasses, is a temperature-dependent gas with an average pressure range in the bottle of 650–1200 PSI depending on the surrounding air temperature. To dispense beer in a balanced keg system you need a constant pressure of roughly 10–12 PSI. If you are force carbonating your beer then you will need up to 30–35 PSI. Most paintball inline regulators are designed to output between 100–800 PSI, far above the pressures used in kegging. By utilizing a common off-the-shelf air compressor regulator you can drop this down to keg-friendly pressures.

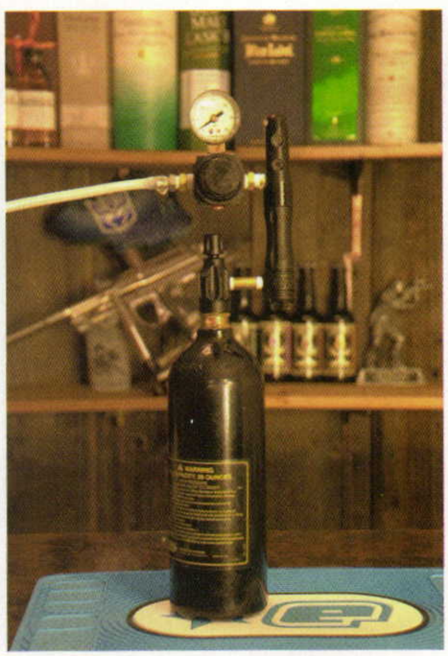
This is a good time to discuss safety relief devices. Gas under pressure is dangerous — don't take any chances. The generic air compressor regulator and the Planet Eclipse inline high pressure regulator both have built in overpressure relief valves. Should either regulator fail or receive more pressure than they are rated for they will immediately vent the remaining CO_2 until the pressure drops or the tank is emptied.

This system is also easily customizable. If you want to use more than one keg, add "T" connectors to your lines. If you want to add a check valve to the system it can be placed anywhere that you have room on your CO_2 distribution hose. If you want to carbonate different styles of beers at different pressures, add additional generic air compressor regulators.

> "Playing paintball and brewing beer are actually great companion hobbies because transferring CO_2 through a paintball marker is fundamentally no different than transferring CO_2 through a kegging system."

Parts and Supplies List

- 2 adjustable wrenches
- Teflon tape
- Planet Eclipse inline high pressure regulator
- Planet Eclipse OOPS (on/off purge system)
- generic ASA (air source adapter)
- generic air compressor regulator
- ⅛-inch NPT close nipple
- ⅛-inch NPT x 1-inch nipple
- (2) ¼-inch x ⅛-inch NPT reducing bushings
- ⅛-inch male quick disconnect (for hose barb)
- worm hose clamp
- CO_2 distribution hose
- 20-oz. paintball CO_2 tank



1. PARTS AND TOOLS

I built the majority of this project with spare parts, however I did have to buy a few additional parts. The tools are simple: two adjustable wrenches and some Teflon tape. All paintball air fittings are ⅛-inch NPT, however air compressor fittings are more commonly found in ¼-inch NPT so two ¼-inch x ⅛-inch NPT, reducing bushings are needed. You will also need two ⅛-inch NPT nipples and a worm clamp from the hardware store. The generic air compressor regulator can be found with the rest of the air tools, and literally any model will work. The Planet Eclipse OOPS (on/off purge system) and high-pressure regulator, male quick disconnect and generic ASA adapter were spare paintball parts. The Planet Eclipse OOPS can turn the paintball tank on and off and also bleed out any extra pressure in the line.

2. ASSEMBLE THE OOPS AND REGULATOR

The first step is to assemble the OOPS and the high pressure regulator using the ⅛-inch x 1-inch nipple. Wrap Teflon tape around the nipple and thread it into the ⅛-inch fittings of the OOPS. Hand tightening should be enough. Be sure to wrap the Teflon tape around the threads clockwise and to keep it out of the opening of the pipe, then thread it into the ⅛-inch fitting of the high pressure regulator, again hand tightening it. Tighten the two pieces by hand until they are both vertical and run parallel with each other. It is important not to over tighten the fittings or you risk damaging the threads, which is very easy to do with small fittings.

3. ASSEMBLE THE INPUT END

Next, apply Teflon tape to the threads of the ⅛-inch NPT close nipple, which may be difficult due to the size of the fitting. Once you have the tape applied, thread the close nipple into the generic ASA adapter. Do not use any pliers or wrenches directly on the threads of the close nipple as they will get damaged. Once this is done, attach the ASA adapter to the top of the Planet Eclipse high pressure regulator. This now makes up the high-pressure input side of the system. The Planet Eclipse high pressure regulator can be dialed down to around 120 PSI to provide input CO_2 to the low pressure generic air compressor regulator.

4. ASSEMBLE THE OUTPUT END

The generic air compressor regulator uses standard ¼-inch NPT air fittings. To work with paintball fittings a standard ⅛-inch x ¼-inch NPT reducing bushing will need to be threaded into the inlet and outlet side of the regulator. Once again apply Teflon tape and thread the fittings in by hand being careful not to over tighten them. In lieu of a hose barb you can also use a paintball male quick disconnect fitting to attach the hose to the regulator. This is the only time you need to use the adjustable wrenches. Place one wrench on the outlet side bushing and thread the quick disconnect into place using the other wrench. Be careful not to over tighten the two fittings and do not let the bushing thread further into the regulator. This now makes up the low-pressure output side of the system.

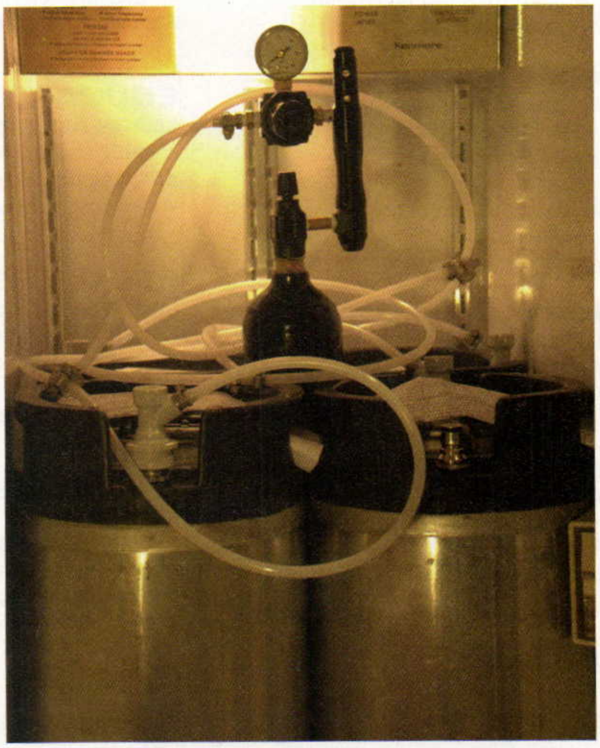
5. ATTACH INPUT TO OUTPUT

Take the input side of the air compressor regulator and thread it into the output side of the generic ASA adapter where you installed the ⅛-inch NPT close nipple. Thread this on hand tight and continue to turn it until the regulators line up and you can easily see the gauge and reach the adjustment knob. The adjustment knob of the air compressor regulator is now all that is needed to control the output pressure to the kegs for carbonating or serving. Some of these regulators also come with a locking ring so that you can set the pressure you want and not have to worry about it getting changed accidentally. Now attach the CO_2 distribution hose to the quick disconnect using the worm clamp.

6. ATTACH THE GAS AND TEST

Once the CO_2 hose is connected to both the regulator system and inlet ports of the keg, attach the paintball CO_2 tank to the inlet side of the Planet Eclipse OOPS. Turn the knob at the top of the OOPS to start the flow of CO_2 through the regulators. Using a spray bottle with soapy water, gently spray each of the fittings to test for leaks. Gradually increase the pressure on the air compressor regulator until the gauge shows your desired pressure reading. Place the keg in your refrigerator and leave it connected for at least a week to carbonate. One 20-oz. paintball tank provides almost enough CO_2 to carbonate four 5-gallon (19-L) corny kegs. A single 20-oz. tank can both carbonate and serve one 5-gallon (19-L) corny keg without an issue. BYO

This is Kevin Verratti's first "Projects" column for Brew Your Own.



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Sister Brews

The story of Ginger and Mary Ann

JD Willoughby • Frederick, Maryland

Ginger and Mary Ann slept in our bedroom last night. It gets crowded in the house when my husband goes on a bender. He stays up all night tending to his girls, sometimes several times in one night. I am actually thankful for the diversion they provide. It means he's not focused on firing up chainsaws or grinding metal in the basement. That's another story altogether.

Let me explain to you about how much we love the "girls" — my husband's favorite homebrews. Occasionally, there are no free spaces for beer buckets in the kitchen, bathroom, or living room. When this happens, we are forced to sleep with the frothy creations. I use the term "sleep" in a sarcastic context. I'm forced to smell the fermenting goodness that is Ginger and Mary Ann while I writhe on my mattress. It's like trying to sleep in the middle of a bakery and not eat the delicious rolls and muffins in the display cases. More often than not, bucketed beer burbles away in the kitchen and, at times, the bathtub. Like a faucet dripping all night long, the buckets in the bathroom echo a consistent rhythmic prattle, the sound bouncing off the bare walls and floor throughout the house. My husband sleeps with his good ear in the pillow. I could carry on a conversation with the burping buckets or a blank wall and he'd never know.

I'm fairly open-minded, but I refuse to share the mattress or covers with "the girls" so they huddle on the floor next to the heat vent. I also refuse to call the buckets by their names. I reserve that for the finished product, one that will hopefully make me forget that the kitchen floor is covered in beer and the walls are splattered with malt extract. I try to ignore my socks making that light adhesive sound as they peel off the beery floor and focus my attention on the stars of the night — Ginger and Mary Ann.

> "Friends ask for Ginger and Mary Ann by name as though they're calling old friends over for a party."

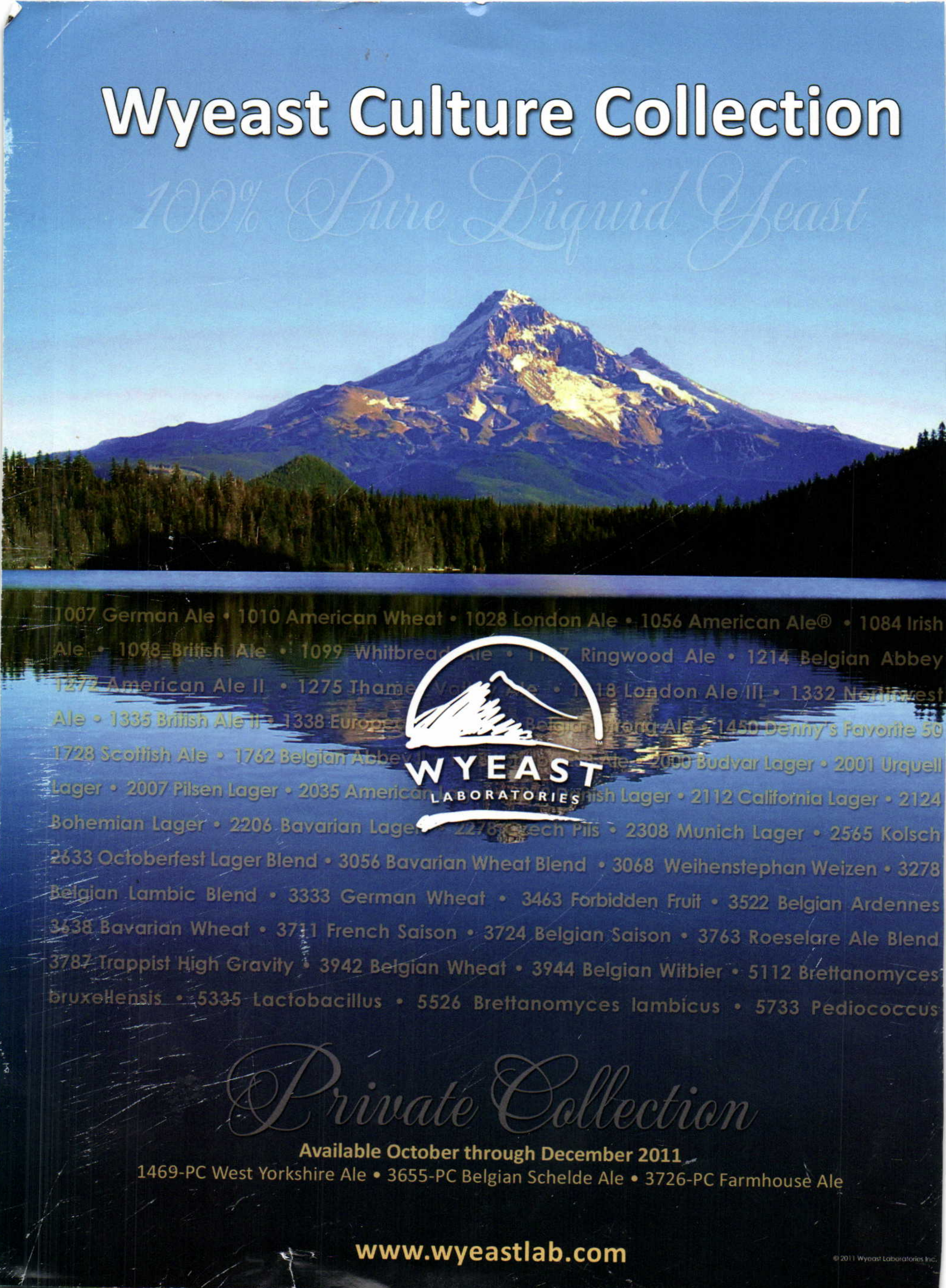
Photo courtesy of JD Willoughby

JD and her husband, Dave, have a mutual love for his homebrews.

My husband has been a homebrewing superstar for years, and most of his batches are claimed before they're even racked. Friends ask for Ginger and Mary Ann by name as though they're calling old friends over for a party. (Either that or it would seem we're running an escort service from our living room, although that might be a more lucrative venture than free homebrews.) These two girls are my husband's most requested homebrews because they both have a smooth, mild, hoppy flavor with notes of honey, but with a slight bite. Much like their "Gilligan's Island" character's namesakes, Mary Ann is the beer next door and Ginger is her flavor-boosted bunk mate.

I am not jealous of Ginger or Mary Ann, I just don't get a chance to interact with them very much once they're bottled. I always hope for a girls' night out with them, but it never seems to happen. They toddle off to a friend's barbecue or a river trip or a vehicle workday with my husband in tow. This could be why I am so bitter about the sticky floor and malt splatters on the walls of our house. I understand the attraction, however, since I have managed to weasel a few swingtops from several batches. I have to drink what I can before company arrives, though — within ten minutes of a party starting, Ginger and Mary Ann have taken over the kitchen, and within an hour, their bottles are empty. They are always the life of the party.

I realize now that it's been much longer than a three-hour beer tour and I will have to share my bedroom and kitchen with Mary Ann and Ginger indefinitely. But I must say that I am looking forward to sneaking some time in with them. I think I'll take them out for a hike or a river trip, just us girls. I'm glad my husband introduced us — Ginger and Mary Ann make everything more bearable. BYO



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