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MARCH-APRIL 2012, VOL.18, NO.2

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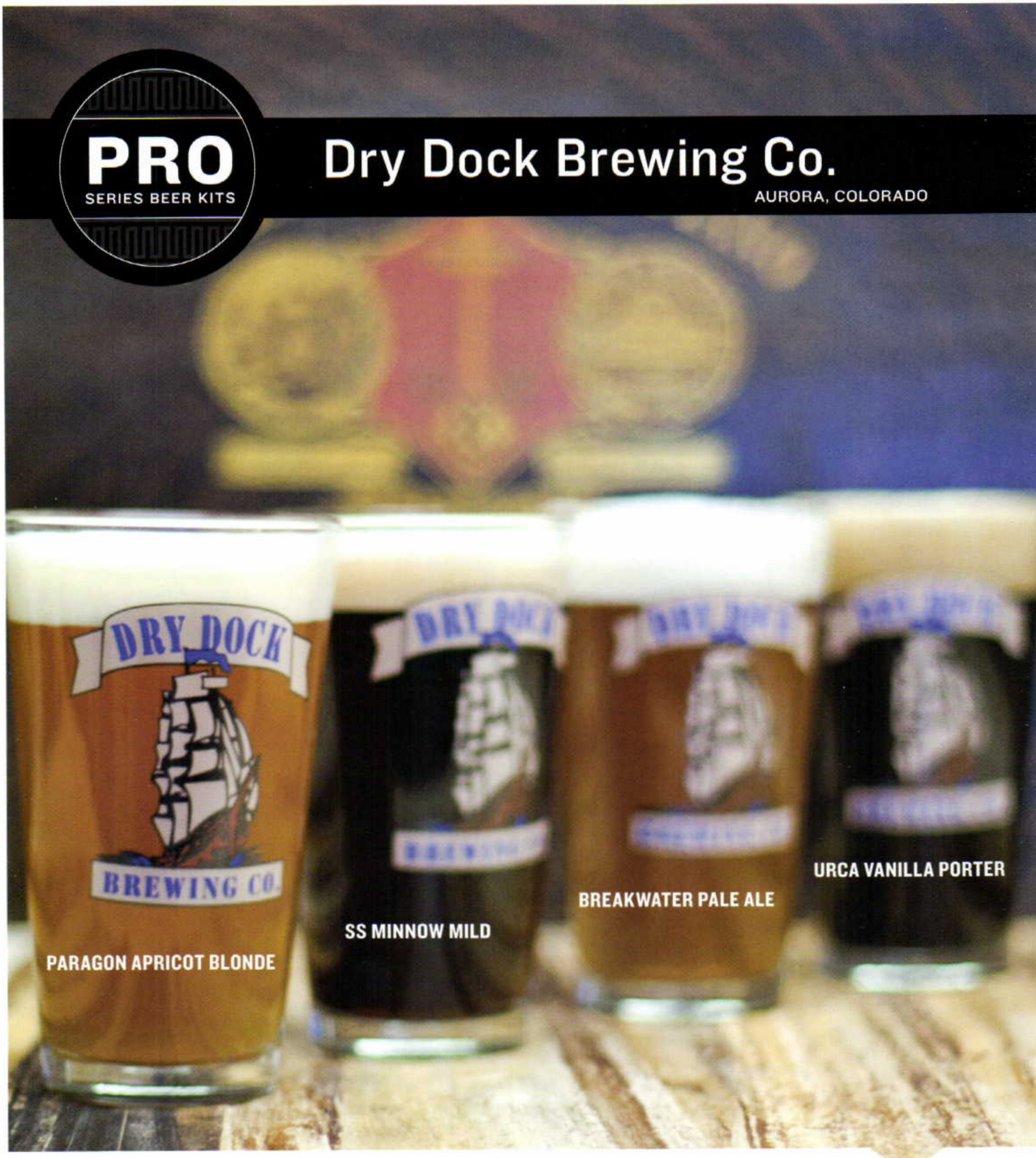
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CONTENTS

March-April 2012 Volume 18 Number 2

features

19

departments

where to find it

RECIPE INDEX

BYO RECIPE STANDARDIZATION

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

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

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

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

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

Chat with *BYO* Writers on Facebook

Join in on *BYO's* live Facebook chats each month featuring some of our most frequent contributors. Ask one of our editors a brewing question, or talk to Jamil Zainasheff about brewing to style, and more! Become a fan of *BYO* on Facebook and look for announcements for upcoming chats.
www.facebook.com/BrewYourOwn

BYO Goes to Belgium

BYO Editor Chris Colby discusses a recent trip to Belgium with *Basic Brewing Radio* where he and some of the *BYO* crew toured breweries including Cantillon, Westmalle Abbey, Dubuisson and many more.
http://goo.gl/lvmcU

Honey Brewing History

Brewing with honey is not a new trend — honey is a big part of fermentation history. Read up on beers from ancient times, and try brewing your own "archaeo" beer.
www.byo.com/component/resource/article/145

Cover Photo: **Charles A. Parker**

Brew THE HOW-TO HOMEBREW BEER MAGAZINE YOUR OWN

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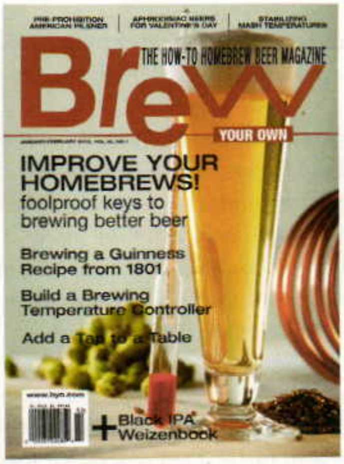

You can't crash here

I am planning on making the Jolly Roger Double Mocha Porter from the January-February 2012 issue, but I have a question. It calls for crash cooling and I have no way of doing that. How important is the process?

Luis Cardona
via email

Crash cooling involves rapidly cooling a beer after fermentation. For homebrewers, this usually means to refrigerator temperature. Crash cooling forces the yeast to quickly drop out of suspension and allows you to rack clear beer to your secondary fermenter, bottling bucket or keg promptly.

If you do not have the means to crash cool — most homebrewers do this simply by placing their carboy in a brewing fridge — you don't have to worry. This will not affect the quality of the beer; but, you will have to wait until the yeast drops out on its own. Many times, racking a beer to secondary will help it clear faster. And, of course, even if you can't crash cool, keeping the beer as cool as is manageable will help.

It is always a good idea to check that all the diacetyl has been reduced before crash cooling. See the procedure given on page 38, within the recipe for the Old Chub clone, for one very effective way of doing this.

Full or partial boil for brews

The two beers I have brewed from your magazine were tasty, but accused of being a bit thin. I normally do a full boil, but thought I should stick to the recipe for these two. Can I do a full boil on any of your recipes without otherwise modifying the recipe? Or is there a standard conversion for taking your recipes from partial to full boil?

Brian Alexander
via email

Switching from a full wort boil to a partial wort boil (or vice versa) should not have any effect on the impression of body in a homebrewed beer. Any BYO *recipe — or any homebrew recipe, for that matter — that prescribes a partial wort*

contributors

Glenn BurnSilver is a freelance writer, record collector and homebrewer who has written many articles for *BYO* over the years, including stories on indigenous brews in Africa and brewers in the US who brew commercially on systems no bigger than your average homebrew setup.

Glenn has lived in Colorado, Alaska and now Arizona and enjoys hiking, backpacking and camping. His latest article, on canned craft beer on page 36 of this issue, will be of interest to anyone who shares these interests and wants to enjoy a beer in the evening (as canned beers are easier to pack in and out). Glenn reviews the state of canning among craft brewers and presents five clones for homebrewers (who are still bottle-bound for the time being).

Jamil Zainasheff is a busy guy. His new commercial brewery — Heretic Brewing Company of Pittsburgh, California — is brewing and selling beer and he still finds time to host his show, *Can You Brew It?*, on the subject of cloning commercial beers at home, on The Brewing Network (www.brewingnetwork.com). In addition, he remains a *BYO* columnist and blogger. (And, as if this weren't enough, in the coming months *BYO* will be releasing a special issue that collects many of his best "Style Profile" columns.) On page 19 of this issue, Jamil discusses a beer style that intrigues many homebrewers with an interest in the history of brewing in the United States — Classic American Pilsner.

Forrest Whitesides brewed his first batch of homebrew in 1995. It was an English brown ale. These days, this graduate of North Carolina State University is more interested in Belgian-style ales.

Forrest is a frequent guest on the *Final Gravity* podcast (which can be found at finalgravitypodcast.webs.com). He lives in Hopatong, New Jersey.

Forrest has written many "Projects" columns for *Brew Your Own* — including many included in our recent special issue *25 Great Homebrew Projects* — ranging from classic picnic cooler mash tuns to cool hopbacks. In this issue, on page 63, he builds a project that is great for any homebrewer who wants to take his beer to picnics, parties, etc. and serve cold beer from a warm keg — the classic draft jockey box.

boil can be modified to use a full wort boil. In fact, any time you can increase the volume of wort you are boiling, up to the point of a full wort boil, you should do so. In a full wort boil, you get better hop utilization, suffer less color pickup and lose less wort to the junk at the bottom of your brewpot (the trub).

In BYO *recipes using malt extract, the boil volume given is usually the minimum volume we would recommend (and this varies with wort density, hop character and beer color). Higher-gravity, more hoppy and lighter-colored recipes benefit from boiling as much wort as you can manage. Our volume recommendations are mainly to ensure stovetop brewers with smaller brewpots don't attempt a beer they have little chance of brewing successfully.*

To modify a recipe from a partial wort boil to a full wort boil, you have two options. You can simply leave the recipe as is, or you can decrease the amount of bittering hops slightly to account for the expected increase in hop utilization. The first option obviously wins when simplicity is desired and the amount of change in your hop character will likely be so small you won't notice it (unless you were boiling a very thick wort).

If, however, you're a "by the numbers" kind of brewer, run both the partial boil and full wort boil recipes through your brewing software and what see adjustment needs to be made. Leave the late boil additions alone and decrease only your bittering hop addition as needed to hit the same calculated target IBU.

With regards to the perceived thinness of your beer, this could be due to any number of factors. Worts made with malt extract are usually less fermentable than comparable worts made with all-grain methods, and hence are more likely to be perceived as having more body. As a first stab at solving this problem, you may want to try a different brand of malt extract and see if this affects the body in your beer. (Some folks will recommend adding Carapils® malt to your grain bill or maltodextrin as a kettle adjunct. You could also consider this, but you'll probably be happier actually identifying the source of your problem rather than covering it up.)

Normally, we recommend that brewers follow the recipe as closely as possible, unless they are sure they know how their proposed change will affect their beer. However, with regards to boil volume, we recommend partial boil brewers always boil as much wort as they can bring to a nice, rolling boil (and cool quickly afterwards).

Grateful for grain mill

Please pass along my thanks to Steve Van Tassell for his article, "Motorize a Grain Mill "(December 2010). He inspired me to build my own using a motor I acquired on eBay, a wooden box on casters I already had in the house and the new grain mill I purchased as I just upped my production from 5 to 10 gallons (19 to 38 L). Just figured out the last glitch and now it's chomping grain like there's no tomorrow.

Flip Colmer
Chelsea, Michigan

Glad you liked the article. Speeding up any brew day task, such as milling your grain, leads to greater enjoyment of brewing. (For more tips on speeding up your brew day, see the article on page 48 of this issue).

Stir plate setup

In your July-August 2007 article on building your own stir plate, I have a question. Do I have to use a flask with a stir plate, or will a ½ gallon or one gallon jug work? I already own the jugs, and don't have a flask yet.

Justin D Bruce
via email

Erlenmeyer flasks — the wide bottomed, tapered flasks most commonly used on stir plates — are handy, but not an absolute necessity. Any flat-bottomed glass or plastic vessel will work well. Large beakers, for example, also work great. Jars or jugs with a raised bottom will not work well with a stir plate as the stir bar will slide off the "hump" in the middle.

California cool

I recently read an article about lagering a California Common and will attempt to make this beer. My California Common has been in the primary at around 64–66 °F (18–19 °C) in a water bath draped in a shirt. When I rack into secondary, I will chill the water with frozen rocks to lower the temperature even more. How much more cooler, I don't know. Here's my question: When I bottle my California Common, do I need to keep my bottles cool at secondary temperatures, or can they rest at normal ale temperatures, say 68–70 °F (20–21 °C)? I do not have the fridge space to keep them so any input would be greatly appreciated.

Liborio Medina
via email

When bottle conditioning any beer, it is best to initially store the bottles warm until they have carbonated. The yeast need to consume the priming sugar and convert it into ethanol and carbon dioxide and they will not do that in a refrigerator. Store at ale temperatures or slightly above. BYO

homebrew nation

READER PROFILE

Brewer: Brian Kolodzinski

Hometown/State: Ashland, Oregon

Years brewing: 1

Type of brewer: Gluten-free

Homebrew setup (volume, style, efficiency): 5-gallon (19-L) single-step infusion mash tun with 5-gallon (19-L) hot liquid tank, 75-80% efficiency. Two 5-gallon (19-L) primary fermenters, four 5-gallon (19-L) carboys and two 7-gallon (26-L) carboys for secondary fermentation.

Currently fermenting: American IPA, Ginger Beer and Malted Ginger Cider.

What's on tap/in the fridge: Orange Hefeweizen, IPA, Brown Ale, Pumpkin Ale and Blackstrap Cider.

How I started brewing: I was interested in homebrewing for many years before my wife purchased a homebrewing kit for my birthday. I reviewed the great deal of literature and videos available to help first-time homebrewers, but I quickly realized that there was very little information on homebrewing gluten-free beer. The owners of my local home brewing store (Grains Beans & Things) provided me with a copy of an extract recipe called "Simple Simon," which was previously published in the March-April 2007 issue of *BYO* magazine, and I've been brewing gluten-free ever since.

Since I experienced difficulty finding gluten-free recipes, I decided to start a Facebook page to bring gluten-free homebrewers together. To date I have posted 45 gluten-free recipes from websites as far away as Australia. Each recipe is listed including the originating website so brewers can spend less time searching the Internet and more time brewing great gluten-free beer. Since gluten-free homebrewing only represents a small portion of homebrewing, the information on the Web is scattered. And as I had already searched the information out, it seemed like a great idea to simplify the process. I have also received several recipes emailed directly to me. (Recipes may be submitted to: gfhb-email@usa.net)

My blog/website: www.facebook.com/GlutenFreeHomeBrewing

byo.com brew polls

Have you ever brewed with honey? (not meadmaking)

Yes, a few times 48%
No, but I would like to 29%
Yes, many times 14%
No, I'm not interested 9%

reader recipe

STEFAN SHOEMAKER'S GLUTEN-FREE AMERICAN IPA
(5 gallons/19 L, all-grain)

OG = 1.061 FG = 1.012
IBU = 43 SRM = 13 ABV = 5.9%

Ingredients:

6 lbs. 10 oz. (3 kg) Briess white sorghum syrup
8 oz. (227 g) Molasses
6 oz. (170 g) Belgian dark candi sugar
14 AAU Cluster hops (60 min.) (2 oz./57 g at 7% alpha acids)
2.87 AAU Cascade hops (15 min.) (0.5 oz./14 g at 5.75% alpha acids)
2.5 AAU Fuggles hops (15 min.) (0.5 oz./14 g at 5% alpha acids)
2.87 AAU Cascade hops (1 min.) (0.5 oz./14 g at 5.75% alpha acids)
2.5 AAU Fuggles hops (1 min.) (0.5 oz./14 g at 5% alpha acids)
1 oz. (14 g) Cascade hops (dry hop)
1 tsp. gypsum (60 min.)
1 tsp. diammonium phosphate (DAP) (15 min.)
1 tsp. Irish moss (15 min.)
9 oz. (255 g) honey (flameout)
1 pkg Safale US-05 dry yeast

Step by Step

Bring 3 gallons (11 L) of water to boil and add the sorghum, molasses, candi sugar. Boil time is 60 min. Add the hops as listed. Chill to 65 °F (18 °C), transfer to a carboy, top up with cool water to reach 5 gallons (19-L) and pitch the yeast. Ferment at 68 °F (20 °C) for 7 days, rack to a secondary and condition for another 7 days at 68 °F (20 °C).

social homebrews

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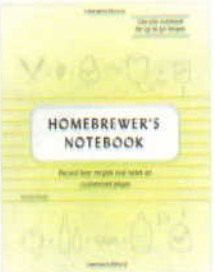
what's new?

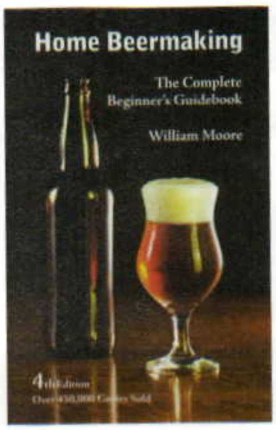
Homebrewer's Notebook



The Homebrewer's Notebook, designed by homebrewer Michele Costello, is a new workbook designed to help homebrewers record and organize their brewing recipes and notes. The notebook contains customized pages that track each recipe's beer style, ingredients, brewing steps, fermentation details, bottling notes and tasting notes. It can hold notes for up to 50 beers and includes a table of contents for reference.

Available at major booksellers and homebrew suppliers

Home Beermaking: The Complete Beginner's Guidebook



Homebrew author William Moore has released this completely rewritten 4th edition of his how-to homebrew guide for beginners. Focusing on helping new brewers brew a quality initial beer from extract, this title explains the basics of the equipment, supplies and steps for making your first batches of homebrew. Also includes a chapter of recipes and some advice for formulating your own recipes. A classic for any new brewer, Moore's book has sold more than 450,000 copies since the first edition was released in 1980.

Available at homebrew suppliers

calendar

March 7
Kailua Kona, Hawaii
Kona Brewers Festival Homebrew Competition

Enter your homebrews in Hawaii's 16th annual homebrew competition, hosted by the Big Island's homebrew clubs, the Kona Coast Barley Boys and the Orchid Isle Alers. The Kona Brewers Festival is sponsored by the Bill Healy Foundation, which has raised more than $360,000 for Hawaii Island nonprofit charities to promote conservation, educational scholarships, and creative arts.
Deadline: March 1
Entry Fee: $7 per entry
Contact: Fred Housel, Fred@kieleokona.com
Web: http://sites.google.com/site/konabrewcontest/

March 16
Manchester Center, Vermont
WineMaker International Amateur Wine Competition deadline

The deadline to enter your homemade meads and wines in the WineMaker International Amateur Wine Competition is coming up — don't miss your chance to compete in the largest event of this kind in the world! All entrants will receive their judging notes back along with a list of the medal-winning wines and meads.
Deadline: March 16
Entry Fee: $25 per entry
Contact: Alex Ramsvig, alex@winemakermag.com
Web: www.winemakermag.com/competition

April 14
Oakland, California
World Cup of Beer

Enter your homebrews in the Bay Area Mashers Homebrew Club's annual competition for the chance to win awards, prizes and of course, bragging rights. The World Cup of Beer is also a regional qualifying event for the Masters Championship of Amateur Brewing (MCAB), a national homebrew competition. MCAB qualifying styles this year are BJCP categories 1–19 & 22.
Deadline: March 24
Contact: Tim McNerney, wc@oneofus.org
Web: http://worldcupofbeer.com/

homebrew drool systems

The Ale Engine

Rawley Macais • San Luis Obispo, California

I discovered my passion for homebrewing in 2005 while attending California Polytechnic State University (Cal Poly), San Luis Obispo studying Mechanical Engineering. I have always appreciated real beer and thought it would be awesome to try brewing it myself. I visited my local homebrew shop, Doc's Cellar, and purchased a basic homebrew kit. The rest is history. After years of extract brewing, I decided to shift gears and try out all-grain brewing. I brewed a few batches using a few kettles, my kitchen counter, and a bar stool as a makeshift three-tier system. After a few batches with that set-up, I made the decision to go all out and put my mechanical engineering degree to use by designing and fabricating a custom single-tier 15-gallon (57-L) brewery using 304 stainless steel tube frame and panels.

Brewing fantastic, award-winning beer does not require a complex system; however, the engineer in me wanted a new project. Working as a full time mechanical engineer at an aerospace company has its advantages; I have access to computer aided design (CAD) software, CNC machines, tools, etc. For a solid six months, I worked during the day designing unmanned air vehicles (UAVs) and spent my free time designing my homebrewery.

Some features of the Ale Engine homebrewery include a custom-built walk-in fermentation chamber (right). The fermentation chamber climate control is a Ranco 2-stage temperature controller and wall mounted air conditioner and heater units. I ferment with two 20-gallon (76-L) stainless steel conical fermenters with built in thermowells, tri-clover fittings, and butterfly valves.

To date, the Ale Engine has been running strong and continues to supply my friends with endless growlers of tasty homebrew. There are lots of other cool features, too — visit http://www.byo.com/photos/category/78 for more photos (including a CAD drawing) and all the gear-related specifics!

LAGER YEAST

by betsy parks

By now, as someone who is interested in beer, you most likely know that there is a difference between an ale and a lager: the yeast. But what are the basic differences between ale and lager yeast?

Lager versus ale

Ale and lager yeast strains are different species. Ale yeast is *Saccharomyces cerevisiae* and lager yeast is *S. pastorianus.* (Turn to page 42 for more history of the lager yeast.) Often you will hear the main difference between the yeasts described in terms of where in the fermenter they tend to collect — the top or the bottom. Ale yeast is commonly described as "top fermenting" and lager yeast is "bottom fermenting." More specifically, ale yeast is thought to collect in a thick, foamy head toward the top of the fermenter during fermentation, while lager yeasts tend to settle out toward the bottom of the fermenter. While these distinctions were obvious when open fermenters were commonly used by ale and lager brewers, this distinction is not so clear when cylindroconical fermenters are used since most ale strains settle to the bottom in a very similar fashion as lager strains.

The most important differences between ale and lager yeast, however, is the conditions in which they ferment, and the subsequent styles of beer they create. Ale yeasts ferment at higher temperatures, often around the range of 70 °F (21 °C), which can produce "fruity" esters that will change the flavor of the beer. This is good for brewing beer styles that require those types of flavors, such as pale ales, porters, wheat beers and stouts. Because ale yeast ferments at warmer temperatures, ales ferment faster than lagers. Primary fermentation normally takes somewhere between two and seven days. Following primary fermentation, most ales can be packaged and be ready to drink, depending on the beer style.

In contrast, lager yeast ferments in the range of 54 °F (12 °C), which is too low for ale yeast strains to be active. This allows brewers to brew styles that require "clean," malty flavors as low fermentation temperatures prevent the yeast from creating those "fruity" esters that occur during warmer ale fermentations. Examples include Pilsners, Helles, bocks and Vienna lagers, as well as dark lagers like schwarzbier.

Because of the cooler conditions, lager yeasts take longer to ferment. Primary fermentation for a typical lager can take anywhere from one to three weeks. Lagers also require a secondary conditioning phase — known as lagering — to allow the yeast to fully finish fermenting and settle out. Depending on the style, this phase can take anywhere from a few weeks to sometimes even months.

Brewing with lager yeast

Brewing with lager yeast requires the ability to maintain cool fermentation temperatures. You can try brewing lagers the traditional way before the days of refrigeration — during cooler months of the year. Or, if that's not an option, you can use some type of temperature-controlled fermenter, or store your fermenter in a climate-controlled space. For more information about temperature control, visit www.byo.com/component/resource/article/1923.

Brewing lagers also requires making sure that you pitch enough yeast — which is often more yeast than you might think you need. Research the pitching rate for your beer style before you brew to be sure that you have enough yeast before you begin. Turn to page 55 for more about pitching rates.

homebrew nation

by marc martin

DEAR REPLICATOR, I TRAVELED RECENTLY TO PORTLAND, OREGON TO VISIT A FRIEND, WHO TOOK ME TO A RELATIVELY NEW BREWERY NAMED OCCIDENTAL BREWING COMPANY. THEY HAD FOUR EXCELLENT BEERS ON TAP BUT BY FAR MY FAVORITE WAS THE DUNKEL LAGER. IT WAS VERY TRUE TO STYLE WITH A CLEAN MALT FLAVOR. I HAVEN'T BREWED A LAGER BEFORE, BUT I WOULD BE FOREVER GRATEFUL IF YOU COULD HELP ME DUPLICATE THIS WONDERFUL BEER.

STEVE WILKINS
EUGENE, OREGON

Homebrewing roots run deep in the uncle-nephew team behind Occidental Brewing Company. Brewmaster and owner Dan Engler and co-brewer/co-owner Ben Engler both readily took to the hobby. Ben homebrewed for three years before joining forces with his uncle to open the brewery, and Dan began homebrewing when he was only 17.

Within a year of starting the hobby, Dan moved up to all-grain batches, eventually working on a stainless steel, 15-gallon (57-L) HERMS system before opening Occidental. This allowed him to perfect many of his commercial recipes.

Moving up from 15-gallon batches to their current 10-barrel brewhouse was somewhat challenging, but you would never know from the quality of their beers. They brewed their first commercial batch in May 2011 and a month later they opened their taproom. Their main lineup of beers is heavily German-style focused. Production for 2011 was only about 200 barrels. Now, with more than 30 tap accounts, the projection for 2012 is approaching 1,000 barrels.

Occidental's Dunkel is a fine representation of the traditional style. Dan says that many people claim that you can't make a 100% Munich grain beer, but he proves this to be false. The extended boil serves to bring out the deep malty flavor and unexpectedly dark color in the beer. Somewhat bready, biscuit flavors are exhibited but fade to a smooth clean finish. This crystal clear beer exhibits a dense off white head and the restrained use of traditional noble hops provide just enough bitterness to offset the medium residual sweetness.

Now Steve, you won't have to drive to Portland for this fine Dunkel because you can "Brew Your Own."

For further information about the brewery and their other fine beers visit the website http://occidentalbrewing.com or call the brewery at 503-719-7102. BYO

OCCIDENTAL BREWING COMPANY'S DUNKEL LAGER CLONE
(5 gallons/19 L, extract with grains)

OG = 1.054 FG = 1.014 IBU = 27 SRM = 19 ABV = 5.2%

Ingredients

- 3.3 lbs. (1.5 kg) Briess Munich liquid malt extract
- 2 lbs. (0.9 kg) Briess amber dried malt extract
- 2.5 lbs. (1.13 kg) Munich malt (6 °L)
- 6 AAU Perle pellet hops (60 min.) (0.75 oz./21 g of 8% alpha acids)
- 3 AAU Hallertauer pellet hops (30 min.) (0.75 oz./21 g of 4% alpha acids)
- 2 AAU Hallertauer pellet hops (5 min.) (0.5 oz./14 g of 4% alpha acids)
- ½ tsp. yeast nutrient (last 15 min.)
- ½ tsp. Irish moss (last 15 min.)
- White Labs WLP830 (German Lager) or Wyeast 2308 (Munich Lager) yeast
- 0.75 cup (150 g) of corn sugar for priming (if bottling)

Step by Step

Steep the crushed grain in 3.4 quarts (3.3 L) of water at 152 °F (67 °C) for 30 minutes. Remove grains from the wort and rinse with 3.0 quarts (2.8 L) of hot water. Add water to make 3 gallons (11 L), add malt extracts and bring to a boil. While boiling, add the hops, yeast nutrient and Irish moss as per the schedule. During the boil, use this time to thoroughly sanitize a fermenter. Add the wort to 2 gallons (7.5 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 the yeast and aerate heavily. Allow the beer to cool to 65 °F (19 °C). When evidence of fermentation is apparent, drop the temperature to 52 °F (11 °C). Hold at that temperature until fermentation is complete (~10 days). Transfer to a carboy, avoiding any splashing. Condition for two weeks at 42 °F (5 °C) and then bottle or keg. Allow to carbonate and age for four weeks.

All-grain option:

This is a single step infusion mash. Replace the liquid and dried malt extracts with an additional 9.5 lbs. (4.3 kg) of Munich malt for a total of 12 lbs. (5.4 kg). Mix the crushed grains with 4 gallons (15 L) of 170 °F (77° C) water to stabilize at 152 °F (67 °C) for 60 minutes. Sparge slowly with 175 °F (79 °C) water. Collect approximately 6.5 gallons (25 L) of wort runoff to boil for 120 minutes. Reduce the 60-minute Perle hop addition to 0.5 oz. (14 g) to allow for the higher utilization factor of a full wort boil. The remainder of this recipe and procedures are the same as the extract with grains recipe. Note: This should be a 90-minute boil for the extract with grains recipe and a 120-minute boil for all-grain recipe in order to develop the flavor and color from the all Munich grain bill.

Golden Homebrew

Brewing with honey

by Betsy Parks

MEAD MAY GET ALL THE PRESS WHEN IT COMES TO FERMENTING BEVERAGES WITH HONEY, BUT THERE ARE MANY CRAFT BEERS WITH A TASTE OF HONEY OUT THERE. IN THIS ISSUE, TWO HONEY-FRIENDLY CRAFT BREWERS DISCUSS USING HONEY IN A HOMEBREWERY.

We love to brew beer with honey here at Town Hall, and we make several different styles. Most notably are our Eye of the Storm (a strong honey beer with a massive amount of honey and many varieties), Thunderstorm (made with orange blossom honey), and L.S.D. (made with sunflower honey).

The desire to brew with honey began after I fostered a relationship with a local honey producer. When we met I found him to have very similar attitudes to most brewers I know, and he took the time to educate me on different types of honey and production methodology. It quickly became evident to me as I got to know him that honey is super interesting and that I needed some beer designed around its complexity.

At Town Hall, we generally use a high quality base malt for beers we brew with honey that offers depth without being the primary focal point of the beer, such as Bohemian Pilsner malt. We use a very neutral/clean ale yeast (California Ale) at cooler fermentation temperatures in order to stay away from too much yeast character. Hops are always used in small amounts (15–17 IBU) and are usually used just for a slight balancing bitterness. We strongly believe these honey beers should be all about showcasing the honey.

For honey varieties, we use Orange Blossom, Clover, Wildflower, Alfalfa, Basswood, Sunflower, Raspberry Blossom, Blackberry Blossom, Fireweed, Star Thistle, Buckwheat and Black Button Sage. All these honeys feature a different sort of magic and we brew with them accordingly. Honey can be another ingredient for beer just like hops. Most brewers use many hop varieties based on their individual characteristics, so why should honey be any different? We add any honey at the end of the boil. This is because the wort is still able to sterilize the honey, but also so that we do not boil off the precious aroma compounds.

Over time we have experimented with different amounts of honey in our beers. This calibrated our brew staff to know what to expect with each beer brewed. I would suggest that you experiment this way at home as well. In order to be the most effective brewer possible you must know as much as you can about your ingredients. Honey is also hyper-fermentable and it was necessary to determine how much of it to use that would not simply ferment out and disappear. Also, for some reason we can't seem to remember to preheat the honey container so that the stuff will pour out!

If you want to experiment at home, I suggest getting your hands on a bunch of different varieties of honeys and make "tea" (honey and water) with each of them — you can really learn differences in varieties that way. Also, honey is great to add complexity to beer that may not intend to be a "honey beer" — like a Belgian-style tripel or even a brown ale. A little honey will go a long way in personal flavor profile.

Finally, when you brew with honey, unlike some ingredients, you should always use more than you think you should. Also, always wait longer to consume the beer than you think you can. Time is a very, very good friend of honey. Our staff always has problems waiting for Eye of the Storm to be ready . . . but when we are patient it is so worth it!

Mike Hoops, Master Brewer at Minneapolis Town Hall Brewery, Minneapolis, Minnesota. Mike pursued a career in brewing while completing a bachelor's degree in international relations and geography at the University of Minnesota, Duluth. In 1995, he graduated both from U of M and University of Sunderland, England's Brewlab certificate program. In 1996 he came on as the Master Brewer at Fitger's Brewhouse in Duluth before starting with Town Hall Brewery in 2000.

Dave Chichura, Brewmaster at Oskar Blues Brewery in Longmont, Colorado. Dave started homebrewing in 1994. He went pro in 1996 at Rock Bottom Restaurant and Brewery in Indianapolis, Indiana, and worked for Bell's Brewery in Kalamazoo, Michigan and Mountain Sun Pub and Brewery in Boulder, Colorado before joining Oskar Blues in 2004.

We recently brewed a smoked porter with honey at our pub in Lyons, Colorado. The idea for the beer came about during a mountain bike ride and had something to do with the "Honey Badger" viral video on YouTube. There's a local honey supplier near Lyons called Madhava so we were able to incorporate another local business into it, too.

We brew Honey Badger with Maris Otter pale malt, Rahr 2-row, Simpsons chocolate malt, Crisp C-120, Crisp roasted barley, Gambrinus honey malt and three additions of Columbus hops. We used our American ale yeast and fermented at 69 °F (21 °C).

We used Madhava's wildflower honey. It's the most flavorful honey type they offer and we thought it might be noticeable if it survived fermentation. I added it to the last 5 minutes of the boil because from the reading I've done this is the safest way to deal with honey. Because of the inherent bacteria and wild yeast in raw honey I felt that it was risky to add it to the wort post-boil unless it was pasteurized. Honestly, I didn't have the time to deal with that, so I added it to the kettle just before the end of boil.

I used about 36 pounds of honey for an 8-bbl batch of beer and the honey accounted for about 10% of the original gravity. Because honey is highly fermentable I didn't want to use a huge amount because it would dry the beer out.

If you want to try brewing with honey at home, try adding different amounts of honey relative to the malt bill as well as adding it at different times in the process (directly to fermenter for example). When you are experimenting, however, be aware that the high degree of fermentability of honey means that you won't get much flavor or aroma unless you are making lighter beers and strategically adding the honey. Most of what I've read about honey tells me that true honey character will be best achieved by adding it to the fermenter, which requires pasteurizing the honey. BYO

Using A Hopback

Refrigeration, refractometers

by Ashton Lewis

Q I JUST ACQUIRED A HOPBACK AND NOW I AM WONDERING HOW BEST TO USE IT. CAN IT REPLACE LATE ADDITION HOPS, AND IF SO, WOULD THE QUANTITIES BE THE SAME? WHAT ABOUT DRY HOPS? WILL RUNNING HOT WORT THROUGH A HOPBACK OBVIATE THE NEED FOR DRY HOPPING AND WHAT WOULD BE THE RATIO OF DRY HOPS TO HOPBACK HOPS? THE INSTRUCTIONS WITH THE HOPBACK SAID USE ONLY WHOLE HOPS AND I CAN UNDERSTAND THAT BUT COULD PELLETS IN A HOP BAG BE SUBSTITUTED?

BILL WINTER
SILVER SPRING, MARYLAND

A The term hopback, or hopjack, has different meanings to different brewers. Before the advent of pelletized hops and hop extracts all brewers used whole hops. Hopbacks were used primarily to strain hops from wort after wort boiling. There were two basic designs for hopbacks; batch and continuous designs. The batch-sized hopbacks looked similar to mash tuns and were designed to hold the contents of one brew. Basically, the kettle was drained (or "knocked-out") and the hopback acted as a strainer to remove the hops while the wort flowed through the strainer installed in the bottom of the hopback. Continuous hopjacks were designed with screw augers that moved the spent hops out of the hopback while wort flowed through the strainer and out. Both basic designs have changed little over the last century and are still used by brewers who use whole hops for brewing.

Brewers who really liked beers with pronounced hop aroma figured out that if a batch-style hopback was loaded up with hops before the kettle knock-out the resulting beer would be full of wonderful hop aromatics, but not hop bitterness. This is true because hop oils, the aroma constituent of hops, are quickly extracted by hot wort while hop bitterness requires hops to be exposed to boiling for a period of time to isomerize alpha acids into their more bitter and soluble cousins, the iso-alpha-acids. The use of the hopback in this fashion is not too different than a drip-style coffee maker or the bed of juniper boughs used in Sahti brewing.

As a brewer and beer connoisseur, I think the three methods you address in your question, late hopping, hopback hopping and dry hopping, are all distinctively different in how hop aroma is expressed in the finished beer. Late hop additions, especially when pellet hops are added to the kettle and not removed from wort until wort cooling is complete, frequently add bitterness to beer in addition to aroma. This feature of late hop additions can be avoided if whole hops are used and then separated with a hopback. As you suggest you can accomplish a similar effect by using a hop bag and removing the bag of pellets after boiling. Late hopping and hopback hopping both extract aroma compounds from hops using hot wort while dry hopping uses beer to extract hop aroma. This makes dry hopping very different, at least to my sensitive schnoz, from these hot wort treatments.

OK, now for the subjective part of the answer. I think hopback hopping is a great substitute for late kettle additions. As far as the aroma contribution is concerned you may find that the aroma retention is better with the hopback since adding hops to the kettle does result in aroma loss if the boil extends much past the addition. However, you may end up with a

> "Sometimes it is difficult to appreciate the nuances of a technique when it is combined with others."

slightly less bitter beer with the hopback. A slight increase to the first hop addition is an easy way to tweak any recipe you have that you want to reproduce with your new hopback.

In the "old days" of really hoppy beers, you know like in the early 1990s, simply hopback hopping or dry hopping with a pretty generous dose of hops, such as ½-ounce per gallon or roughly 4 grams per liter, was enough to make most beer drinkers say "wow, this is a really hoppy beer." Things are different nowadays, especially since that documentary, "Hopheads Gone Wild," inspired the ultra-hoppy tipple movement. Some of these beers use the belt-and-suspenders approach to brewing and are hopped using as many methods as possible. There are really no rules, as long as you are willing to pay to play. There is no doubt that if you hopback hop and then later dry hop the same beer that another layer of hoppy complexity will be added.

I am a fan of balance, even with big beers that are often a bit unbalanced by their very nature. Sometimes it is difficult to appreciate the nuances of a technique when it is combined with others. It's kind of like attempting to appreciate an ethereal jazz flute solo while the drummer is bashing on the kit with sticks. But if you really want to crank the dial up on the hop-o-meter the combination of hopback hopping and dry hopping can be fun. My inclination would be to balance the two methods such that neither overwhelms the other. In my experience I find that it takes about twice the weight of hops used in dry hopping to approximately equal the impact of one part of hops when hopback hopping, for example use a ½ ounce per gallon of dry hops and a ¼ ounce per gallon of hopback hops. With that being said, you bought a tool, so go experiment with it and figure out what works best for your preferences!

Q NOT KNOWING MUCH OF ANYTHING ABOUT HOW A REFRIGERATOR WORKS, I WAS WONDERING IF IT IS POSSIBLE TO PUT ONE OUTSIDE (CENTRAL MISSOURI GETS PRETTY COLD) WITH THE TEMPERATURE CONTROL SET AT, SAY 68 °F (20 °C), AND EXPECT IT TO HOLD THAT TEMPERATURE ALL YEAR ROUND? THIS WOULD BE HOME TO MY CONICAL, NATURALLY. I SEE SODA MACHINES OUTSIDE, AND THE CONTENTS DON'T SEEM TO FREEZE DURING THE WINTER.

JIM CROW
COOPER HILL, MISSOURI

A The refrigeration cycle is pretty nifty and its development began in the late 1700s. The earliest use of commercial refrigeration occurred sometime in the mid 1800s by, you guessed it, breweries. The refrigeration cycle is pretty, well, um, cool, and has four main parts to the cycle.

The cycle begins by compressing a refrigerant gas, such as ammonia; this results in high-pressure, hot, refrigerant gas. The hot gas flows from the compressor into the condensing coil where a coolant, normally air from a fan (this is the thing outside of your house that blows hot air in the summer), removes heat from the hot gas, thereby converting it into high pressure liquid. This phase change occurs because the gas condenses when cooled.

The third step is where the cool begins; the high pressure gas flows through an expansion valve, which is essentially a nozzle providing backpressure to the liquid side of the system. The nozzle creates pressure drop in the system and when the high pressure liquid expands the result is a mixture of cold refrigerant gas and liquid (for more on why the mixture becomes cold read about adiabatic expansion). This mixture then flows to the heat exchanger responsible for chilling, often called "the coil" in a refrigeration system, where the refrigerant absorbs energy from the environment and is evaporated into gas. The energy absorbed by the refrigeration is removed from the system as the warm gas enters the compressor. The cycle now repeats itself and the energy removed in the condenser represents the energy absorbed in the evaporator coil.

Depending on how this system is set up, in terms of what the compressor and thermal expansion valve are doing to the refrigerant, and what type of refrigerant is being used this type of refrigeration loop works great as either a refrigerator or a freezer. The system starts and stops by activating the compressor and this is triggered using a thermostat. The bottom line is that the unit is designed to remove heat from the system, in other words make the inside of the cooler cold, when running. And when the unit is not running the inside of the cooler becomes warmer if there is a heat source inside of the cooler, such as a fermenting batch of beer, or if warm air from the outside environment infiltrates the cooler, or as the cold from inside the cooler is transferred out across the walls of the cooler.

So, what happens in the winter time when a refrigerator is placed outside and the thermostat is set to 68 °F (20 °C)? If the temperature inside is warmer than 68 °F

> "The bottom line is that the unit is designed to remove heat from the system . . ."

(20 °C), the compressor kicks on and stays on until the temperature reaches 68 °F (20 °C). However, if the outside temperature is cold, let's say it's 20 °F (-7 °C) out and the cooler begins to drop below 68 °F (20 °C), nothing happens with respect to the compressor. The temperature inside the cooler will continue to drop as the cold from outside the cooler transfers inside. This is no different than what happens inside your house during the winter. Eventually, the contents of the refrigerator will freeze if the outside temperature stays cold for long enough. This process is slowed by insulation, but insulation does not stop it.

If you really want to have a refrigerator that does not drop below the set point, then you must install a heater and use two thermostats. The simplest heater is to use a heat lamp, but if you ferment in glass carboys you need to be careful not to damage your beer with light. Refrigerator heater kits are sold by some refrigerator manufacturers specifically to keep refrigerators located in garages from becoming too cold.

Q

I HAVE BEEN USING BOTH A BRIX REFRACTOMETER AND A HYDROMETER TO DETERMINE THE FINISHED STATE OF MY BEER. MY LOGIC IS THAT IF I MEASURE THE SAME BRIX READING IN TWO CONSECUTIVE DAYS, MY BEER IS DONE WITH PRIMARY FERMENTATION. UPON RACKING TO SECONDARY, I MEASURE THE SPECIFIC GRAVITY USING THE HYDROMETER FOR AN ABSOLUTE NUMBER. ARE THERE ANY FLAWS IN MY LOGIC?

TODD MORGAN
OLYMPIA, WASHINGTON

A

Refractometers measure the refraction, or "bending," of light caused when light passes through various media. The refraction of light is not the same for all media and this difference is a useful property that can be used to indirectly measure the concentration of a sugar solution, for example. This works when there are two parts to the system being measured, for example water and glucose. If there are other components of the system things become confused, especially if the components have very different refractive indices. This is why refractometers work well for measuring the sugar concentration of wort, but do not work well when fermentation begins and ethanol is present.

Hydrometers measure the density of liquids and do not depend on the nature of the liquid. In other words, if a liquid solution has a density of 1.000, the hydrometer does not behave differently if the liquid is water or a mixture of water, sugar and ethanol. Hydrometers are especially useful in brewing because they are robust tools for tracking the density of wort as it is transformed into beer.

What you want to do with your refractometer is totally valid. Since changes in the composition of beer by fermentation will change the refractive index of the beer, no changes in the refractive index imply that the composition of beer has not been changed and that fermentation must be complete. As long as you use the method as a simple indicator of activity and nothing more, you will not be mislead by the results. The key to this method is that after you determine that fermentation is complete, you then measure the final gravity of your batch. The downside, however, is that the refractive index of ethanol is greater than water, but the refractive index of sugar solutions decrease with dilution. This means that the sugar and alcohol affect the refractive index in opposing ways. At least with a hydrometer the density changes in the same direction as fermentation moves towards completion. BYO

Poured in the USA

Classic American Pilsner

by Jamil Zainasheff

Classic American Pilsner is a much bigger beer, in terms of flavor and aroma, than today's mainstream American Pilsners. Like your grandpappy's Pilsner, this is a rich malty and hoppy beer. I am not a fan of the current BJCP Style Guideline description for this beer style. It is certainly correct in the right context, but it can be very misleading. For example, it says that classic American Pilsner has a "rich, creamy mouthfeel" but it is critical to realize that the description is in the context of other Pilsner beers. Yes, compared to American light lager, classic American Pilsner is a rich, creamy beer. But compared to a bock, it is not nearly as rich. The same goes for things like hop character and bitterness. Is the hop character high compared to other Pilsners? Sure, but it is pretty pedestrian compared to most IPAs.

Even though classic American Pilsner is a rich, creamy Pilsner, it should always finish crisp and refreshing. This is a moderate alcohol beer (4.5 to 6% ABV) with a medium body and medium to high carbonation. Appearance ranges from yellow to deep gold with brilliant clarity. Good examples will exhibit both grainy malt and hop character.

Common wisdom says to use six-row malt to allow for higher adjunct levels and perhaps historic accuracy. I would not bother with six-row. I use domestic two-row malt labeled either pale malt or Pilsner. Continental Pilsner malt is a good choice too and a blend of domestic and continental Pilsner is an easy trick to get a little more grainy sweetness without going too far. About 20 to 30% of the fermentable sugars in this style are from non-malt sources, such as corn or rice. Corn is the best choice, giving the beer a subtle sweet corn character, which judges seem to look for in this style. If you use rice, you will get a cleaner, less sweet flavor. The key to brewing with corn is in obtaining the freshest ingredients you can get. Corn can very quickly take on a mealy, stale taste once processed into flakes, so taste your ingredients before committing to a brew. Grits or polenta is a little more shelf stable, but they require boiling separately first to make the starches available to the enzymes once added to the mash.

If you cannot bear having such a simple recipe, you can add head and body forming dextrin malts such as Carapils®, but it is best to keep these malts between 0 and 10% of the grist. Some brewers add small amounts of Vienna, light Munich or melanoidin malt in hopes of creating a richer malt background, but I would avoid it unless you are stuck using completely flavorless base malt. Even then, use restraint and keep the percentage to less than 5% of the grain bill. You do not want to overwhelm the grainy malt flavors of this beer.

Extract brewers will have trouble with this style. While brewer's (high maltose) corn syrup is available, it will not provide the same corn character as using fresh corn flakes or grits. If you are an extract brewer and are serious about making a great classic American Pilsner, you will need to do a partial mash with flaked corn. For the extract portion, you should use a Pilsner-type extract that attenuates at least 75% or more. Most light colored extracts will attenuate fairly well and should be close enough.

Historically, brewers would most likely have used a decoction mash and perhaps a separate cereal mash for the corn or rice, but I like to avoid any work that I do not feel is necessary, so I prefer to use flaked corn or rice and a single infusion mash. I find that fresh, high quality ingredients and ideal fermentation conditions are the keys to award-winning beer. It is far more important to invest time and effort in fermentation, sanitation and post fermentation handling than trying

Continued on page 21

CLASSIC AMERICAN PILSNER by the numbers

OG:	1.044–1.060 (11–14.7 °P)
FG:	1.010–1.015 (2.6–3.8 °P)
SRM:	3–6
IBU:	25–40
ABV:	4.5–6%

Photo by Jim Witmer

Classic American Pilsner
(5 gallons/19 L, all-grain)

OG = 1.060 (14.7 °P)
FG = 1.014 (3.6 °P)
IBU = 35 SRM = 4 ABV = 6%

Ingredients
4.4 lb. (2 kg) Great Western domestic two-row malt (2 °L)
4.4 lb. (2 kg) Best Malz continental Pilsner malt (2 °L)
3.3 lb. (1.5 kg) Briess flaked corn (1 °L)
6.5 AAU Czech Saaz hops (1.87 oz./53 g at 3.5% alpha acids) (60 min.)
3.5 AAU Czech Saaz hops (1 oz./28 g of 3.5% alpha acids) (15 min.)
3.5 AAU Czech Saaz hops (1 oz./28 g of 3.5% alpha acids) (0 min.)
White Labs WLP800 (Pilsner Lager) or Wyeast 2001 (Urquell) 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 149 °F (65 °C). Hold the mash at 149 °F (65 °C) until enzymatic conversion is complete. You might want to extend your mash time, due to the lower mash temperature and the need to convert the corn. 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 6.5 gallons (24.4 L) and the gravity is 1.046 (11.5 °P).

The total boil time will be 90 minutes. Add the bittering hops 30 minutes after the wort starts boiling. Add Irish moss or other kettle finings and the second hop addition with 15 minutes left in the boil. Add the last hop addition just before shutting off the burner. Chill the wort rapidly to 50 °F (10 °C), let the break material settle, rack to the fermenter, pitch the yeast and aerate thoroughly.

You will need to pitch 4 packages of fresh yeast or make a large starter to have enough yeast to best ferment this beer. You might consider first brewing a small batch of lower gravity Munich helles or something similar to grow up the yeast you need. Once you have pitched enough clean, healthy yeast, ferment at 50 °F (10 °C).

When fermentation is finished, carbonate the beer to approximately 2.5 volumes.

Classic American Pilsner
(5 gallons/19 L, extract only)

OG = 1.060 (14.7 °P)
FG = 1.014 (3.6 °P)
IBU = 35 SRM = 4 ABV = 6%

Ingredients
6 lb. (2.7 kg) Pilsner liquid malt extract (2 °L)
2.2 lb. (1 kg) high maltose corn or rice syrup (0 °L)
6.5 AAU Czech Saaz hops (1.87 oz./53 g at 3.5% alpha acids) (60 min.)
3.5 AAU Czech Saaz hops (1 oz./28 g of 3.5% alpha acids) (15 min.)
3.5 AAU Czech Saaz hops (1 oz./28 g of 3.5% alpha acids) (0 min.)
White Labs WLP800 (Pilsner Lager) or Wyeast 2001 (Urquell) yeast

Step by Step
I have used a number of Pilsner-type extracts, all with success. Always choose the freshest extract that fits the beer style. If you cannot get fresh liquid malt extract, use an appropriate amount of dried extract instead. Using fresh extract is very important to this style. Finding high maltose rice or corn syrups can be difficult in smaller quantities, but some homebrew shops do carry them. Alternatively, you could use dextrose in place of the syrup. Ideally, you would do a partial mash with corn or leave this style to all-grain.

Add enough water to the malt extract to make a pre-boil volume of 5.9 gallons (22.3 liters) and the gravity is 1.051 (12.6 °P). Stir the wort thoroughly to help dissolve the extract and bring to a boil.

Once the wort is boiling, add the bittering hops. The total wort boil time is 1 hour after adding the first hops. Add Irish moss or other kettle finings and the second hop addition with 15 minutes left in the boil. Add the last hop addition just before shutting off the burner. Chill the wort rapidly to 50 °F (10 °C), let the break material settle, rack to the fermenter, pitch the yeast and aerate thoroughly.

You will need to pitch 4 packages of fresh yeast or make a large starter to have enough yeast to best ferment this beer. You might consider first brewing a small batch of lower gravity Munich helles or something similar to grow up the yeast you need. Once you have pitched enough clean, healthy yeast, ferment at 50 °F (10 °C). When fermentation is finished, carbonate the beer to approximately 2.5 volumes.

Web extra:
Follow Jamil's blog as he opens his own commercial brewery, Heretic Brewing:
www.byo.com/blogs/blogger/Jamil

to mimic historic practices. Also, malt has drastically changed during the last century and things that were once done for a certain reason are often times not totally necessary with today's malt, unless you enjoy the extra brewing procedures. For single infusion, target a mash temperature range of 147 to 150 °F (64 to 66 °C). If you are making a lower gravity beer, use the higher end of this temperature range to leave the beer with a bit more fullness. Keep in mind that lower mash temperatures need a little longer to convert than high mash temperatures. Test your mash for conversion and extend your mash until you are confident conversion is complete.

Hop character in this style is medium to high, comprised of any classic Pilsner hops (Saaz, Hallertau, etc.) to develop a spicy-floral character. Some say that Cluster hops are the hop of choice for brewing classic American Pilsner, because Cluster made up the bulk of American hop production historically. However, I am not a big fan of Cluster, as it can come across as a bit harsh and catty. If you want a "rustic" character without the catty character, give Northern Brewer hops a try. For this style, I prefer the classic noble hops, but substitutions are fine. The trick is to select hops with a similar flowery or spicy noble hop character. You do not want to use anything fruity or citrusy. Some decent substitutions are Liberty and Mt. Hood. You can also try Crystal, Ultra and Vanguard. The important thing, when trying to make an excellent example of the style, is to balance the hop character with the malt character. You want the grainy malt and corn notes to be evident at least in the background. You want the drinker to get a hint of malt character along with the hop bittering, flavor and aroma. One to two ounces (28 to 57 g) of noble hops spread out over the last 20 minutes of the boil will provide a nice level of hop character without overwhelming the malt.

Bittering ranges from medium to high. Keep in mind that "high" in the context of Pilsners is a firm and clearly balanced bitter, but not a palate

"For this style, I prefer the classic noble hops, but substitutions are fine. The trick is to select hops with a similar flowery or spicy noble hop character. You do not want to use anything fruity or citrusy."

"You will find that each lager yeast strain emphasizes different aspects of the beer. Some will have more malt character and some more hop character, but all can produce an excellent classic American Pilsner."

blaster like the West Coast IPAs of today. Remember, the goal for every Pilsner-type beer is to produce a highly drinkable beer. Beers that are heavy with too much bitterness and too much sweetness are less drinkable. The bitterness-to-starting gravity ratio (IBU divided by OG) ranges between 0.5 and 0.7. I like to target around 0.6 and go heavier on the hop aroma and flavor.

You can ferment classic American Pilsner with almost any lager yeast, though my favorites are White Labs WLP800 (Pilsner Lager) and Wyeast 2001 (Urquell) strains. You will find that each lager yeast strain emphasizes different aspects of the beer. Some will have more malt character and some more hop character, but all can produce an excellent classic American Pilsner.

When making lagers, I like to chill the wort down to 44 °F (7 °C), oxygenate, and then pitch my yeast. I let the beer slowly warm over the first 36 hours to 50 °F (10 °C) and then I hold this temperature for the remainder of fermentation. If fermentation seems sluggish at all after the first 24 hours, I am not afraid to raise the temperature a couple degrees more. The idea is to reduce the diacetyl precursor alpha-acetolactate, which the yeast create during the early phase of fermentation. Once the growth phase of fermentation is complete, it is important that fermentation be as vigorous as possible. It may never be as robust as fermentation at ale temperatures, but it is important to have enough activity to blow off aromatic sulfurs and other unpleasant compounds. Vigorous yeast activity at the end of fermentation also improves reduction of compounds such as diacetyl. Starting fermentation colder only works well if you are pitching enough clean, healthy yeast at the start. If not, you will need to start warmer (perhaps 55 °F/13 °C) to encourage more yeast growth. Even if you start fermentation warmer, you can still raise the temperature toward the latter part of fermentation.

Since diacetyl reduction is slower at colder temperatures, a cold fer-

Classic American Pilsner Commercial Examples

All American Pilsner
Terrapin Brewing Company
Athens, Georgia
http://terrapinbeer.com

Beach Haus Classic American Pilsner
East Coast Beer Company
Point Pleasant, New Jersey
www.beachhausbeer.com

Boulevard Pilsner
Boulevard Brewing Company
Kansas City, Missouri
www.boulevard.com

Joe's Premium American Pilsner
Avery Brewing Company
Boulder, Colorado
www.averybrewing.com

Kickstand
Bear Republic Brewing Co.
Healdsburg, California
www.bearrepublic.com

Kuhnhenn Imperial Classic American Pilsner
Kuhnhenn Brewing Company
Warren, Michigan
www.kbrewery.com

Legacy Lager
Silver Moon Brewing
Bend, Oregon
www.silvermoonbrewing.com

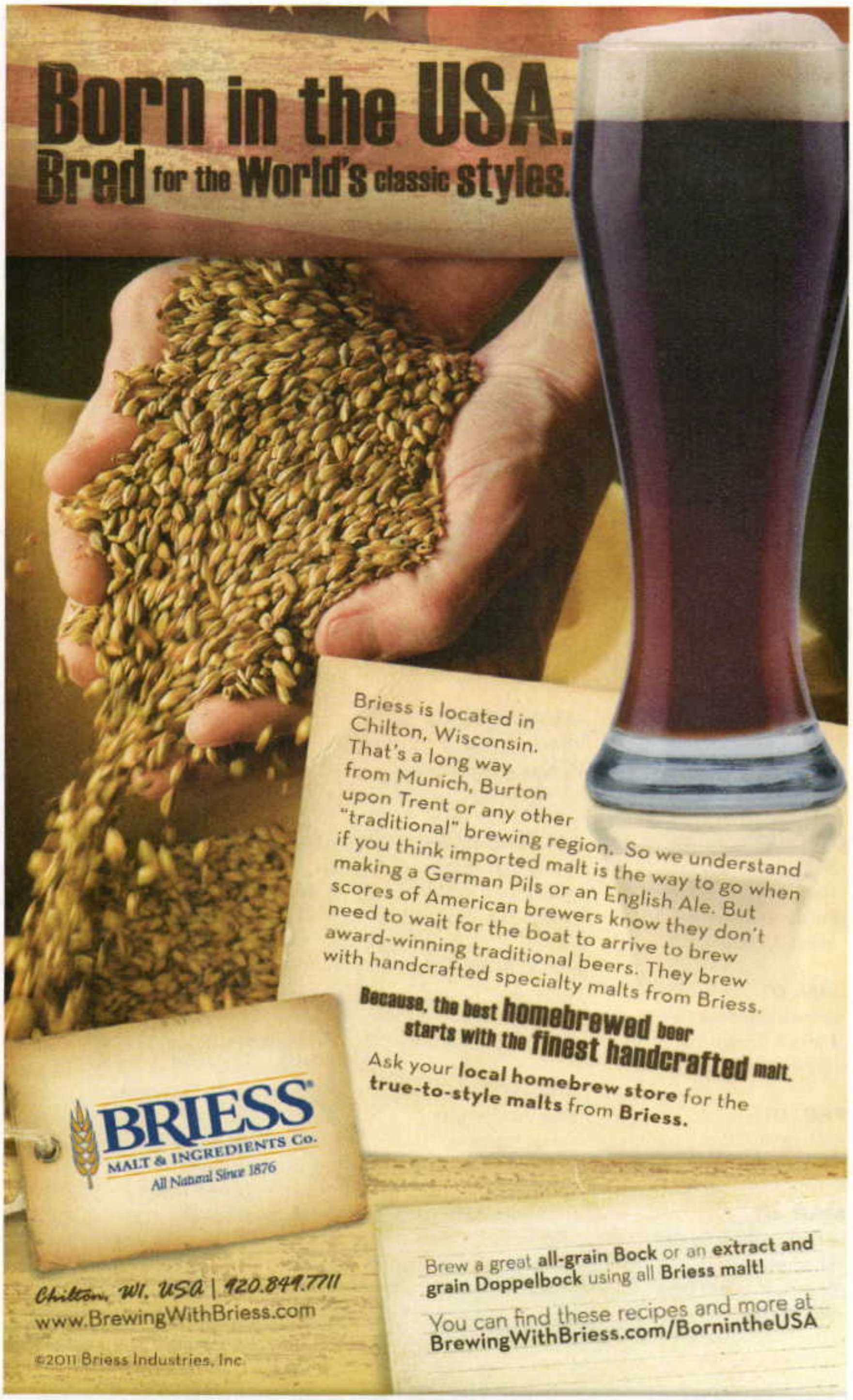
Ray Hill's Classic American Pilsner
Hill Brewing Company
St. Louis, Missouri
www.rayhills.com

Von Jakob American Pilsner
Von Jakob Brewery
Alto Pass, Illinois
www.vonjakobvineyard.com/brewery/

Totally Naked
New Glarus Brewing Co.
New Glarus, Wisconsin
www.newglarusbrewing.com

mented lager may require a diacetyl rest. To perform a diacetyl rest, simply raise the temperature into the 65 to 68 °F (18 to 20 °C) range for a two-day period near the end of the fermentation. While you can do a diacetyl rest after the fermentation reaches terminal gravity, a good time for a diacetyl rest is when fermentation is 2 to 5 specific gravity points (0.5 to 1 °P) prior to reaching terminal gravity. Brewers ask how they should know when fermentation has reached that stage. Raise the fermentation temperature for a diacetyl rest as soon as you see fermentation activity significantly slowing. It will not hurt the beer and it should help the yeast reach complete attenuation as well. BYO

Jamil Zainasheff writes "Style Profile" in every issue of BYO.



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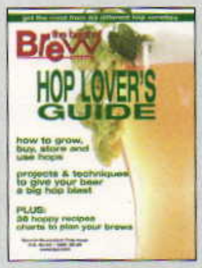

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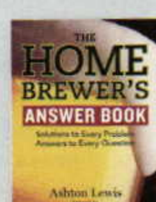

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BREWING WITH HONEY

Story by **Mick Spencer**

Honey has been used in brewing for thousands of years. As far back as 700 BC, honey was used by at least one Iron Age tribe in a mixed beverage that might reasonably be called beer; a chemical analysis of residue from 2,700 year old drinking vessels found in modern Turkey revealed compounds from honey, as well as barley and grapes. Although honey is not a traditional ingredient in most modern beer styles, it can be used to add flavor and aroma to nearly any style — lagers, IPAs, cream ales, and imperial stouts, to name a few.

The Bee-ology of Honey

Honey comes from bees. Honey bees (of the genus *Apis*) produce honey to provide a year round food source for their hive. Evolution has seen to it that honey bees are attracted to the bright or highly contrasting colors of the blossoms of flowering plants, which signal that nectar — a sugary liquid excreted by the plants — is likely available. The bee ingests the flower's nectar by sucking it through its tube-like tongue, known as a proboscis, and depositing it into a special "honey stomach." Enzymes in the bee's honey stomach convert the nectar into honey, which is then regurgitated into the hexagonal cells of honeycomb back at the hive. Honey is a good food source for the hive because it is rich in simple sugars. Other than sugars and water, just a small amount of other material, made up of more than 100 different compounds, is present. Many of these compounds, whose quantities depend on what type(s) of blossoms the original nectar came from, are the source of honey's flavors and aromas.

The profile of sugars varies a little depending on the variety of honey, but an average breakdown of the total sugars would look something like this: 48% fructose, 40% glucose, 9% maltose, 2% sucrose and 1% higher sugars.

The Beer-ology of Honey

Ale and lager yeasts can ferment the first four sugars completely, and the remaining "higher sugars" may contain partially fermentable sugars such as maltotriose. Therefore the fermentability of the sugar component of honey is very close to 100%, and for convenience can be treated as such.

In spite of honey's high sugar content (and urban legend to the contrary), it will not add sweetness to beer. That's because the sugars are converted to alcohol during fermentation, leaving only the other flavor and aroma compounds. It's these flavors and aromas that make honey a useful ingredient in beer.

How much and what type of honey to use is largely a matter of personal preference. A good place to start experimenting is with one to two pounds of honey per 5-gallon batch (~0.5–1 kg/19 L) of mid-gravity beer. One pound (0.45 kg) will tend to impart a fairly subtle flavor, while two

HONEY, I BREWED SOME BEER

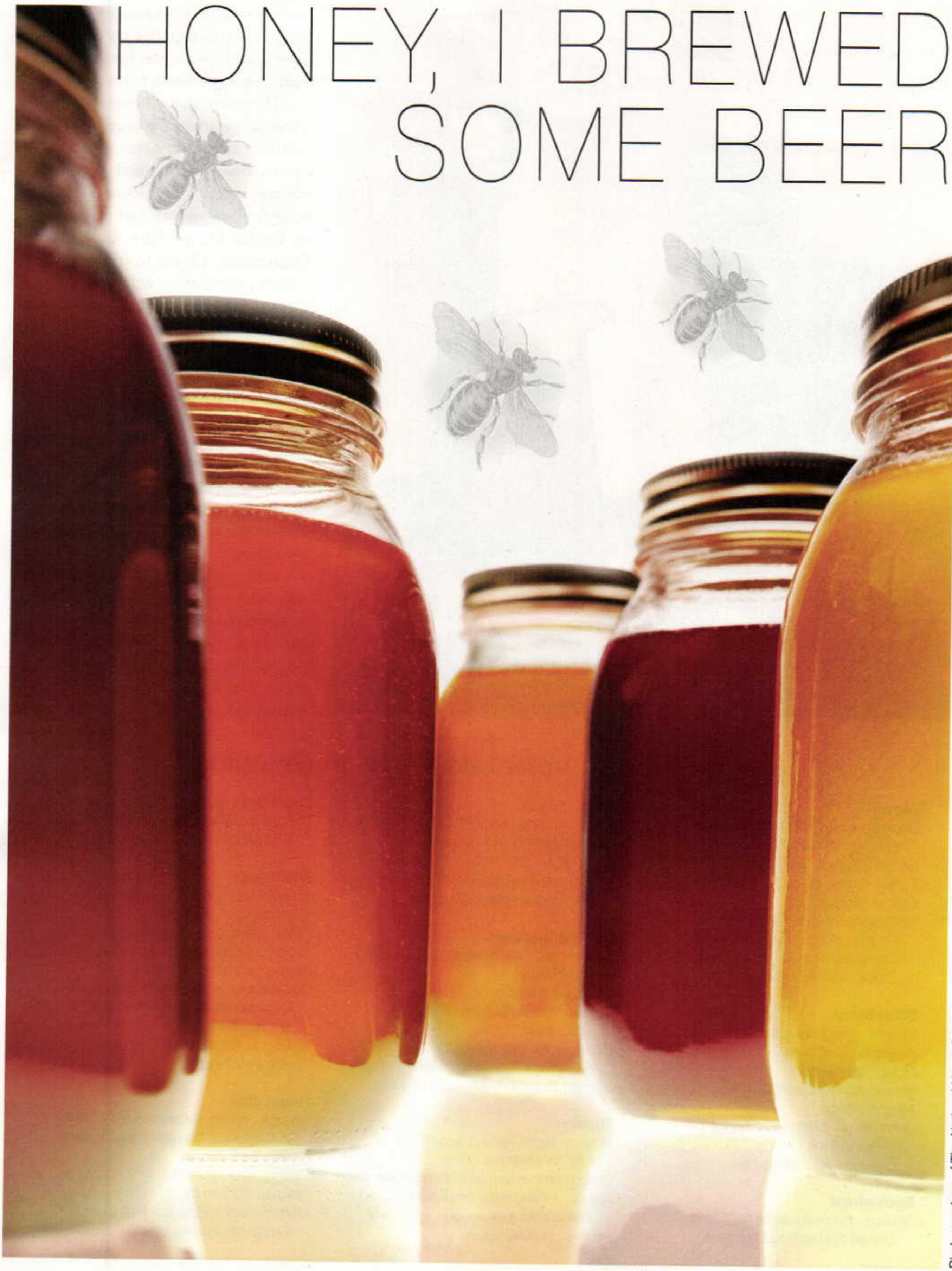


Photo courtesy of The National Honey Board

Photo courtesy of The National Honey Board

pounds (0.91 kg) will yield a much more pronounced and noticeable contribution. This also depends on the type of honey used, when the honey is added and other ingredients in the recipe.

There are many honey varietals – 'varietal' meaning the type of blossom that provided the nectar — and each has its own aromas and flavors (see sidebar below.) For example, clover honey's floral aroma can complement an English Brown Ale's subtle, earthy English hops. Or the fruitiness of tupelo honey can further enhance the yeast derived fruity flavors of a saison. There are no hard and fast rules for usage because honey is not a traditional ingredient in most beer styles. In general, raw, unfiltered honeys are preferred over highly processed, pasteurized, filtered honeys, because raw honey tends to retain more flavor and aroma. Potential sources of raw honey include local organic or health food stores, as well as local and online homebrew supply stores.

It seems the majority of commercial breweries use locally produced wildflower honey. I polled a large number of commercial breweries who make honey beers, and a significant 68% of those who responded use locally produced wildflower honey. This makes

Some Honey Varietals Used in Brewing

Clover
Source: white and red clover throughout the USA
Color: straw to amber
Flavor: lightly floral
Aroma: lightly floral
Commercial examples: ORF Honey Roast, Olvalde Farm & Brewing Company The Auroch's Horn, Bee Creek Hoosier Honey Wheat

Blackberry
Source: blackberry blossoms of the Pacific Northwest
Color: light amber
Flavor: fruity/citrus/blackberry
Aroma: fruity
Commercial examples: Oakshire Brewing Line Dry Rye, Ambacht Golden Farmhouse Ale

Buckwheat
Source: buckwheat herb of Midwest United States and California
Color: purple
Flavor: strong molasses, malty
Aroma: strong molasses
Commercial examples: Firestone Walker Brewing PL Honey Blonde Ale, Dogfish Head Tweason'ale

Orange Blossom
Source: orange blossoms of California and Florida
Color: light amber
Flavor: fruity/citrus/cream soda
Aroma: fruity
Commercial examples: Jackie O's Pub & Brewery Wood Ya Honey, Alpine Beer Company Mandarin Nectar

Tupelo
Source: tupelo gum trees of Florida wetlands
Color: amber/yellow with greenish cast
Flavor: mildly fruity, floral and sometimes cinnamon
Aroma: herbal, vanilla
Commercial examples: Terrapin SunRay Wheat Beer, Swamp Head Wild Night Honey Cream Ale

Wildflower
Source: any and all wild blossoms throughout the USA
Color: variable by locale
Flavor: variable by locale
Aroma: variable by locale
Commercial examples: Olde Hickory Imperial Stout, Dogfish Head Bitches Brew, Rapscallion Honey, Rogue Ales Somer Orange Honey Wheat

Honeydew
Source: aphid secretions (not nectar) in California, Hawaii, New Zealand
Color: dark brown
Flavor: savory, malty
Aroma: dark fruity
Commercial example: Wolf Brewing Company Honey Beer

sense for a few reasons, including lower cost and fresher product. For example, Joe Pond of Olvalde Farm and Brewing Company uses whatever varietals he can get from local keepers (mostly clover and wildflower) as they are available. His emphasis is on local ingredients and flavors, and he sees the slight honey character change from batch to batch as a positive thing.

As already noted, if honey is added to an existing recipe it will increase a brew's gravity (OG) and alcohol by volume (ABV) content, but not the final gravity (FG) because honey's sugars are essentially 100% fermentable. Sometimes a highly fermentable ingredient is desirable. Some styles, such as tripels and Belgian golden strong ales call for table sugar (sucrose) or other simple sugars for this purpose.

A good way to experiment with honey flavors in beers that contain simples sugars is to substitute honey for table sugar, at a rate of about 1.3 lbs of honey per pound of sugar from the original recipe. However, if we want to add honey character to beer that does not already use simple sugars, without increasing the ABV or drying the beer, there is a solution we can use to arrive at the same OG, FG and ABV as the original recipe.

Before we tackle the math, let's walk through some theory, concentrating first on the ABV problem. Suppose we have a recipe for a nice 5.3% ABV brown ale, with OG of 1.053 and a FG of 1.013. It's a great recipe, but we decide that two pounds of clover honey would really hit the spot. To hit the original recipe's ABV, we can replace some amount of our base malt with the two pounds of honey. However, there's the drying problem. Even after reducing the base malt (to make room for the honey) and achieving the same ABV, the beer will be drier than the original recipe. This is because the honey doesn't contribute any significant non-fermentable sugars. In any beer, it's the relative level of non-fermentable sugars (and other non-fermented compounds) left in the beer that determine how dry the finished beer seems, with an inverse relationship between non-fermentables and dryness. The solution is to add non-fermentable sugars, to make up for those lost by the reduction in the base malt. The simplest ingredient to accomplish this goal is maltodextrin powder, because it is malt based and virtually 100% non-fermentable by ale and lager yeasts; all of its sugars (non-fermentable dextrins) contribute to the body of the final beer, and counteract the drying effect of the honey. If we do the math right, we can arrive at a final product with exactly the same OG, FG and ABV as the original recipe, while adding the amount of honey flavor and aroma we wanted. (Note: because maltodextrin has a fairly bland flavor, you may also want to use a more flavorful base malt.) Bring on the numbers.

The potential OG contribution to the wort of any sugar source can be expressed in points per pound per gallon (PPG), a term that may be familiar to most homebrewers. Note that for barley malt, PPG by itself does not specify what portion of those sugars will actually be extracted in practice, what portion of the extracted sugars are theoretically fermentable, or how good any given yeast strain will be at converting the fermentables to alcohol. So we need to know the amount of base malt that is a "fermented equivalent" to a pound of honey. I'll skip the math, but assuming a honey with a gravity contribution of 35 PPG, a typical base malt with a potential gravity contribution of 36 PPG, a 65% mash efficiency, and a yeast strain with a nominal 77% attenuation rate, we would need to remove about 1.94 lbs of base malt from the base recipe per each pound of honey added (or, equivalently, 1.94 kg malt per 1 kg honey), to bring the ABV back to its original level. (If your normal mash efficiency is significantly different, you can multiply the 1.94 lbs. by 65%, then divide by your own efficiency. Likewise, if your yeast's nominal attenuation is much different, you can multiply by 77%, then divide by its attenuation.)

Next, we need the amount of maltodextrin that's a non-fermented "body equivalent" to a pound of base malt. Again skipping the math, and

Blackberry Honey Wheat Ale

(5 gallons/19 L, all-grain)
OG = 1.052 FG = 1.012
IBU = 20 SRM = 4 ABV = 5.3%

Ingredients

3.0 lbs. (1.4 kg) Maris Otter pale malt
4.0 lbs. (1.8 kg) wheat malt
rice hulls (as needed)
0.50 lb. (0.23 kg) maltodextrin powder
2.0 lbs. (0.91 kg) blackberry honey
4.8 AAU Willamette hops (60 mins) (1.0 oz./28 g at 4.8% alpha acids)
0.3 oz. (8.5 g) Willamette hops (0 mins)
White Labs WLP320 (American Hefeweizen) or Wyeast 1010 (American Wheat) yeast

Step by Step

Mash grains at 152 °F (67 °C) for 60 minutes. (If sparge sticks, add rice hulls as needed.) Boil wort for 60 minutes, adding bittering hops and maltodextrin at start, and aroma hops and honey at finish. Cool to 63 °F (18 °C) and pitch yeast. Ferment at 65 °F (19 °C) until final gravity is reached. Wait 1 week. Bottle or keg.

Blackberry Honey Wheat Ale

(5 gallons/19 L, extract with grains)
OG = 1.052 FG = 1.012
IBU = 20 SRM = 4 ABV = 5.3%

Ingredients

3.25 lbs. (1.5 kg) light dried malt extract (such as Coopers)
0.85 lbs. (0.39 kg) Maris Otter pale malt
1 lb. 2 oz. (0.52 kg) wheat malt
6 oz. (0.17 kg) maltodextrin powder
4.8 AAU Willamette hops (60 mins.) (1.0 oz./28 g at 4.8% alpha acids)
0.3 oz. (8.5 g) Willamette hop pellets (0 mins)
2.0 lbs. (0.91 kg) blackberry honey
White Labs WLP320 (American Hefeweizen) or Wyeast 1010 (American Wheat) yeast

Step by Step

Steep grains at 152 °F (67 °C) in 2.7 quarts (2.6 L) of water for 60 minutes. Add water to make at least 3 gallons (11 L) and boil wort for 60 minutes adding half the malt extract, bittering hops and maltodextrin at start. Stir in remaining malt extract with 15 minutes remaining in boil. Add aroma hops and honey at finish. Cool to 63 °F (18 °C) and pitch yeast. Ferment at 65 °F (19 ° C) until final gravity is reached. Wait one week. Bottle or keg.

assuming base malt with 36 PPG, 65% mash efficiency, yeast with a 77% attenuation rate, and maltodextrin with 40 PPG, we would need to add 0.135 lbs., or 2.2 oz. (61 g), maltodextrin for each pound of base malt removed from the recipe, to restore the body lost by removing the base malt. (If your normal mash efficiency is significantly different, you can multiply the 0.135 lbs. by your efficiency, then divide by 65%. Similarly, if your yeast's nominal attenuation is much different, you can multiply by [1 - your attenuation], then divide by [1 - 77%].) Now we have determined the following equivalents:

Fermented Equivalent:
1 lb. honey = 1.94 lbs. base malt
Body Equivalent:
1 lb. base malt = 0.135 lbs. maltodextrin

For our brown ale example, to which we're adding 2 lbs. of honey, we'd need to remove 3.88 lbs. (2 x 1.94 lbs.) of base malt and add 0.52 lbs. (3.88 x 0.135 lbs.) of maltodextrin. This will bring the OG, FG and ABV all back to the starting point, while adding the honey aroma and flavor we want.

But what about malt extract recipes? Using the same assumptions as above, we get the following:

Fermented Equivalent:
1 lb. honey = 1.01 lbs. dried malt extract
Body Equivalent:
1 lb. dried malt extract = 0.259 lbs. (or 4.1 oz.) maltodextrin

Formulas aside, the important point is that we can counteract a honey induced increase in ABV by removing some base malt or malt extract, and can restore body by adding some maltodextrin. All-grain brewers may want to use something like Carapils® instead of maltodextrin, but the precise fermentability of Carapils® is unknown (though certainly very low). A quarter pound of Carapils® added to the mash per one pound of base malt removed would be a reasonable starting point.

It's About Time, Honey

The best time to add honey to the

wort is often debated. The truth is it can be safely added almost any time — during the boil, at flameout, or into the fermenter at high kräusen. If added during the boil, the honey will be very well sanitized, but volatile flavor and aroma compounds will be lost to evaporation, much like hops added early in the boil. Added at flameout (my usual recommendation), the honey will still be sanitized, but less of the volatile compounds will be lost. And for the more adventurous, adding the honey to the fermenter at high kräusen adds nothing to sanitation, but does result in the least amount of flavor and aroma loss. Luckily, honey itself is very resistant to bacterial growth, and so in practice does not present much risk of contamination to your beer. Sanitizing the mouth of the jar and pouring carefully into the fermenter should be sufficient. If you do add honey to the boil kettle, pour slowly, stirring gently as you go.

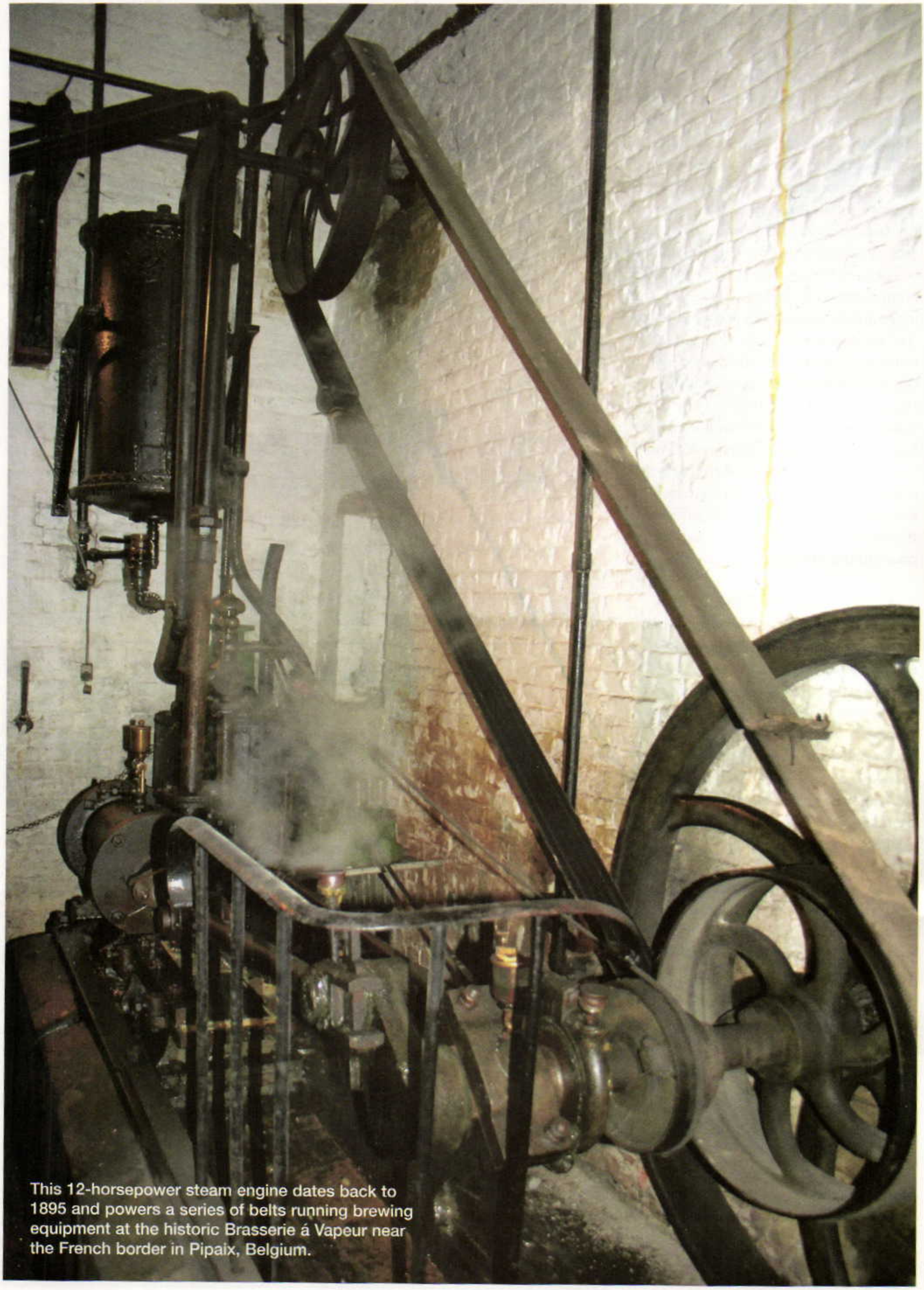
TLC for Your Honey

Honey should be stored in a cool, dark place, in a tightly sealed container. In a sealed container, it has a very long shelf life (measured in decades, perhaps even centuries). Most varieties of honey (tupelo being a notable exception) may crystallize over time. The main problem with crystallization is that it makes the honey difficult to pour. Fortunately, there is a simple fix. You can simply heat the honey right in its glass jar (with the lid on). The best way do this is on the stove in a pan of water, over low heat, until the honey has thinned out to its original consistency, then let it cool slowly. If the honey is in a plastic jar, you can either transfer it to a glass jar and proceed as above, or if you're in a hurry, try 10–15 seconds in a microwave oven.

Bee-fore You Turn the Page

In summary, honey is capable of adding wonderful flavors and aromas to your beer, and although it can be drying, it doesn't have to be. With planning, you can find the type and amount of honey to complement almost any beer style.

This is Mick Spencer's first article for Brew Your Own *magazine.*



This 12-horsepower steam engine dates back to 1895 and powers a series of belts running brewing equipment at the historic Brasserie á Vapeur near the French border in Pipaix, Belgium.

Belgian Steam-Powered brews

THE FIRST THING that hits you upon opening the old red double doors to Brasserie à Vapeur is the steam. This is appropriate given that you are entering the world's last remaining steam-powered brewery. Appearing through the mist, you see a steampunk scene right out of Jules Verne — an amazing industrial age collection of pulleys, belts and gears, all spinning above an open, cast iron mash tun sheathed in wood staves. The gears and belts drive the large paddles, stirring in the malt and hot water at the start of another brew day here in Pipaix, Belgium just a few miles away from France. Piercing the sound of the gears and belts whirring and the paddles stirring, there's a sharp whistle every few seconds coming from the star of this historic brewing show — a 12-horsepower steam engine nestled against the brewery's old painted brick wall.

With both the steam engine and mash tun dating back to 1895, and other equipment like the malt mill even older, a visit to Brasserie à Vapeur is a step back in time to see how beer was made over a century ago. And that is exactly the intent of brewer Jean-Louis Dits, who rescued the brewery and its equipment in 1984 to set up this living museum. Jean-Louis cranks up this historic brewery promptly at 9 a.m. on the last Saturday of every month, to honor the past by showcasing the equipment and brewing techniques to visitors, while producing his regular range of beers, including a saison, a strong, 9% ABV amber ale and an 8% ABV lager. These monthly brew days also double as a community party in the rural Wallonian town, with a group lunch that includes plenty of beer samples to wash down a big buffet of local cheese, breads and foods using Vapeur beer as an ingredient.

Story and photos
by **Brad Ring**

Jean-Louis dresses the part for his monthly brew days, wearing an old leather brewer's apron while hustling around the brewery, talking to visitors and checking on the mash. Brasserie à Vapeur uses a step mash with their beers. The thick mash starts off at 113 °F (45 °C) and the temperature is raised with the addition of more hot water after each rest. After mashing out, the wort drains into a grant sunk into the floor beneath the mash tun. A pump recirculates the wort through hoses from the grant back into the top of the mash tun. When Jean-Louis deems the wort clear enough, runoff and sparging begins. All runoff goes first into the grant and then is pumped upstairs to one of the two cast

RECIPES

Brasserie à Vapeur's Saison de Pipaix clone
(5 gallons/19 L, all-grain)

OG = 1.054 FG = 1.007
IBU = 21 SRM = 11 ABV = 6%

Vapeur's saison is orange/amber, darker than most saisons. It is also more heavily spiced than other saisons. A slight tartness, relatively low ABV (as Belgian beers go) and dry finish keep the beer eminently quaffable.

Ingredients

7.0 lbs. (3.2 kg) Belgian Pilsener malt
2.25 lbs. (1.0 kg) Vienna malt
2.0 lbs. (0.91 kg) Munich malt
0.25 lb. (0.11 kg) amber malt (35 °L)
4.5 AAU Hallertauer hops (60 mins)
(1 oz./28 g of 4.5% alpha acids)
2.4 AAU East Kent Goldings hops (15 mins)
(0.5 oz./14 g of 4.75% alpha acids)
0.25 oz. (7 g) ginger root (15 mins)
0.25 oz. (7 g) black pepper (15 mins)
0.25 oz. (7 g) sweet orange peel (15 mins)
0.25 oz. (7 g) star anise (15 mins)
0.25 oz. (7 g) Curaçao orange peel (15 mins)
White Labs WLP565 (Belgian Saison I) or Wyeast 3726 (Farmhouse Ale) yeast (2–4 qt./2–4 L yeast starter)
0.75 cup (150 g) corn sugar (for priming)

Step by Step

Mash in grains at 113 °F (45 °C) and hold for 15 minutes. Increase temperature to 131 °F (55 °C) and hold for 30 minutes. Raise to 143 °F (62 °C) and hold for 45 minutes. Raise temperature again to 161 °F (72 °C) and hold for 15 minutes. Recirculate until clear and sparge with 176 °F (80 °C) water. Boil for 60 minutes adding the first addition of hops. With 15 minutes left in the boil, add the remaining hops and spices. Cool the wort to 68 °F (20 °C). Pitch your yeast and aerate the wort heavily. Ferment at 68 °F (20 °C), then rack to secondary and drop temperature down to about 55 °F (13 °C). Condition for 1 week and then bottle or keg. Bottle condition for two weeks.

Brasserie à Vapeur's Saison de Pipaix clone (5 gallons/19 L, extract with grains)

OG = 1.054 FG = 1.007
IBU = 21 SRM = 11 ABV = 6%

Ingredients

5.0 lbs. (2.3 kg) light liquid malt extract (such as Weyermann Bavarian Pilsner malt extract)
2.25 lbs. (1.0 kg) Vienna malt
2.0 lbs. (0.91 kg) Munich malt
0.25 lb. (0.11 kg) amber malt (35 °L)
4.5 AAU Hallertauer hops (60 mins) (1 oz./28 g of 4.5% alpha acids)
2.4 AAU East Kent Goldings hops (15 mins) (0.5 oz./14 g of 4.8% alpha acids)
0.25 oz. (7 g) ginger root (15 mins)
0.25 oz. (7 g) black pepper (15 mins)
0.25 oz. (7 g) sweet orange peel (15 mins)
0.25 oz. (7 g) star anise (15 mins)
0.25 oz. (7 g) Curaçao orange peel (15 mins)
White Labs WLP565 (Belgian Saison I) or Wyeast 3726 (Farmhouse Ale) yeast (2–4 qt./2–4 L yeast starter)
0.75 cup (150 g) corn sugar (for priming)

Step by Step

Steep milled grains in 2.0 gallons (7.6 L) of water at 152 °F (67 °C) for 30 minutes. Remove grains from the wort and rinse with 1.0 gallon (3.8 L) of hot water. Add the malt extracts and boil for 60 minutes. Add the hops and spices at the times indicated in the ingredient list. Cool wort and transfer to fermenter. Top off with cold water to 5.0 gallons (19 L). Aerate wort and pitch yeast. Ferment at 68 °F (20 °C) until fermentation is complete. Transfer to a carboy, and drop temperature down to about 55 °F (13 °C). Allow the beer to condition for 1 week and then bottle or keg. Allow the beer to carbonate and age for two weeks before sampling.

Jean-Louis Dits oversees brewing operations at Brasserie á Vapeur, the world's last remaining steam-powered brewery.

iron brew kettles, which date back to 1919 and are heated by steam coils. Boil times can last two hours, but most are at least 90 minutes. And being located in Belgium, there are almost always some spices and sugar going into the boil along with hops in his recipes. Fermentation takes a more modern turn with a new stainless steel fermenter and conditioning tank. The beer is bottle conditioned before shipping out for sale.

The brewery in Pipaix dates all the way back to 1785. Gaston Biset used much of this same equipment for his namesake brewery from 1926 to 1984. After 58 years of brewing beer, he was ready to retire. The brewery was slated to be sold off in pieces and demolished, with no obvious buyers interested in an outdated brewery. Jean-Louis — a fan of Biset's saison and a homebrewer — decided to step in and save the brewery, restore the equipment and keep brewing operations going. Marc Rosier, then acting Brewmaster at nearby Brasserie Dupont, gave him guidance at the start, helping Jean-Louis transition to brewing professionally. Jean-Louis renamed the brewery after its most memorable quality — "*Vapeur*" is French for steam. He continues to brew Biset's saison from the original recipe. A homebrew clone of the saison — spiced with ginger, pepper, star anise, Curaçao and sweet orange peels — can be found on the facing page. Over the last 20 years, Jean-Louis has also added his own recipes to the mix, including his best-seller, a 9% ABV strong amber sporting a naked cartoon pig label known as Vapeur Cochonne.

Preparations for the monthly brew requires taking apart old equipment, greasing up all those gears and reassembling it all again. But all the challenges of brewing on this historic system are worth it, according to the brewer. "Every day when you get to brew here it is a good day," Jean-Louis says smiling. "It's the best day of work." Then he spins around and disappears back into the steam of his brewery. BYO

Brad Ring is Publisher of BYO.

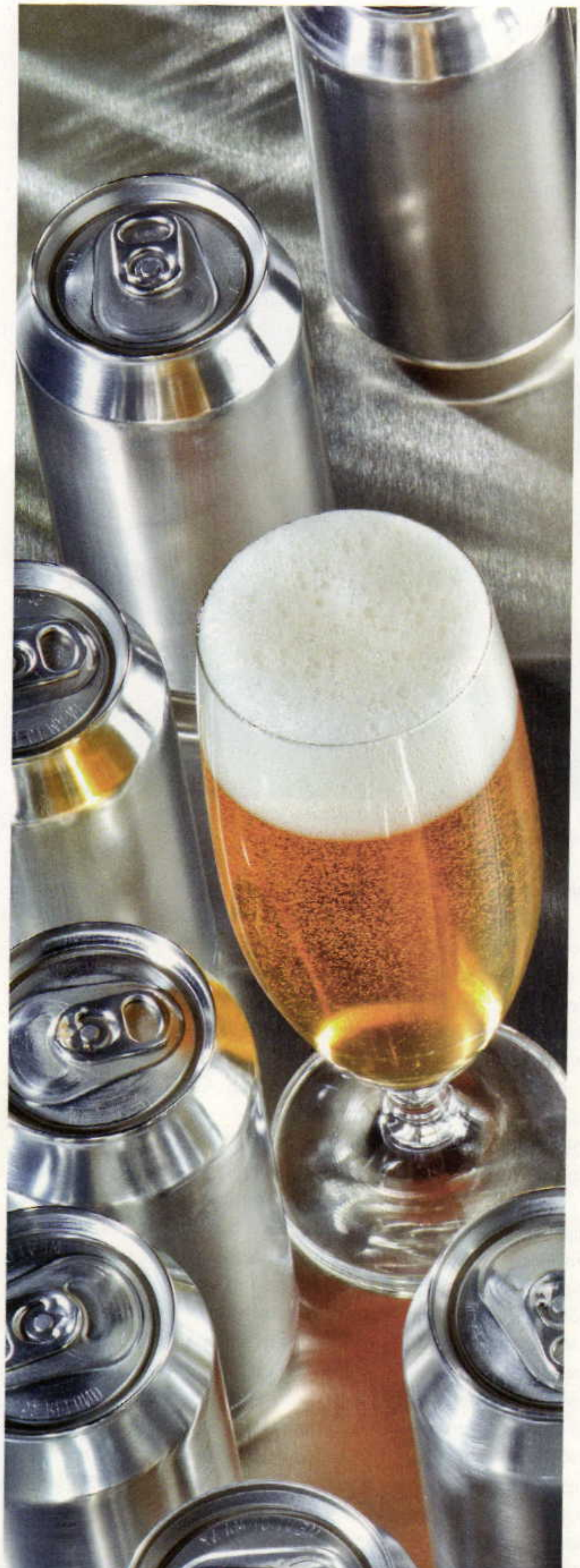


Photo by Charles A. Parker/Images Plus

THE NEW "CAN-DO" ATTITUDE IN CRAFT BREWING

Story by **Glenn BurnSilver**

IT WASN'T SO LONG AGO that a trip to the local liquor store for some canned beer presented but a few options. If you were lucky, there may have been some imports such as Bitburger or Warsteiner. In certain parts of the country, regional breweries — Yuengling, for example — offered some flavorful canned beers. And, of course, there was a brief moment in the '80s when Foster's "oil cans" made a bit of a splash. However, for most US residents, canned beer was largely the domain of American Pilsner type beers produced by larger breweries.

That scenario started to change back in 1989 when Guinness introduced Draught Guinness in a widget can. Upon opening the can, the widget dispersed nitrogen and caused the beer to pour with foam similar to Guinness pushed by beer gas (a mixture of nitrogen and CO_2). A few breweries, including Murphy's and Boddingtons, followed suit with their own widget cans, but the idea of canning beer didn't spread very far.

Then, in 2002, Oskar Blues kicked off what they call the

ATTITUDE ON THE UPSWING

"Canned Beer Apocalypse" with the introduction of Dale's Pale Ale — an amber beer with hopping levels similar to an IPA. Dale's Pale Ale quickly gained a lot of attention, and now an increasing number of craft brewers are exploring cans as a packaging option. Colorado's New Belgium Brewery has released their flagship beer — Fat Tire — in cans and a canned version of Sierra Nevada Pale Ale may be at a liquor store near you by the time you get this magazine.

Today, according to statistics compiled by CraftCans.com, there are 443 craft beers canned by 148 breweries in 41 states. Colorado leads the way with 19 breweries canning 56 beers, while Wisconsin, California and Arizona tie for second with 8 breweries each. American IPA, pale ale and amber are the three most popular canned styles, in that order. Almost every style, it seems, is covered,

"It's definitely more common to see craft beer in cans now, and I think it is more accepted by not just the brewing community, but the craft beer-drinking public."

—*Oskar Blues head brewer Dave Chichura*

as well, today's cans sport a thin coating that prevents the beer from actually touching the metal.

"(Beer drinkers are) getting past the misnomers of canned beer being flaccid, bland alcohol-delivery devices,"

An increasing number of US craft brewers are offering their brews packaged in cans. Turn the page to find clones of these five beers — Oskar Blues Old Chub, Surly Bitter Brewer, 21st Amendment Bitter American, Anderson Valley Barney Flats Oatmeal Stout and SanTan Epicenter Ale.

including Belgian ales, barleywines, stouts, lagers and even schwarzbier.

"It's definitely more common to see craft beer in cans now, and I think it is more accepted by not just the brewing community, but the craft beer-drinking public," explains Oskar Blues head brewer Dave Chichura.

"Every year there are more brewers turning to cans because it's the best package for beer. We all take great pleasure in introducing people to their first canned craft beer experience; it really opens people's minds. They are blown away that a huge hop aroma or high-viscosity liquid can come from a can. I never get tired of turning people on to that experience."

Overcoming Stereotypes

Perhaps the biggest hurdle faced by Dale Katechis when he starting canning his beers was the perception that beer in a can would absorb flavor characteristics from the can. While this was true with tin cans, and in the early days of aluminum

Chichura says. "They're realizing that the beers don't taste like metal. They smell and taste the freshness that the can maintains."

Gabe Wilson, lead brewer at SanTan Brewing Company in Chandler, Arizona agrees, "There are still those out there who have negative perceptions of canned beer, or those who are convinced that canned craft beer is merely a fad, but I think that the majority of craft beer drinkers are able to overcome their prior perceptions of canned beer and realize that it was not cans they had negative perceptions of, but the beer the cans contained."

Still, as Wilson alludes to, nothing changes overnight.

CLONES FROM A CAN

Oskar Blues Old Chub Scotch Ale clone

(5 gallons/19 L, all-grain)
OG = 1.078 FG = 1.020
IBU = 35 SRM = 32 ABV = 7.4%

Ingredients

13 lb. 10 oz. (6.2 kg) North American 2-row malt
18 oz. (0.52 kg) English dark crystal malt
12 oz. (0.34 kg) Munich malt (10 °L)
3.5 oz. (99 g) English chocolate malt
6 oz. (0.17 kg) Special B malt
4.5 oz. (0.13 kg) Weyermann smoked malt
9.6 AAU Nugget hops (60 mins) (0.8 oz./23 g of 12% alpha acids)
Wyeast 1056 (American Ale), White Labs WLP001 (California Ale) or Fermentis Safale US05 yeast (3.5 qt./3.5 L yeast starter)

Step by Step

Single infusion mash at 155 °F (68 °C). Boil for 90 minutes. Ferment at 69 °F (21 °C). We turn this beer out in about 15 days usually. I recommend at least 3 weeks for a homebrewed version. It's important to maintain fermentation temperature below 70 °F (21 °C) to keep esters from getting out of control. Ensure no diacetyl left in beer before cooling fermented beer (if you indeed do that). To do this, put a small beer sample in a sealable jar. Immerse jar in 170 °F (77 °C) water bath until the sample is 170 °F (77 °C), holding for 15 minutes. Cool jar to room temperature in a cool water bath, then smell sample. If you detect any buttery notes, continue to age beer at room temperature and check again the next day. Cool beer once diacetyl is not detected.

Oskar Blues Old Chub Scotch Ale clone

(5 gallons/19 L, extract with grains)
OG = 1.078 FG = 1.020
IBU = 35 SRM = 32 ABV = 7.4%

Ingredients

8 oz. (0.23 kg) North American 2-row malt
18 oz. (0.52 kg) English dark crystal malt
12 oz. (0.34 kg) Munich malt (10 °L)
3.5 oz. (99 g) English chocolate malt
6 oz. (0.17 kg) Special B malt
4.5 oz. (0.13 kg) Weyermann smoked malt
3.0 lbs. (1.4 kg) light dried malt extract (such as Muntons)
5.5 lbs. (2.5 kg) light liquid malt extract (such as Muntons)
9.6 AAU Nugget hops (60 mins) (0.8 oz./23 g of 12% alpha acids)
Wyeast 1056 (American Ale), White Labs WLP001 (California Ale) or Fermentis Safale US05 yeast

Step by Step

Steep grains at 155 °F (68 °C) in 5 quarts (4.7 L) of water. Rinse grain and add water to "grain tea" to make at least 3.5 gallons (13 L), add dried malt extract and bring to a boil. Boil for 60 minutes, adding hops at beginning of boil. Stir in liquid malt extract near end of boil. Cool wort and transfer to fermenter. Top up to 5 gallons (19 L) with cool water. Aerate and pitch an adequate amount of yeast. Ferment at 69 °F (21 °C).

Surly Bitter Brewer clone

(5 gallons/19 L, all-grain)
OG = 1.040 FG = 1.008
IBU = 37 SRM = 13 ABV = 4.1%

Ingredients

3 lb. 9 oz. (1.6 kg) Fawcett Optic malt
3 lb. 9 oz. (1.6 kg) Canadian Malting pale ale malt
12 oz. (0.34 kg) Simpsons Golden Naked Oats
6.0 oz. (0.17 kg) Simpsons medium crystal malt
0.8 oz. (23 kg) Simpsons roasted barley
3.5 AAU Glacier hops (FWH) (0.5 oz./14 g of 7% alpha acids)
8 AAU Warrior hops (90 mins) (0.5 oz./14 g of 16% alpha acids)
1.75 oz. (50 g) Glacier hops (0 mins)
2.5 oz. (71 g) Glacier hops (dry hops)
Wyeast 1335 (British Ale II) yeast (1 qt./1 L yeast starter)

Step by Step

Mash at 153 °F (67 °C). Add first wort hops (FWH) to wort as you are collecting it. Boil wort for 90 minutes. Ferment at 68 °F (20 °C).

Surly Bitter Brewer clone

(5 gallons/19 L, extract with grains)
OG = 1.040 FG = 1.008
IBU = 37 SRM = 13 ABV = 4.1%

Ingredients

1.0 lb. (0.45 kg) Fawcett Optic malt
1.0 lb (0.45 kg) Canadian Malting pale ale malt
3.0 lbs. (1.4 kg) Golden Light dried malt extract
12 oz. (0.34 kg) Simpsons Golden Naked Oats
6.0 oz. (0.17 kg) Simpsons medium crystal malt
0.8 oz. (23 kg) Simpsons roasted barley
3.5 AAU Glacier hops (FWH) (0.5 oz./14 g of 7% alpha acids)
8 AAU Warrior hops (90 mins) (0.5 oz./14 g of 16% alpha acids)
1.75 oz. (50 g) Glacier hops (0 mins)
2.5 oz. (71 g) Glacier hops (dry hops)
Wyeast 1335 (British Ale II) yeast

Step by Step

Steep grains in 1.0 gallon (4 L) of water at 153 °F (67 °C) for 45 minutes. Rinse grains with a half gallon (2 L) of 170 °F (77 °C) water. Add water to make at least 3.0 gallons (11 L), add roughly half of the dried malt extract and first wort hops (FWH) and bring to a boil. Boil for 90 minutes, adding bittering hops at beginning of boil. Stir in remaining malt extract near end of boil. (Don't let boil volume fall too far below 3 gallons/11 L; keep a small pot of boiling water handy to keep the volume up.) Cool wort and transfer to fermenter. Top up to 5 gallons (19 L) with cool water. Aerate and pitch yeast. Ferment at 68 °F (20 °C).

21st Amendment Bitter American clone

(5 gallons/19 L, all-grain)
OG = 1.048 FG = 1.015
IBU = 44 SRM = 11 ABV = 4.2%

Ingredients

8.5 lbs. (3.9 kg) Golden Promise pale malt
10 oz. (0.28 kg) Munich malt
5.0 oz. (0.14 kg) Crisp crystal malt (15 °L)
5.0 oz. (0.14 kg) Crisp crystal malt (45 °L)
8.5 AAU Warrior hops (90 mins) (0.5 oz./14 g of 17% alpha acids)
6 AAU Cascade hops (15 mins) (1.0 oz./28 g of 6.0 alpha acids)
1.5 oz. (43 g) Centennial hops (0 mins)
1.6 oz. (45 g) Centennial hops (dry hop)
0.88 oz. (25 g) Simcoe hops (dry hop)
White Labs WLP001 (California Ale) (1.5 qt./1.5 L yeast starter)

Step by Step

Mash at 158 °F (70 °C) for 60 minutes, followed by a mash out to 168 °F (76 °C). (Don't let the mash or wort temperature dip below 158 °F/70 °C; you need to make a wort that is not very fermentable to achieve high FG.) Boil wort for 90 minutes, adding hops at times indicated. Ferment at 66 °F (19 °C). Dry hop in secondary or keg.

21st Amendment Bitter American clone
(5 gallons/19 L, extract with grains)
OG = 1.048 FG = 1.015
IBU = 44 SRM = 11 ABV = 4.2%

Ingredients
12 oz. (0.34 kg) Golden Promise pale malt
10 oz. (0.28 kg) Munich malt
5.0 oz. (0.14 kg) Crisp crystal malt (15 °L)
5.0 oz. (0.14 kg) Crisp crystal malt (45 °L)
2.0 lbs. (0.91 kg) light dried malt extract (such as Briess)
3.0 lbs. (1.4 kg) light liquid malt extract (such as Briess)
8.5 AAU Warrior hops (90 mins) (0.5 oz./14 g of 17% alpha acids)
6 AAU Cascade hops (15 mins) (1.0 oz./28 g of 6.0 alpha acids)
1.5 oz. (43 g) Centennial hops (0 mins)
1.6 oz. (45 g) Centennial hops (dry hop)
0.88 oz. (25 g) Simcoe hops (dry hop)
White Labs WLP001 (California Ale)

Step by Step
Steep grains at 158 °F (70 °C). Boil wort for 90 minutes, adding hops and dried malt extract at beginning of boil. Stir in liquid malt extract near end of boil. Cool wort and transfer to fermenter. Top up to 5 gallons (19 L) with cool water. Aerate and pitch yeast. Ferment at 66 °F (19 °C).

Anderson Valley Barney Flats Oatmeal Stout clone
(5 gallons/19 L, all-grain)
OG = 1.060 FG = 1.017
IBU = 14 SRM = 49 ABV = 5.8%

Ingredients
8.75 lbs. (4.0 kg) 2-row malt
12 oz. (0.34 kg) crystal malt (40 °L)
12 oz. (0.34 kg) crystal malt (80 °L)
12 oz. (0.34 kg) Munich malt (20 °L)
1.3 oz. (37 g) roasted malt
14 oz. (0.39 kg) chocolate malt
15 oz. (0.42 kg) flaked oats
4 AAU Columbus hops (60 mins) (0.29 oz./8.1 g of 14% alpha acids)
0.25 oz. (7.1 g) Northern Brewer hops (0 mins)
Anderson Valley house yeast, Wyeast 1968 (London ESB) or White Labs WLP002 (English Ale) yeast (2 qt./2 L yeast starter)

Step by Step
Mash at 154 °F (68 °C) in 18 qts. (17 L) of water. Collect wort until last runnings dip below 3.0 °P (1.012). Adjust pre-boil volume to have enough for a 90 minute boil. Fermentation temperature is 68 °F (20 °C).

SanTan Epicenter Ale clone
(5 gallons/19 L, all-grain)
OG = 1.056 FG = 1.014
IBU = 21 SRM = 24 ABV = 5.4%

Ingredients
9.0 lb. (4.1 kg) 2-row brewers malt
13 oz. (0.37 kg) caramel malt (80 °L)
8.0 oz. (0.23 kg) Munich malt (20 °L)
8.0 oz. (0.23 kg) wheat malt
8.0 oz. (0.23 kg) Victory® malt
8.0 oz. (0.23 kg) Vienna malt
1.0 oz. (28 g) roasted barley
5 AAU Fuggle hops (60 mins) (1 oz./28 g of 5% alpha acids)
1 whirlflock tablet (10 mins)
White Labs WLP001 (California Ale) yeast (1.5 qt./1.5 L yeast starter)

Step by Step
Mash at 152 °F (67 °C) in 16 qts. (15 L) of water. Boil wort for 90 minutes, adding hops and whirlfloc at times indicated. Ferment at 70 °F (21 °C).

SanTan Epicenter Ale clone
(5 gallons/19 L, extract)
OG = 1.056 FG = 1.014
IBU = 21 SRM = 24 ABV = 5.4%

Ingredients
4 lb. 5 oz. (2.0 kg) Briess Gold dried malt extract
6.0 oz. (0.17 kg) Briess Amber dried malt extract
1 lb. 4 oz. (0.56 kg) Briess Dark dried malt extract
3.0 oz. (85 g) Briess Wheat dried malt extract
1.0 oz. (28 g) roasted barley
5 AAU Fuggle hops (60 mins) (1 oz./28 g of 5% alpha acids)
1 whirlflock tablet (10 mins)
White Labs WLP001 (California Ale) yeast

Step by Step
Stir the malt extracts into 3 gallons (11 L) of water in your brewpot. Heat to a boil, steeping roasted barley until temperature reaches 160 °F (71 °C). Boil wort for 60 minutes, adding hops at beginning. Ferment at 70 °F (21 °C).

Yet the benefits of canned beer easily outweigh the misperceptions, and more and more brewers — and consumers — are latching onto the idea of canned beer, and not just for what's inside. There are number of reasons typically cited by these breweries for utilizing cans over bottles, and these range from beer quality to environmental concerns.

For starters, cans keep beer fresher longer. Even with the darkest glass bottles, some light can penetrate and that light affects the beer's chemistry. Ever wonder why green bottle beers like Moosehead or Heineken taste "skunky?" That flavor is the direct result of the spectrums of light penetrating the glass. Cans are also airtight, preventing early oxidization.

Cans are also more portable than bottles, being both lighter (by about 35 percent) and safer to haul around than bottles. Backpackers and campers know all too well that every ounce matters in that pack, so cans are the best way to enjoy quality refreshment after a long hike — and they won't discover a wet sleeping bag from a broken glass bottle!

"You can go up (a mountain), take your beer, drink it on top, crush the can and carry it out," says Shaun O'Sullivan, co-founder of 21st Amendment Brewing Company, another leader in canned craft beer.

"It's great; you can't beat it."

Additionally, cans chill faster than glass, a good thing anytime, but certainly when relying on a mountain stream for cooling.

Lastly, cans are more environmentally friendly. Cans use less packaging — no labels or cardboard six-pack holders — cost less to transport due to weight and size (110 cases of cans fit on a pallet compared to 70 cases of bottles), and the energy expenditure in recycling aluminum cans is less than glass. It's a win-win all around, for the beer drinker, the brewer (since cans also cost less) and Mother Earth.

Canning at Home?

While all this is great news, the average homebrewer, for the moment, must be content to watch from the sidelines. Home canning units are not available and even the smallest commercial units typically run about $15,000, according to Jamie Gordon, technical sales representative for North America for Cask Brewing Systems, a Canadian manufacturer of canning machines.

Even if someone were to fill cans at home in the same siphon method currently employed on bottles, the mechanical seamer used to seal the can runs about $11,000.

"If someone devises an inexpensive hand seamer, I think that home canning would be possible, but not until then," Wilson says.

"The only way I could see this becoming available for the homebrewer," Gordon suggests, "was if a club or (on-premise) store purchased the equipment."

Another hurdle is space — and not just where to put the canner. Considering the typical 5-gallon (19 L) homebrew batch equals about two cases of beer, and the minimum empty can purchase is equal to one pallet, that's a lot of cans that need to be stored somewhere.

"You're looking at about 7,000 cans," Gordon clarifies, again noting this could work within an ambitious homebrewer's club setting.

It was this conundrum that O'Sullivan says led 21st Amendment to move their beer production to a Minnesota brewery. There just wasn't space at their San Francisco pub for the canning line or empty can storage.

Gordon says the idea of making a home unit has been batted about but, he says, "It would probably be only half the price" of a commercial unit.

Perhaps, once canned craft beer has gained more acceptance, canning at home will become a reality.

"People in their 20s see canned beer all the time and eventually it won't be a big deal," O'Sullivan says. "It's all changing. It's definitely about getting people into the idea, and we're seeing the shift in the thinking and perception in the package . . . It's just taking a long time."

Beer packaging is always changing. Not too long ago, growlers and 22 oz. "bomber" bottles were new to beer drinkers. Will beer follow the path that wine has taken and start offering boxed beers?

As homebrewers, of course, we know that the beer itself is more important than the package it comes in. And on page 38, we present five canned clones that will still taste great in bottles or kegs. BYO

Glenn BurnSilver is a freelance writer living in Scottsdale, Arizona. He is a frequent contributor to Brew Your Own.

Story by **Chris Colby**

THE ORIGINS OF LAGER YEAST

A recent discovery in Patagonia solves the mystery of how lager yeast originated — and raises the possibility of improved lager strains in the future.

The domestication of barley coincides with the first year-round settlements of early humans, who were previously nomadic. This event occurred in the Fertile Crescent — the region surrounding the Tigris and Euphrates rivers, and sometimes extended to include the Nile Delta — 6,000 years ago. In this same time period, brewing was invented, as shown by evidence of brewing in ancient Sumer by this period. (Sumer was mostly located between the Tigris and Euphrates, in what is currently southeastern Iraq.) Subsequently, numerous plants and animals have been domesticated by human populations all over the world for agricultural, industrial and other purposes. And, of course, brewing spread to every human culture thousands of years ago.

It takes more than barley to make beer, however. Scientists have made substantial progress in understanding the domestication of most important macroscopic agricultural species. However, it has only been recently that they have begun to make real progress towards understanding the domestication of microscopic species. This includes the yeast strains used in brewing. The advent of DNA sequencing technology, and particularly the newer methods of obtaining large amounts of sequence quickly and cheaply, have driven this progress.

Finding the wild progenitor (or a closely related species) of a domesticated organism helps scientists determine how that species was domesticated. In the classic example, scientists in the 1930s first recognized that wild species of teosinte (now classified as subspecies and named *Zea mays parviglumis* and *Zea mays mexicana*), found in Mexico and Central America, were related to domestic corn (maize, *Zea mays*). Later genetic studies revealed that the major differences between the grass teosinte and large-eared corn were due to only five genes. Modern sequence data shows that the modern corn genome is mostly derived from *Zea mays parviglumis*, with a small amount of sequence coming from hybridizing with *Zea mays mexicana*. Furthermore, estimates of the divergence time between teosinte and corn taken from comparative DNA sequence data mesh closely with the archaeological evidence that this happened roughly 9,000 years ago.

In addition, if a wild population of the ancestral species (or a close relative) still exists, this can be a source of genetic material to potentially improve the domesticated species. (During domestication, many potentially beneficial genetic variants from the parent stock can be lost.) To continue with the corn example, in 1977, scientists found a new species of teosinte (*Zea diploperennis*), which turned out to harbor several genes that conferred resistance to various viral diseases of corn. Using genes from this species, modern corn varieties were improved.

Recently, a group of scientists have reported finding a species of yeast that is very likely one of the ancestors of lager yeast. In order to appreciate the importance of this, it pays to understand a little of what is currently

A previously undiscovered species of *Saccharomyces*, isolated from beech trees in Patagonia (shown here) , sheds light on the origin of lager yeast.

Photo courtesy of iStockphoto.com

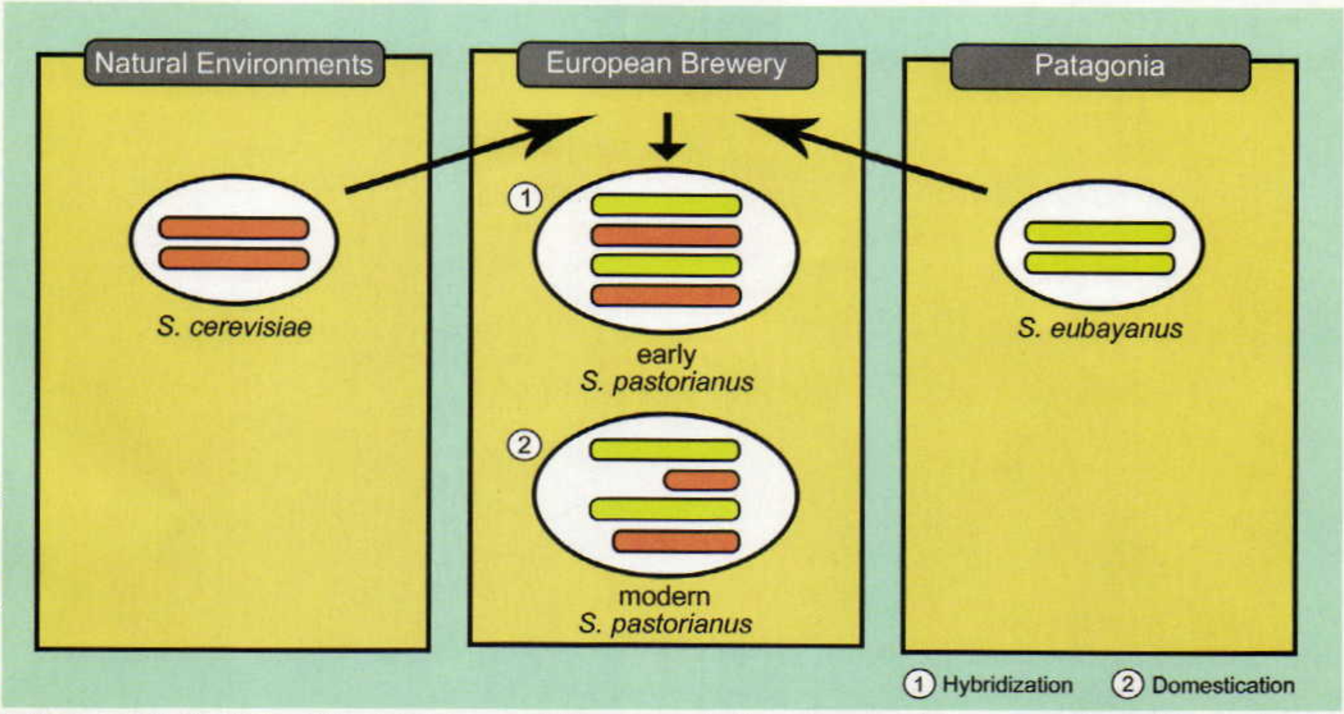


Illustration by Chris Champine

A diagram showing the basics of the origin of lager yeast. The orange and yellow rods represent chromosomes. *S. cerevisiae* was domesticated from the wild in ancient times. In the 15th Century, wild *S. eubayanus* from Patagonia ended up in a European brewery and hybridized with a domesticated strain of *S. cerevisiae*. Following hybridization, sequences originating in the *cerevisiae* genome were lost.

known about the origin of brewing strains of yeast.

Saccharomyces

Except for a few experimental beers brewed with *Brettanomyces*, beer is brewed with yeast from the genus *Saccharomyces* as the primary fermenting organism. Indeed, in the vast majority of brewery fermentations, other microbial species present are contaminants. Sour beers — in which some combination of *Brettanomyces* (wild yeast), *Lactobacillus* (bacteria) and *Pediococcus* (bacteria) may also be used — are the exception.

Saccharomyces is a genus of fungi that contains many species. Microbial taxonomy is continually in flux — with multiple former species being lumped together into one, former single species being split into two or more and new species being found and named all the time. So, citing an exact number would involve a number of assumptions. There are over twenty species common enough to have their own names. *Saccharomyces* species involved in brewing and winemaking include *S. cerevisiae* (ale and wine yeast), *S. pastorianus* (lager yeast), *S. bayanus* (used in some wine fermentations), *S. uvarum* (a contaminant that can grow at low temperatures; used to be considered a substrain of *bayanus*). The wild species *S. paradoxus* is the closest known species to *S. cerevisiae*.

Ale Yeast

Ale yeast (*S. cerevisiae*) is utilized by humans in baking leavened breads and conducting fermentations of ales, wines, saké, mead and cider. (Some wines are fermented with strains of *S. bayanus*.) Ale fermentations are generally conducted in the temperature range of 65–72 °F (18–22 °C). Ale yeast grows better at temperatures higher than this. However, at higher temperatures most ale strains would produce an ale that was too estery and might contain potentially harmful levels of fusel oils. In winery fermentations of red wine, fermentation temperatures up to 90 °F (32 °C) are not uncommon. Among *Saccharomyces* strains, *cerevisiae* is called thermotolerant.

S. cerevisiae is found in bakeries, breweries, wineries and in the wild. Specifically, in North America, *S. cerevisiae* is frequently found in the sugar-rich exudates of oak trees. Until recently, biologists were unsure if *S. cerevisiae* found in the wild was free-living wild population, or the result of continuing contamination from human sources. Recent genetic analysis has shown that wild populations of *S. cerevisiae* contain much more genetic diversity than domesticated strains and wild populations harbor alleles that are not present in domesticated strains. The implication is that *S. cerevisiae* does live in the wild, apparently with little interbreeding with domesticated strains.

S. cerevisiae is a diploid species, meaning its genome consists of two of each of its chromosomes. (Humans are also diploid, we inherit one set of chromosomes from our father and another set from our mother.)

For more on the genetics of *S. cerevisiae*, see "The Biology of Yeast," in the September 2009 issue of *BYO*.

"Other" Yeasts

Two other yeasts play ancillary roles in the story of lager yeast — *Saccharomyces uvarum* and *S. bayanus*. *S. uvarum* is a diploid yeast that is sometimes found as a contaminant in brewery or winery fermentations. *S. uvarum* is more tolerant of cold temperatures than *S. cerevisiae* (its cryotolerant, in the lingo). As a relative of *S. cerevisiae*, *S. uvarum* has a similar genome, but there is no evidence of recent hybridizations. (The level of sequence divergence between *uvarum* and *cerevisiae* is relatively constant across their whole genome.) Like *S. cerevisiae*, *S. uvarum* is found in the wild, in Europe and elsewhere.

S. bayanus is sometimes used in winery fermentations. Like both *cerevisiae* and *uvarum*, it is diploid. However, the pattern of sequence similarity between these species suggest that *S. bayanus* contains a mixture of genes recently derived from *S. uvarum* and an unidentified yeast, along with a minority of sequences from *S. cerevisiae*. *S. bayanus* is not found in the wild.

Lager Yeast

Lager yeast (*Saccharomyces pastorianus*) is used by brewers in the production of lager beer. Typical lager fermentations range from 48–55 °F (8.9–13 °C). Scientists call *S. pastorianus* cryotolerant, just like *S. uvarum*.

About 20 years ago, scientists discovered that lager yeast was a hybrid organism. The genome of *S. pastorianus* was found to be tetraploid (contains four copies of each chromosome, instead of two like the other yeasts we've discussed). The *S. pastorianus* genome was also known to contain sequences from *S. cerevisiae* and one other species of *Saccharomyces*. The other species was alternately hypothesized to be *S. bayanus*, *S. uvarum* (then called *S bayanus* var. *uvarum*), a combination of these two or an undiscovered cryotolerant species of *Saccharomyces*. Later work strongly suggested that *S. pastorianus* was a hybrid of *cerevisiae* and a yet-to-be-identified yeast.

The Discovery

Lager yeast is only found in breweries. It is not found in the wild in Europe — where lager brewing originated — or elsewhere. Likewise, searches for the cryotolerant component strain of the *S. pastorianus* hybrid species in Europe failed to uncover a match. So, it was somewhat surprising when researchers found the missing piece of the lager puzzle in Patagonia, a region in South America that overlaps part of Argentina and Chile.

The researchers, which included scientists from Argentina and the United States, discovered two strains of yeast living on Southern Beech trees (*Nothofagus*) in Patagonia. They found two different cryotolerant species, one associated with two different species of beech (*N. antartica* and *N. pumilio*) and one associated with a third species of beech (*N. dombeyi*). The two species did not appear to be interbreeding. The species associated with *N. dombeyi* was found to have sequences very similar to *S. uvarum*. The species associated with the other trees was a previously uncategorized species. When the researchers compared the genome of this new species to the genome of *S. pastorianus*, they found that its genome was highly similar to half of the genome of *S. pastorianus* — the missing species of yeast had been found. Because the new yeast also showed some sequence similarity to *S. bayanus* (which I'll explain in a moment), they proposed that the new species be called *S. eubayanus*.

The Big Picture

If you take all the information that is known — including a few things not explained here — the whole story goes something like this. Somehow — and this has yet to be determined — a wild yeast from Patagonia contaminated a European brewery in the 15th Century. (Europe traded with South America at the time, so items made of beechwood carrying *S. eubayanus* may have shuttled the yeast there.) This diploid yeast (*S. eubayanus*) hybridized with an ale strain of *S. cerevisiae* (also diploid), producing the tetraploid ancestor of modern lager yeasts. This combination of a proven beer fermenter (*cerevisiae*) and a species that thrived in colder climates was selected accidentally as brewers cold-aged their beer.

Early *pastorianus* is thought to have contained roughly 50% *eubayanus* sequences and 50% *cerevisiae* sequences. However, new genomic sequencing data shows that many of the genes originally contributed by *S. cerevisiae* have been deleted, while almost all of the *eubayanus* sequences remain. In short, you can think of present day *S. pastorianus* as containing a full set of chromosomes from *S. eubayanus* and a set of "shrunken" chromosomes from *S. cerevisiae*. (This pattern of sequence lost after hybridization is common. The basic idea is that, following hybridization, duplicate genes eventually become deleted and are lost because the remaining gene "takes up the slack.")

As *S. pastorianus* was domesticated, other genetic changes occurred as well. For example, a bit of one *cerevisiae* chromosome, that contained multiple copies of the gene maltase, got copied to the end of one of the *pastorianus* chromosomes. (The gene maltase produces the enzyme that degrades maltose, the main wort sugar.)

For brewers, that's the most interesting bit, but for yeast biologists, the story has a final twist. Remember *S. bayanus*? Some of its sequences were similar enough to *S. eubayanus* to inspire its name. As it turns out, *S. bayanus* is the result of multiple hybridization events and contains sequences from *S. cerevisiae*, *S. uvarum* and *S. pastorianus*. However, unlike *S. pastorianus* — which contains a mix of chromosomes from its parent species — *S. bayanus* chromosomes themselves are a patchwork of sequences from the three species. (This indicates that a lot of genetic recombination has occurred in *S. bayanus*. In contrast, except for the "displaced" *cerevisiae* sequence tacked onto one of the *pastorianus* chromosomes, little recombination between *cerevisiae* and *eubayanus* chromosomes has occurred in *S. pastorianus*.) Like *S. pastorianus*, *S. bayanus* does not occur in the wild.

What Does This Mean?

What does this mean to us as brewers? In terms of how we handle lager yeast and conduct lager fermentations, very little. Nothing in the new information obviously suggests that changes are needed in any brewing practice. The value of the study will come when researchers begin to survey the genetic diversity found in wild populations of *S. eubayanus*. It is possible — likely even — that some alleles found in nature could be moved into domesticated *S. pastorianus*, either by hybridization or (more likely) genetic engineering, to improve lager yeasts.

Conclusion

So, lager yeast (*S. pastorianus*) arose in a European brewery via chance hybridization. The next time you brew a lager, you can take some vicarious pride in knowing that, without brewers, it would not exist. BYO

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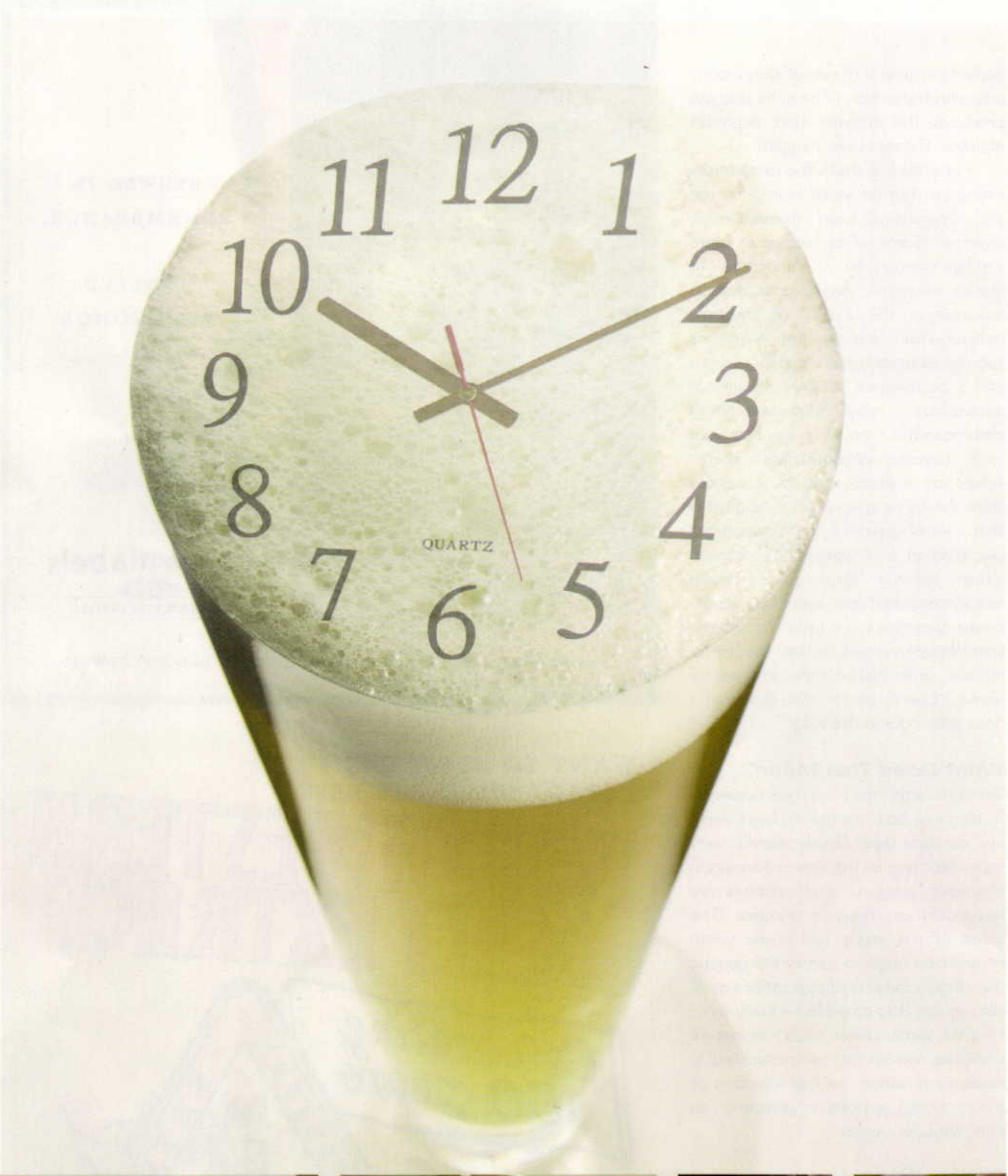


mashing


boiling


transferring


pitching

speeding UP YOUR all-grain DAY

Story by **Dave Louw**

time saving tips for a shorter brew day

A key aspect of improving your beers is to brew more often. Unfortunately, since homebrewing is just a hobby, many brewers struggle to fit additional brewing sessions into their busy lives.

Of course, the shorter the brew session, the easier it is to find the time for. If you can crank out a beer in less than four hours, that opens up weeknights and ensures you can reserve your limited weekend time for "honey do's" or spending time with the family.

In the following pages, I'm going to show you how to shave hours off your average brew session. We will start by discussing the core techniques of speeding up the brew day. Then we will go through some tips that can shave big chunks off your total brewing time. Finally we will wrap everything up with a step-by-step example brew day utilizing all the items we covered. Regardless of the beer you are brewing, there are three main concepts to saving time. Keep them in mind at all times and you are in for a quick ride.

Focus on the Critical Path

Whether it is building a house or brewing a beer, focusing on the critical path is the heart of time efficiency. The basic principle of the Critical Path Method is to identify the longest set of activities that must be done sequentially to complete a project. This technique can easily be applied to your brew session to ensure you remain focused on getting the job done. When you look at your brew day, there is a sequence of tasks you have to complete before you are done. For an all-grain brew day, this sequence is:

Setting up your hot liquor vessel
Heating your strike water
Doughing in
Mashing
Lautering
Boiling
Chilling
Transferring to the fermenter
Pitching yeast
Cleaning the boil kettle and putting away the last equipment

Each of these items should be your highest priority since any delays will directly add to the length of your brew day. Additionally, focus your energy on shortening these steps because the sum of their durations is your total brew day.

The ideal optimization is to move a task off of the critical path so it no longer contributes to the total at all. You will notice that there are many typical brew day activities that do not appear on my list. Items like milling your grain, setting up your mash tun, heating the wort to boiling, and sanitizing the fermenter. I skipped them because you can do them while you are waiting around for the other steps to complete. Which leads to our next concept.

Fill the Downtime With Other Tasks

There are plenty of times during the brew day when there is nothing you can actively do on the critical path. However, there are things you can accomplish. For example, while the strike water is heating up, you can grind your grain.

There are many tasks you can do during otherwise wasted downtime, including setting up the boil kettle during the mash and weighing out hops during the mash so you are ready to add the 60-minute addition right when the boil starts.

Timed Brew Day Example

Start (HH:MM)	Finish (HH:MM)	Duration (min)	Step
0:00	0:05	5	Set up equipment
0:05	0:35	30	Heat up water to strike temperature
0:05	0:15	10	Mill grain*
0:35	0:40	5	Dough-in
0:40	1:25	45	Mash (abbreviated)
0:40	0:45	5	Measure hop additions*
1:25	1:30	5	No-sparge drain (lauter)*
1:25	1:45	20	Heat up runoff to boil
1:45	2:45	60	Boil
1:45	2:00	15	Clean up mash tun*
2:45	3:05	20	Chill to fermentation temperature
2:45	2:55	10	Sanitize fermenter*
3:05	3:15	10	Transfer to fermenter and pitch yeast
3:15	3:35	20	Clean boil kettle and misc. equipment
3:35	3:45	10	Put equipment away

* = steps not on the critical path

Another time-saving tip some brewers miss is to begin heating the wort while you are lautering. You can start your burner as soon as you have about an inch (~ 2.5 cm) of runoff in your boil kettle. Ideally you should reach a boil right about the time that you complete the lauter.

Of course, you should also set up equipment before you need it. For example, if you use hoses for lautering, connect them before the end of the mash. And likewise, use the time during the boil or while chilling the wort to sanitize the fermenter.

While those are some very specific tasks I do during my brew day with my system and process, you should look to apply the general pattern. Whenever you have downtime on brew day, ask yourself what you can be doing to shorten the session. Prioritize preparing for the next critical path item, but then feel free to handle anything else. If you stay on top of tasks, you will still find plenty of time to kick up your feet and relax during the longer steps.

Special Case: Clean as You Go

One of the most important downtime activities is cleaning up and putting away equipment. Some brewers I have spoken to take up to an hour to clean up everything at the end of the brew. Worse yet, I have heard of brewers leaving equipment, including mash tuns, dirty. Not only does this extend your next brew day, but it establishes a barrier to brewing the next time. Who wants to start a brew session by cleaning up last time's mess?

Just like eating your vegetables before dessert, it makes sense to not put off any cleaning. Some things you can do during your brew day include wiping down and putting away the grain mill while waiting for the strike water to heat or the mash to convert and cleaning out and putting away the mash tun during the boil. With these steps, you will only be left with a few items to clean at the tail end of the brew day. Ideally that should be just your boil kettle, chiller, transfer hoses, and pump (if you use one) since they were all in use until you put the wort in the fermenter.

Brew to a Plan

It is critical for you to have a mechanism to enforce consistency on your brew day so that you can make improvements. The easiest way to do this is to follow a plan that ensures you do not miss steps, you have the cues to prepare for upcoming tasks and you are able to lock in time savings on future batches.

The simplest way to do this is with the printable brew day checklists available in many brewing texts. Start with one of these and make a checklist that reflects your process. A slightly more advanced approach is to use brewing software that provides templates for printing out the steps specific to an individual beer recipe.

A plan is not useful unless it is followed, so make sure you have it available and take good notes as you work your way through it.

Ultimately, your goal is to have your checklist cover all the details so you do not have to deal with exceptions. Varying from your process usually means you are distracted from working on your critical path tasks while you deal with the problem. For example, if you forget to mill your grain before your strike water is ready, you now have to delay your dough-in as you catch up, adding minutes to the length of your brew day.

Measure Your Process

Once you have a plan for your brew day, you have the perfect place to confirm your critical path tasks and document how long each takes. Set a timer at the start of session and write down the starting time for each item. With a little math, you will be able to see how long each item takes and therefore where it is worth investing in optimizations. You can also go back and identify items that could be removed from the critical path.

For example, when I started brewing, I was using a kitchen stove. Heating up 5 gallons (19 L) to boiling could take an hour and a half. Since it was a critical path item, I had to wait for it to complete before moving on to the next critical path item (the boil) and so my day was pretty long. One of the biggest improvements I made back then was to get a turkey fryer style propane burner that got me to boiling in 30 minutes, shaving off a full hour from my brew day. I realized another big gain in time savings by upgrading my wort chiller.

This idea is the core of shortening your brew day: identify and measure your critical path tasks, and then find ways to shorten them without compromising the quality of your beer.

Tips to Optimize Your Critical Path Tasks

Over the years, I have found the following tips to be great time savers on brew day. They fall into several categories.

Setting Up Equipment

Establish a dedicated brew area that does not need to be cleaned up to prepare for brewing. In that area, leave as much equipment set up as possible so that you do not have to set it up and break it down each brew session. Store your remaining equipment near this dedicated brew area, so that you are not walking long distances to get what you need. Also, minimize the time you spend looking for items by returning them to their designated immediately after you have finished using them.

Grain Milling and Water Heating

Milling your grain shouldn't be a critical path item, unless it takes a long time. Still, some ways to speed this task include motorizing your mill. While milling, you can be heating your water. Invest in the strongest burner you can find — there is a huge difference between a stovetop electric element and a propane turkey fryer. If you are brewing on a stovetop, consider goosing the temperature with some heat sticks if you have available electricity.

I have seen some commercial breweries and have heard of some homebrewers using tankless water heaters dialed up to higher temperatures to achieve an instant strike temperature right from the faucet. Please consult a licensed plumber if you decide to go this route, and make sure it is set up in a way that does not risk scalding anyone.

Mashing

You may be able to shorten your saccharification rest and still brew good beer. The 60-minute mash time given in most single infusion recipes is just a rule of thumb, but most mashes will convert much more quickly than this. If you want to save time, test for conversion after about 20 minutes, check your specific gravity and start the lauter once you show complete conversion and have hit a reasonable specific gravity. Stir the mash regularly to speed this process along.

> "THE 60-MINUTE MASH TIME GIVEN IN MOST SINGLE INFUSION RECIPES IS JUST A RULE OF THUMB, BUT MOST MASHES WILL CONVERT MUCH MORE QUICKLY THAN THIS."

To cut drastic amounts of time from your brew day, skip multi-step mashing in favor of single infusion. You may also want to skip the mash out, although your extraction efficiency might suffer slightly.

What's the ultimate way to shorten your mash? Brew with malt extract instead. This is particularly true for styles that have fairly straightforward grain bills and when you can find a good supply of fresh extract.

Lautering

Increasing the rate at which you run off your wort will save time. You may want to increase the rate of your fly sparging or try batch sparging. You will likely need to lower your expected efficiency and correspondingly increase your grain bill to compensate, though.

To minimize the amount of time spent lautering, try no-sparge brewing (see the November 2011 issue of *BYO*).

Boiling

When using malts that have been kilned beyond the lightest amounts, you have less to worry about with regards to dimethyl sulfide (DMS), so you do not need a full 60-minute boil. If you move your earliest hop additions to later in the boil (adjusting for the difference in hop utilization), you can shorten the boil time.

Wort Chilling

To speed wort chilling, increase the diameter and length of your immersion chiller, if that is what you are using. (Stepping up from ⅜-inch x 25 feet to ½-inch x 50 feet is a huge improvement.) Use a cheap sump pump to recirculate ice water through the chiller once your tap water has stopped dropping the temperature as quickly. Or, switch to a counter-flow chiller, which can be faster to get to pitching temperatures than an immersion chiller. Whirlpool your wort with a pump or spoon, or at the very least swirl your chiller around in the cooling wort to ensure that hot wort is constantly being exposed to the chiller.

Putting Everything into Practice

All of that theory sounds great, but what does it look like in practice? On page 50 is a timeline for my typical 6-gallon (23-L) all-grain brew day. Items marked with an asterisk are not on the critical path. The whole brew day takes under 4 hours.

Conclusion

You never get something for nothing, and advanced brewers will see obvious tradeoffs associated with some of these suggestions. Use your own judgement about where your priorities lie (for example, in a faster brew day or achieving higher extract efficiency). To ensure that you continue to brew high quality beer, you should also avoid adopting more than one time-saving tip each brew day — determine if shortening one step affects your beer before shortening another. Hopefully these suggestions will help shorten your brew sessions! BYO

Dave Louw is a frequent contributor to Brew Your Own *magazine.*

Major League Pitching

Going big for better beers

by Terry Foster

"I used the packet of yeast that came with the kit."
"How old was that?"
"A couple of years I think. It seemed to work okay."

The above exchange was part of a real conversation I had about brewing a beer, me being the questioner. And the other person was not a beginning brewer, nor an ignoramus, but a very intelligent and well-educated scientist. And worse, his idea of "working okay," and that of many other homebrewers I have spoken to, was that fermentation was noticeably underway after one to two days. Craft brewers, as well as writers in this magazine, have frequently laid down strictures about the need to pitch sufficient amounts of active yeast, but it seems that many homebrewers seem to still ignore all of these recommendations.

Is pitching rate really that important? Does it matter if the yeast takes a bit more time to get going, so long as the beer isn't infected and tastes all right? Well, actually, yes it does matter, because for a start if you consistently have long lag times you will brew infected beer sooner or later. Also, even if it is free of spoilage organisms your beer will not taste "all right," it will taste like "homebrew." Ask any professional brewer and he will tell you that the most common mistake made by amateurs is under pitching their yeast, and this is what causes that homebrew tang. This is exactly what Garrett Oliver, from New York City's Brooklyn Brewery, said in the December 2011 issue of *BYO*. He explains that an insufficient amount of healthy cells means that the yeast will struggle and throw off a lot of estery profiles, "which is a common flaw in homebrews." He also points out that you will find in a commercial brewery that warm fermentations, "are very clearly active within 12 hours."

What prompted this column was a letter from a *BYO* reader about Jamil Zainasheff's recipe for Maibock (*BYO* October 2011), which quoted a 15-L starter for a 5 gallon (19-L) brew. The reader seemed to think that that meant he had to add all of the 15-L of his liquid, and that just is not how starters work. Quite simply, you need to pitch only the yeast from the starter, not the liquid. What this means is that once the high head or kräusen has formed and started to subside, you decant up to 90% of the liquid (depending upon how well the yeast flocculates), swirl the vessel to loosen the sediment and add that to the wort in the fermenter. In case you are wondering whether Jamil and I have different viewpoints on this, I confirmed with him that that is exactly what he meant. And of course, in the case above you would probably finish up with 1.5 to 3-L (0.4 to 0.8-gallon) of liquid to pitch, a much more reasonable volume to handle. As the response to the reader's inquiry (*BYO*, November 2011) pointed out, you could in any case reduce the size of the starter by using two packets of liquid yeast rather than one. Jamil himself also recommended in his recipe that you could use 5 packets of liquid yeast instead of making a starter.

Jamil also pointed out that an even better method would be to make a smaller beer first, and to crop the yeast from that for pitching into the bigger beer. That of course is exactly how a commercial brewery would approach it. For example, where I brew — BrüRm@BAR in New Haven, Connecticut — we take the settled yeast from our Toasted Blonde and use it to pitch all our other beers. Toasted Blonde is our blandest and weakest beer at 1.040 (10 °P). This is also where I usually get my yeast when I am brewing at home.

Obviously, you could do the same if you live close enough to an obliging craft brewery. If you don't have such a

> "If you consistently have long lag times you will brew infected beer sooner or later. And, even if it is free of spoilage organisms your beer will not taste 'all right,' it will taste like 'homebrew.'"

Photo by Les Jörgensen

> An even better method would be to make a smaller beer first, and to crop the yeast from that for pitching into the bigger beer.

source you could brew a "small" beer at a similar gravity, and use the yeast sediment obtained at racking from the primary to pitch into your bigger beer. If you do that you should not re-pitch yeast from a beer with OG much above 1.050 (12.5 °P), nor keep the yeast for longer than one to two weeks before re-pitching. Either of these mistakes will result in a batch of yeast, which is already "tired," and you will negate the reason for doing this procedure in the first place. Yet what do you do if you can't do that, because you don't have the time or the space or whatever reason? Then you are back to making a starter to give you an appropriate amount of yeast for a big beer.

But how do you know what is an "appropriate amount?" Well, you could go to Jamil's website, www.mrmalty.com, and go to the "Yeast Tools" section where there is a pitching rate calculator. You just punch in the beer type, original gravity, volume, type of yeast (liquid, dry or slurry), and type of starter and it will tell you what volume of starter you need. Wyeast (Wyeastlab.com) also has a pitching rate calculator on their website, although it is simpler than the one on mrmalty.com. Or you can make some straightforward calculations yourself. If you consult various brewing textbooks you'll see that you need 1 million cells per milliliter/°P for a "regular" beer at around 10–12 °P. Or, if you prefer, this is close to 1 million cells/mL/4 degrees SG (the latter being OG x 1000), for a beer at 1.040 to 1.050. So, taking the lower figure, for 5 gallons (19 L) at 1.050 (12.5 °P) you need:

$$5 \times 3.78 \times 1000 \times 106 \times 50/4 = 1181 \times 109 = 238 \text{ B cells}$$

As the original gravity increases the amount of yeast increases, so that for a beer of OG 1.080 (19.3 °P) or more you would need up to twice this amount, or about 400–500 billion cells. That is because you need sufficient yeast for the fermentation to proceed at a normal rate — by which I mean that the desired terminal gravity is reached in 3–5 days. If it doesn't go at a normal speed, then the yeast is going to be struggling to finish its job of attenuation when it is in a high alcohol environment, which will make it struggle even more. Note also that lager brewers generally like to pitch up to twice as much yeast as ale brewers do, to counteract the fact that their cooler fermentations result in a slower absolute fermentation rate.

Let's say we want to make 5 gallons (19 L) of a strong ale with an OG of 1.090 (21.5 °P) (the recipe appears at right). I don't want this to be too sweet, so we want good attenuation with a finishing gravity no more than 1.025 (6.3 °P), which means aiming for a pitching rate of around 500 billion cells. We shall consider only liquid yeast strains for the moment, and White Labs states that their vials contain 75–150 billion cells; clearly that is not enough for this beer, so that we would need around five vials for direct pitching. But White Labs recommends a starter, and say that 1 vial in a 0.5-gallon (2-L) starter will give about 240 billion cells in two days.

Wyeast numbers are very similar as they state that their Direct Pitch Activator packs contain 100 billion cells, and a 0.5-gallon (2-L) starter would yield 240 billion cells. So in either case we are looking at 2 packs or vials and a 1-gallon (4-L) starter to get up to around 5 billion cells. Actually these figures for growth might be somewhat low, for a normal fermentation results in a three-to-five-fold increase in the amount of yeast. However, they know their yeasts better than I do, so we'll go with those figures.

Therefore we need to prepare a starter, and for that

Cy Young Strong Ale
(5 gallons/19 L, extract only)

OG = 1.090 (21.5 °P) FG = 1.020-1.025 (5-6.3 °P)
IBU = 40 SRM = 30 ABV = 9.3-10.0

Ingredients

13 lb. 10 oz. (6.2 kg) amber* malt extract syrup
12 AAU East Kent Goldings hops (60 mins.) (2.4 oz./68 g at 5% alpha acids)
10.8 AAU East Kent Goldings hops (0 mins.) (2.7 oz./76 g, at 4% alpha acids)
Wyeast 1098 British Ale yeast or White Labs WLP002 English Ale yeast (starter prepared as in text)
(*Use a syrup brewed with crystal malt or one that uses both crystal/caramel and Munich malts.)

Step by Step

Dissolve the extract in 3 gallons (11 L) of warm water, top up to 5 gallons (19 L) and bring to a boil. Add the hops per the above schedule. Cool to 70–75 °F (21–24 °C), and pitch the starter. Aerate thoroughly or oxygenate. Fermentation should be visible within 12 hours. Leave for 7 days then rack to the secondary. Condition for up to one month before packaging.

we want a wort at about 1.040 (10 °P). If you should happen to have that on hand, fine, but you will probably have to prepare it separately. Malt extract will serve well for that, and since I am planning on using an amber extract in the recipe we'll use that for the starter as well. So for one gallon (3.7 L), we'll need 1 lb. 2 oz (0.5 kg) of amber malt extract. Dissolve the extract in the water, and bring to a boil. Add 0.5 oz (14 g) of East Kent Goldings hops — this will give around 40 IBU, which is what we'll target in the beer, and we need the hops here so the yeast can to adjust to this environment, and to provide some preservative characteristics to the wort. Boil for 30 minutes, transfer to a sterilized jar, cover with cling film, or, if the jar has a narrow neck, stuff it with cotton wool. Cool as rapidly as possible to around 70 °F (21 °C), agitate well, or better still oxygenate for one to two minutes, then pitch the two yeast vials or packs. In the latter case, activate the packs by "smacking" as instructed by the suppliers, before adding to the starter. Keep in a warm place for two days, by which time there should be a good amount of sediment of yeast in the jar. Pour off at least half the liquid, swirl the remainder until the sediment is fully suspended, and pitch this to the wort, using the extra amount to adjust your final volume to 5 gallons (19 L). Don't forget to agitate, or better oxygenate the wort after pitching.

There are a couple of points about this, the first being that you have to plan ahead for your brew day so that your wort is ready when your starter is ready! Secondly, I have assumed that we have made a "simple" starter; that it isn't agitated nor continuously aerated during its fermentation. Both of these latter approaches will accelerate growth, but I don't have space to deal with them here, and in any case they would require a more complicated setup. And of course, I have assumed that we have chosen yeast strains which flocculate quite well (but not so well that they'll settle out before completing attenuation). I have recommended two yeast strains, which you will see in the recipe on page 57.

Conclusion

The recipe I have given is quite a simple one; it will still give a satisfying strong ale, but the real point about it is the yeast and how it is pitched. This simple fungus is amazing and capable of doing some wonderful things for us, but like us it does have its limitations. It is a brewer's friend, so treat it like a friend and make its task as easy as possible. You would not expect a right-handed baseball starter to pitch well with his left arm, and you similarly shouldn't expect an insufficient amount of yeast to be capable of producing top quality beer. BYO

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

Oxygenation of Wort

How it happens and why it matters

by Chris Bible

Availability of dissolved oxygen to yeast during the initial stage of fermentation is very important. Yeast use oxygen to build cell membrane components that are essential to replication.

Unsaturated fatty acids, sterols (both found in wort) and oxygen are all necessary for yeast to rapidly reproduce during the initial stage of fermentation. Without enough available oxygen, yeast cells are unable to properly utilize unsaturated fatty acids and sterols during the initial stage of fermentation.

If the yeast cells are unable to rapidly replicate during the initial stage of fermentation, a sluggish or abnormal fermentation may result. This can lead to higher than normal levels of ester production by the yeast with corresponding off-flavors in the beer. If oxygen levels are too low, compounds such as ethyl acetate, isoamyl acetate and ethyl caproate will be produced in excess. These are the compounds that cause finished beer to have flavors that are often described as fruity or solvent-like.

Additionally, inadequate oxygenation can cause pyruvic acid, amino acids and fatty acids to decarboxylate and become aldehydes.

Decarboxylation of pyruvic acid is usually the most pronounced, and leads to the formation of acetaldehyde, which creates the impression of green apples within the finished beer.

Yeast requirements

Different strains of yeast have different requirements for oxygen in the initial stage of fermentation. Most yeast strains perform well when a minimum of 5 ppm (parts per million or, equivalently, milligrams per liter) of oxygen is initially present in the wort. Higher initial levels of oxygen are usually desirable, but some yeast strains show no change in performance when levels rise above 6 ppm. Experiments with lager yeasts have shown that some strains achieve optimal performance only at levels of 10–12 ppm oxygen.

Oxygen solubility in wort

So where does this much-needed oxygen come from? And how does it get into the wort? Oxygen can come from either the air in our atmosphere (which is comprised of approximately 79% nitrogen and 21% oxygen) or from a tank of compressed oxygen. Homebrewers generally use one of several techniques to get oxygen into their wort, including shaking the fermenter or using an aeration pump with an appropriate diffusion device submerged into the wort. To prevent contamination of the wort, the pump must be equipped with a sterile air filter capable of filtering out particulate matter that is <0.5 μm in diameter. Homebrewers may also use an oxygen tank with an appropriate diffusion device submerged into the wort.

The general trade-offs between the above-listed methods are relative difficulty and effectiveness versus complexity and cost. Regardless of the method used, the idea is to dissolve something that is in the gas-phase (oxygen) into something that is in the liquid-phase (the wort).

The solubility of oxygen in wort is affected by temperature and by the partial pressure of oxygen over the wort. The solubility of oxygen is greater in colder wort than in warmer wort. Oxygen molecules dissolve by slipping into "gaps" that exist in the loose hydrogen-bonded network of water molecules within the wort.

The oxygen is then "caged" by water molecules, which weakly pin it in place within the liquid. The dissolution reaction is exothermic overall, so cooling shifts the equilibrium towards the dissolved form. Partial pressure of the oxygen over the wort is important because oxygen in water (or wort) obeys Henry's law rather well. This relationship is shown in Figure 1 on page 60.

> "If the yeast cells are unable to rapidly replicate during the initial stage of fermentation, a sluggish or abnormal fermentation may result."

Photo by Les Jörgensen

Figure 1: Equilibrium Concentration of Air-Derived Dissolved Oxygen in Water

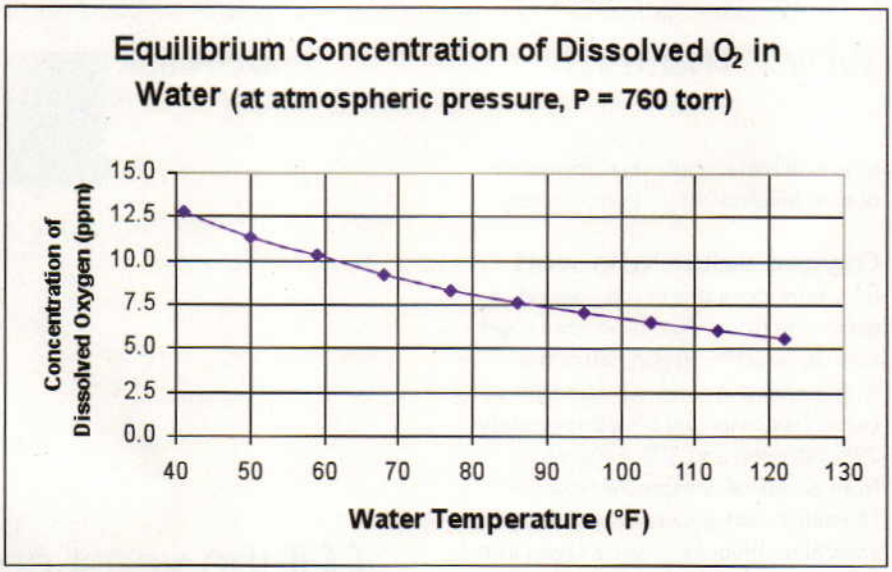


Figure 1 shows that, for example, at 50 °F (10 °C) water can hold no more than about 11 ppm of air-derived, dissolved oxygen. Figure 1 is strictly accurate only for a water/air-derived oxygen system. This is due to the fact that the other dissolved components within the wort will inhibit the ability of the liquid to hold dissolved oxygen.

Oxygen transport rate

Although Figure 1 addresses the absolute maximum amount of air-derived oxygen that can be held in solution within the water (or wort), it says nothing at all about the rate at which oxygen can be dissolved. The rate at which oxygen passes from the gas-phase into the liquid and then into the yeast cell depends upon several factors:

* The concentration of oxygen already dissolved in the wort.
* The concentration of oxygen in the gas phase.
* The surface area of the contact interface between the gas phase (atmosphere or pure oxygen) and the wort.
* The ease with which oxygen can pass through the gas-liquid interface.
* The ease with which oxygen can pass from the liquid phase into the yeast cell.

The equations that describe each of these transport steps are:

(A) Mass Transfer from Bubble to Bulk Liquid:
$R_A = k_b a_b (C_i - C_b)$

(B) Mass Transfer from Bulk Liquid to Cell Surface:
$R_A = C_c k_c a_c (C_b - C_0)$

(C) Diffusion Across Yeast Cell Membrane:
$R_A = C_c (D_e/L) a_c (C_0 - C)$

(D) Rate of Oxygen Consumption Inside Yeast Cell:
$R_A = C_c \mu C$

Where:

R_A = overall rate of oxygen movement during the transport step in question, g/s

a_b = total surface area of bubbles in contact with the liquid, m2

a_c = cell surface area per unit mass of cell, m^2/g

k_b = mass transfer coefficient for transfer from bubble to bulk, m/s

k_c = mass transfer coefficient for transfer from bulk liquid to the cell surface, m^4/s

D_e = effective diffusivity across the cell membrane, m^2/s

L = thickness of yeast cell membrane, m

C_c = concentration of cells within the wort volume, g/m^3

C_i, C_b, C_0, C = saturation, bulk, external surface, and internal cell concentration of oxygen, respectively

μ = reaction rate constant for the metabolism of oxygen within the yeast cell , m^6/g_{cells}-s

By making the assumptions that, at any point within the system, the overall rate of oxygen transport is at steady-state and that the movement is rate-limited by the slowest step in the transport process, all of the RA terms can be set equal to one another. Using this statement of equality, and adding together equations (A) thru (D) (since each step must occur in sequence for any given molecule of oxygen), the overall effective oxygen transport rate is given as:

$$\frac{C_i}{R_A} = \frac{1}{k_b a_b} + \frac{1}{C_c}\left(\frac{1}{k_c a_c} + \frac{L}{D_e a_c} + \frac{1}{\mu}\right)$$

It is worth noting that the step of diffusion across the yeast cell-wall membrane can usually be neglected.

Hough, et.al., (in their book, "Malting and Brewing Science, Volume 2." Chapman & Hall, 1999) provide a model and some data describing the rate at which oxygen passes from the atmosphere into solution. The model that they describe is:

Rate of uptake = $K_L a\ (C^* - C_L)$

Table 1: Laboratory Derived Oxygen Absorption Rates in a Fermenter

Vessel	Volume of Medium	Comments	Air Flow (liters/min)	$K_L aC^*$ (millimoles O_2/liter/min)
18 x 150 mm test-tube	10 ml	Stationary	---	0.03
Erlenmeyer flask, 500 ml	20 ml	Stationary	---	0.32
Erlenmeyer flask, 500 ml	20 ml	Eccentric Shaker (250 rev/min)	---	1.1
Indented Erlenmeyer flask, 500 ml	20 ml	Eccentric Shaker (250 rev/min)	---	2 – 9.5
Indented Erlenmeyer flask, 500 ml	50 ml	Reciprocal Shaker (80-100 strokes/min)	---	0.78 – 1.5
Indented Erlenmeyer flask, 1000 ml	200 ml	Reciprocal Shaker (80-100 strokes/min)	---	0.22 – 0.78
Baffled Tank, 3.5 liter	1460 ml	Stirred, 750 rev/min	5.8	3.6
Baffled Tank, 3.5 liter	1460 ml	Stirred, 1100 rev/min	6.1	6.33

Where:

K_L = overall constant specific to the system (can be thought of as a "lumping together" of all of the mass-transfer k values from the model discussed earlier)

a = surface area of the gas-liquid interface

C^* = equilibrium concentration of oxygen in the wort

C_L = the actual concentration of the oxygen within the wort.

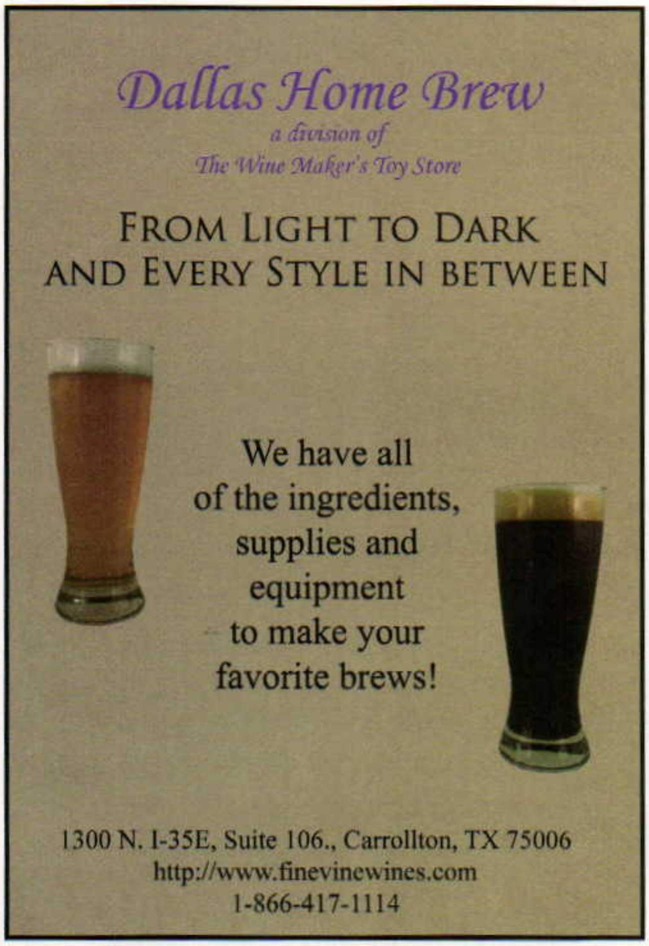
This model is essentially the same as equation (A) from the previously-described model. The laboratory-generated data from this reference is presented in Table 1 on this page. The data validates what is already known by most homebrewers: more splashing and agitation achieves a better aeration of the wort.

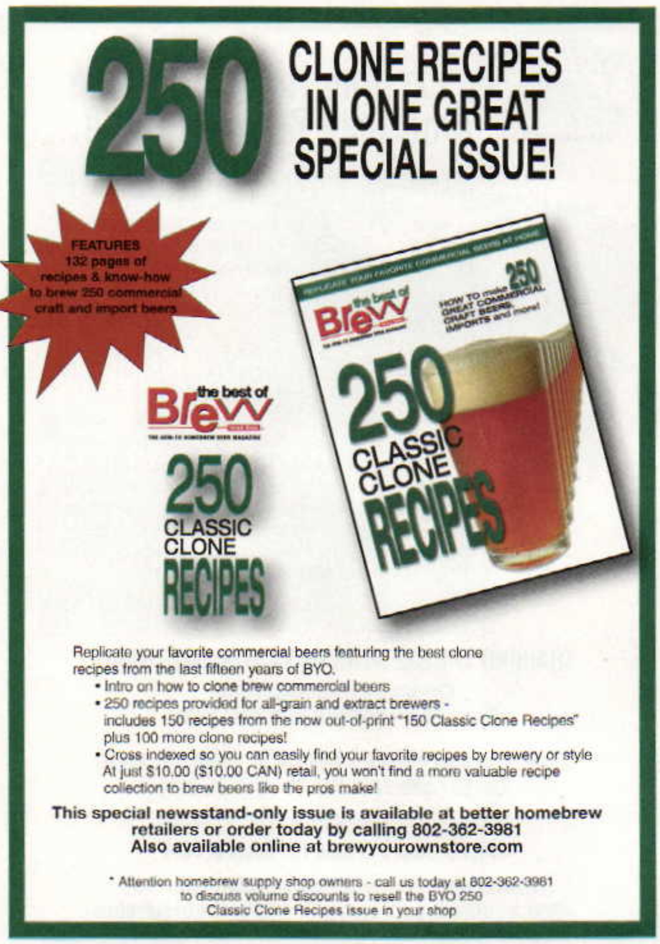
Practical conclusions

So what can we take from these equations, as practical guides? To ensure good oxygenation:

Ensure that the wort is as cool as practicable. Cooler wort has a higher equilibrium oxygen concentration and so can contain more oxygen. Agitate the wort as much as possible after chilling to yeast-pitching temperatures. Try to create as many gas bubbles as possible within the wort. If possible, use pure oxygen to oxygenate the wort after chilling to yeast-pitching temperatures. This will not only increase the rate of oxygenation, but will also increase the overall theoretical equilibrium concentration of oxygen that can be held within the wort. Working the equations will give you a better idea of the extent that the differences matter. BYO

Chris Bible, an engineer, is Brew Your Own's *"Advanced Brewing" columnist.*





Cold Homebrew To Go

Build a compact jockey box

by Forrest Whitesides

You have your kegerator set up and running smoothly; your friends love to drop by and drink your homebrew on tap. But now you (and they) want to bring your finely crafted brew out and about to parties, picnics, and other social gatherings. You could build a portable kegerator (see *BYO*'s "Projects" in the May-June 2011 issue), but there is a cheaper and simpler alternative that also opens up the possibility of serving multiple kegs on the go: a jockey box.

For those who don't already know what it is, a jockey box is a "just-in-time" beer chilling and dispensing rig made from an insulated cooler, a coil of metal tubing, and standard draft dispensing hardware. The jockey box is packed with ice (and a little water) to get the coil cold. Beer is pushed from the keg into the jockey box, which cools the beer as it travels through the chilled metal and is then dispensed through a standard draft faucet. This allows for temperature-correct draft beer to be served in any place where electric refrigeration is not convenient or possible, such as a camping trip.

Commercial jockey boxes are often made using a plate chiller to cool the incoming beer. These are very efficient chillers, and somewhat similar to the wort plate chillers used in commercial and homebrewing. As you might expect, these chillers are not cheap, and so our jockey box project will use more common metal tubing - stainless steel (although it can be built with copper as well), which is available at most hardware stores.

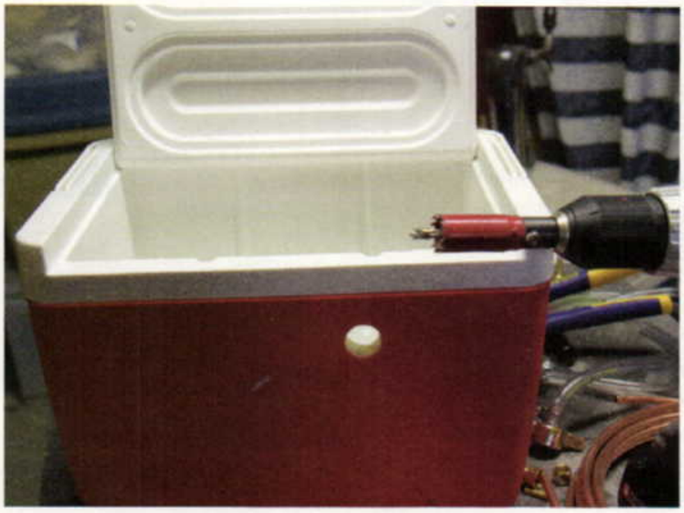
Stainless steel is the metal of choice for this project as finished beer comes in contact with the metal. Many homebrewers build jockey boxes with copper tubing as copper is amazingly efficient at heat transfer (it has tremendously high thermal conductivity). It is great for any project related to chilling, such as immersion chillers, however copper can be the source of some negative consequences when it comes in contact with finished beer, which has a different pH than wort. Copper has the potential to cause staling post-fermentation because it catalyzes staling reactions, including the production of hydrogen peroxide and can oxidize the alcohols to aldehydes. There is also potential for copper to lead to copper poisoning (nausea, vomiting) from too much exposure. If you don't want to worry about it, go with stainless steel — it's more expensive and harder to bend, but non-reactive.

> "A jockey box is a "just-in-time" beer chilling and dispensing rig made from an insulated cooler, a coil of metal tubing, and standard draft dispensing hardware."

Tools and Materials

Tools
- Drill with ⅞-inch hole saw
- Rotary tool (Dremel) or hack saw with metal cutting blade
- Adjustable wrench
- Flathead screwdriver

Parts
- Insulated cooler (the size will depend on how many taps you plan to add. For a single tap, the cooler can be very compact.)
- 2x Beer shanks — one for beer in to the box; one for beer out.
- 3x Shank nuts
- Wing nuts and tail pieces, as needed
- Dispensing faucet
- 20 feet of pre-bent stainless steel tubing: ¼-inch OD
- 1 foot (approximately) of vinyl tubing: ⅜-inch OD
- Hose clamps
- Teflon pipe tape



1. PLAN FOR DRILLING

I used a fairly small cooler (2.25 gallons/8.5 L), but there is enough space for two taps and coils, so I drilled the faucet hole (front of cooler) a little off center. This way, I can add a second faucet in the future and have both taps the same distance from the center and maintain a neat, symmetric look.

The position of the beer inlet hole (back side of the cooler) isn't all that critical, as you can easily bend the copper and vinyl tubing to accommodate the shank. However, for multiple inlets, spacing them far apart can be helpful in getting each coil to fit neatly.

2. DRILL AND TEST SHANK

Both the faucet hole and inlet hole should be ⅞-inch. Measure off your center points (measure twice!) and drill out the holes.

I used a faucet shank that has a hose barb attached. I just happened to have it handy for this project, but any type of beer shank will work, provided that it is long enough to extend enough threading through the wall to accommodate a shank nut, wing nut and tailpiece.

3. MODIFY THE SHANK

I decided to spec my jockey box with standard beer shanks for both the inlet side and faucet side. I have seen many similar projects that make use of brass compression fittings for the inlet hardware, but I wanted to keep everything compatible with standard kegging equipment. However, this requires that one of the shanks be modified to make it into what amounts to a long pipe nipple. It's also possible to use brass compression fittings instead, but I find the shank to be far easier to work with in the long run and more solid. It takes three or four separate brass fittings to make the connection through the thick wall of the cooler, and the total cost is about the same as a beer shank and wingnuts anyway. Plus, with the shank you can cut it down to fit precisely the thickness of your cooler.

4. CUT TO FIT, INSTALL

Start by cutting off the non-threaded portion of the shank (the end where the faucet screws in to the collar). Now fit the cut shank through the inlet hole, screw a shank nut (the flat hex nut that comes with the shank) on the inside of the cooler, and then screw on a wing nut with the tailpiece attached. Push the shank towards the inner wall until the shank nut is flush with the cooler wall. Now screw another shank nut onto the shank on the outside of the cooler until it is flush with the outside wall. A wing nut uses about ⅜-inch of the threads, so mark the shank approximately ½-inch out from the edge of the nut.

Remove the nuts from both ends of the shank and cut it off where you made the mark. A rotary tool or hacksaw will work fine. Be sure to wear safety goggles when cutting metal, especially if using a power tool. Reassemble the inlet hardware to make sure everything fits.

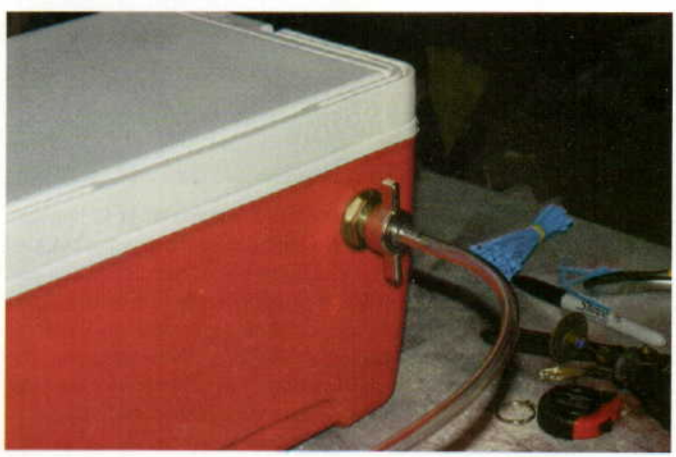
5. CHOOSE YOUR COIL

As I mentioned earlier, and as you can see in the photo above, you can build your jockey box with either copper tubing or stainless steel. Copper works, and you can bend it yourself, but I recommend going with a pre-bent stainless steel coil. Not only will you not have to worry about the metal reacting with the beer, but you also won't have to go to the trouble of bending the tubing — which requires purchasing or borrowing a stainless steel bending tool. Many homebrew suppliers sell stainless steel coils in various lengths, such as this one pictured here from MoreBeer! (which runs about $80). Be sure you know the dimensions of the cooler before you purchase a coil, however, so that it will fit inside the cooler when you assemble the finished project. You may need to have a coil cut down to size.

Photo courtesy of MoreBeer!

6. FINAL CONNECTION

With the faucet and inlet shanks cut, fit, and secured, all that remains is to connect the coil to the shanks. Cut two short lengths of vinyl tubing and slide them onto the hose barbs on the shank tailpieces. Onto the inlet side vinyl tubing, slide two hose clamps and then insert one end of the copper coil into the vinyl tubing; tighten one clamp on the hose barb and the other where the vinyl overlaps the copper tubing. Repeat the same procedure for the faucet side hardware. Now secure the faucet to the front shank and connect the vinyl tubing from a keg to the outside inlet tailpiece. Next, test the box for leaks. Once leak testing is complete, load the box with ice and a little water. Hook up a keg of homebrew and experiment with gas pressure and hookup tubing length to get it dialed in for a smooth pour. BYO



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Brew for Your Life

Homebrewing in a zombie apocalypse

Mark Pasquinelli • Elysburg, Pennsylvania

It's only a matter of time before The End. Like the timeless cycle of the cicada, the dead will rise again.

Most homebrewers will be unprepared for a class-4 outbreak of zombie hoards crashing through their doors, catching them with their hydrometer down, right in the middle of a double decoction on a Munich dunkel. Before they know it, "Zack" will be feasting on a pairing of entrails and an Eisbock.

But it doesn't have to end this way. Brewing, which many sociologists credit for civilization as we know it, may be the very thing that allows us to survive.

How does a homebrewer prepare for the unprepareable? To be forewarned is to be forearmed. Use the downtime during a saccharification rest or a boil to Google key words, like "mass homicide," "violent insanity," "cannibalism," or "riots with no logical cause." The trained mind can then separate zombie incidents from the plethora of information — and misinformation — coursing through the Internet. Viewed from this context, events like the Donner Party and Roanoke take on a new meaning. Eventually, the number of these incidents will become so great that the government will issue confirmations to their official denials. This is the signal for the beginning of the end.

It's also the signal for an "End of the World" party. If there ever was a time to break out that 10-year-old bourbon barrel Russian imperial stout and essential rarities waiting for a special occasion, this is it. One might argue that an impending zombie invasion is no time to throw a party. The ghouls could be the fleet-of-foot "28 Days Later" species rather than the lumbering "Dawn of the Dead" variety. However, in the event of a Zack attack, you don't have to outrun them — you just have to outrun the other homebrewers.

Next will be the reality of brewing in an undead world. The challenge will be unique. Zack is a 24/7 threat — a mindless, voracious killing machine. (The only thing that can kill him is a headshot to deactivate the brain.) But the ghouls won't be the only foe, either. With the collapse of society, alcohol will be a valuable commodity, not only as a beverage, but as currency in a barter economy. Homebrewers might be the only humans with access to literal liquid gold. The countryside will be crawling with unsavory characters, so be prepared to defend your domain.

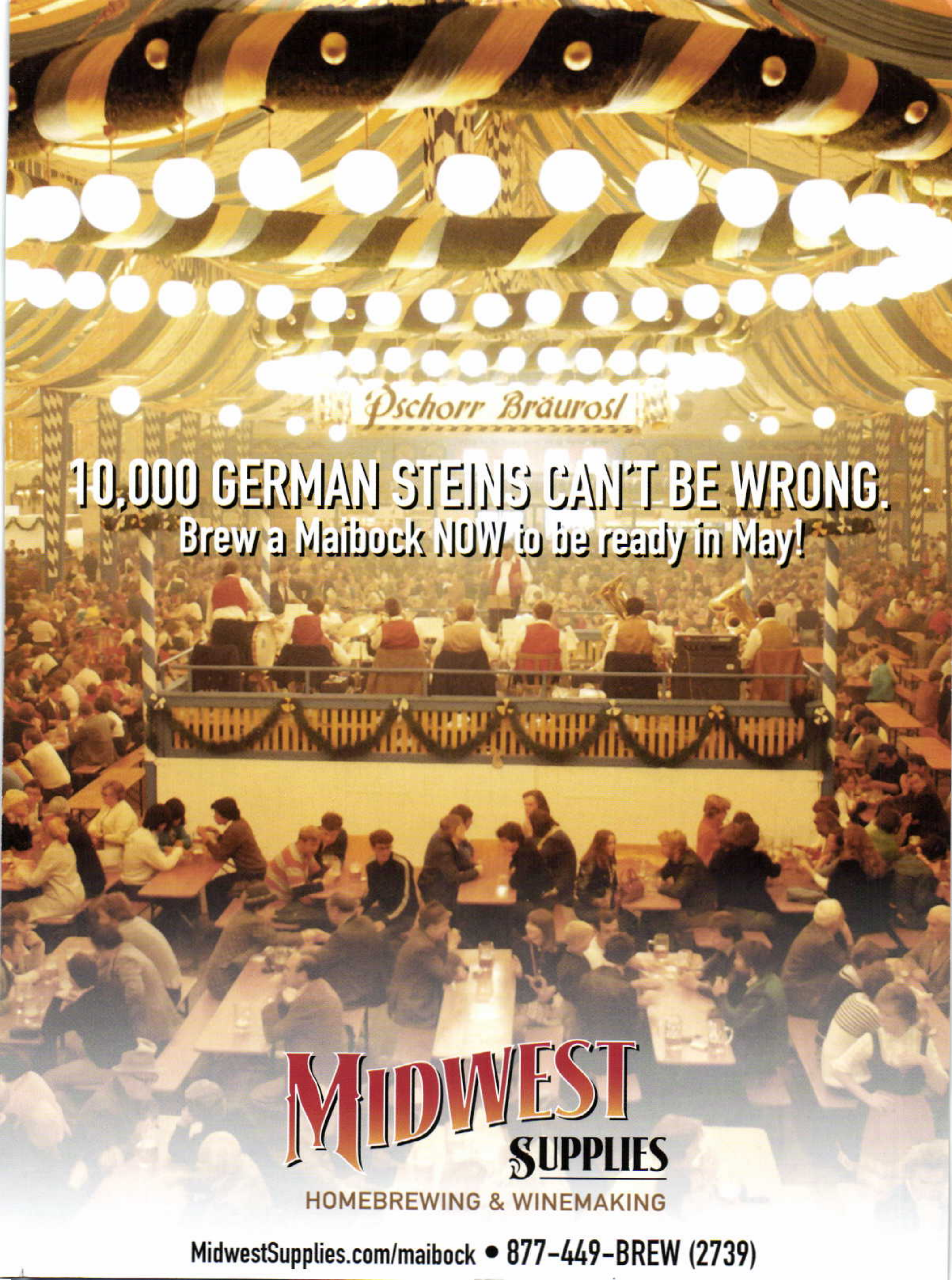
Some things will stay the same. The eternal question will still persist: extract or all-grain. Good advice now will be good advice then — be versed in both. Brew quick extract batches, things like fast-fermenting hefeweizens, during times of high alert. In times of relative security, when Zack moves to more fertile feeding grounds, switch to all-grain. Speaking of security, consider getting a partner if you're a solo act. One can brew; one can be the lookout.

Homebrewers will also have to be resourceful. There will be no homebrew shops, electricity to run the pumps or propane to fuel the burners. Brush up on Middle Age and Colonial brewing techniques. Befriend a barley farmer if you live in a rural area and research malting your own grain. There will be no Internet, so buy books on these topics. Unless you grow hops, don't count on them either. Gruit ales that use herbs like yarrow, bog myrtle, and wild rosemary might be in for a comeback.

No doubt the zombie apocalypse will be a protracted battle. The attrition will be frightful, but mankind will prevail over the ghouls. Well, at least that's how the movies always end. I happen to have some barleywines cellared to celebrate that very occasion . . . just in case. BYO

"Alcohol will be a valuable commodity, not only as a beverage, but as currency in a barter economy. Homebrewers might be the only ones with access to literal liquid gold."

Photo Courtesy of Mark Pasquinelli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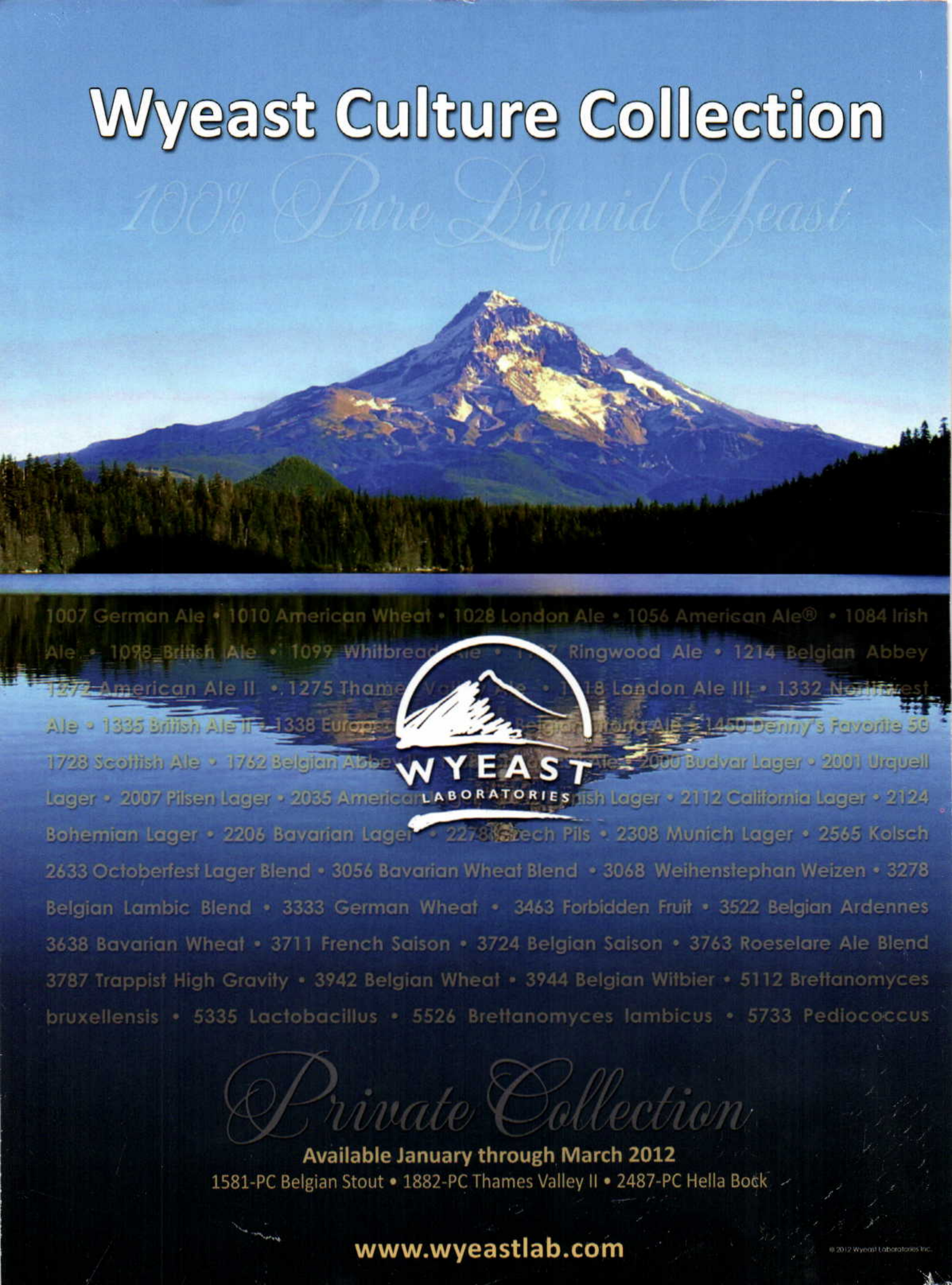
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