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OCTOBER 2010, VOL.16, NO.6

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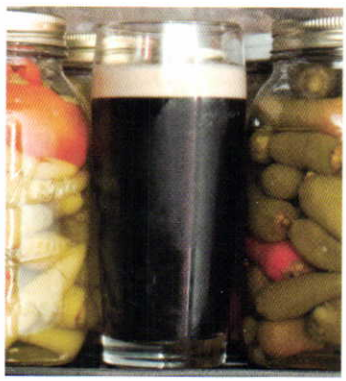

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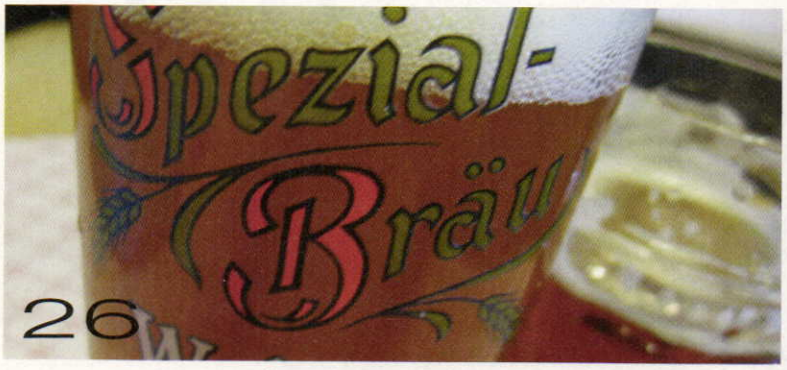

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BYO

RECIPE STANDARDIZATION

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

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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

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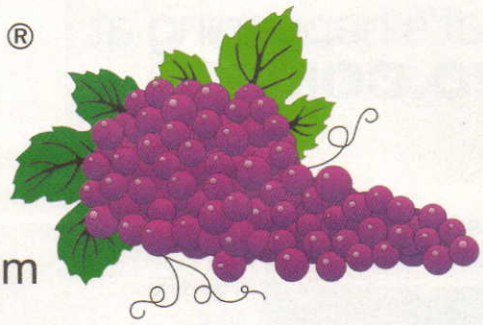

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what's happening at BYO.COM

10 steps to better extract brewing

The differences between extract and all-grain brewing are more extensive than the presence or absence of the mash. In fact, extract brewing has its own set of rules. Check out some tips specific to extract brewing.

www.byo.com/component/resource/article/10-10-steps-to-better-extract-brewing

Yearly brewery checkup

Is it time to give your brewery a good yearly cleaning? Is all your equipment in working order? Take a day off from brewing to get your workspace in shape.

www.byo.com/component/resource/article/1692

Brew Something New

Recipes for all different styles of homebrews are added to byo.com every day. Find something new to brew by style today!

www.byo.com/stories/recipes/recipeindex

Cover Photo: **Charles A. Parker**

Brew Your Own — The How-To Homebrew Beer Magazine

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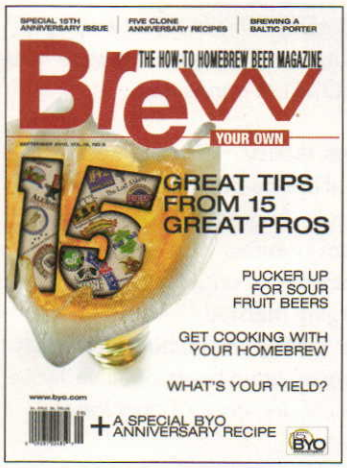


Math for a massive malt bill

I just finished reading the latest *BYO* and I am very interested in brewing the 15th Anniversary ale (September 2010 issue, p. 41). I just have a few questions I hope to get answered before the brew day. How much water was used for the mash and sparge? I plug in the numbers and I got roughly 6.5 gallons. I then should lose about 2 for absorption with the large grain bill, leaving me with about 4.5. Then I would assume sparge with about 2.5 to 3 gallons to make a 7-gallon preboil. I just wanted to double check my numbers and compare them to yours.

Also, the fermentation time was vague, about how long did you ferment it for? How long from grain to glass? I'd appreciate any feedback.

Ed Cedor
via email

Chris Colby responds: "Glad you're interested in brewing our 15th Anniversary Ale. I think you'll like it.

"For the mash, 6.6–7.3 gallons (25–28 L) of brewing liquor will give you a reasonable mash consistency. If you have any "dead space" in your mash tun (for example, space under a false bottom) add that volume of water to this number. This is a lot of grain and water, so be sure your mash tun can hold it all before starting. (You might be able to squeeze this all in a 40-qt. (38-L) mash tun, but you'll probably be full to the rim.)

"Two gallons (7.6 L) is a pretty good estimate of how much water you will lose with this grain bill due to the absorption of the grains.

"The amount of sparge water that is required depends on a lot of factors. The numbers you give would be the absolute minimum and do not make any allowances for liquid left over under your false bottom (if you have one) or in tubing. Also, you would need to run the grain bed dry to make sure that the last bit of liquid made it into the kettle.

"I would start with your numbers and add in the volume of dead space (if any) in your system. Also, if you sparge such that you always keep a couple inches of water over the grain bed, add another 4.5–5.0 gallons (17-19 L) to account

contributors

Bob Hansen is the former brewer at the Water Street Brewery, in Milwaukee, Wisconsin — an extract-based brewpub. Bob joined Briess Malting, of Chilton, Wisconsin, in 2001 and is now Manager of their Technical Services division. In the May-June 2008 issue of *BYO*, he wrote the article, "Making Malt Extract," detailing the process of extract manufacture.

On page 44 of this issue, he interviews professional brewers who use malt extract in their brewing — including two whose brewhouses are primarily geared towards extract brewing — and compiles their advice on making the most of this common ingredient.

Horst Dornbusch was born in Germany, but now lives in Massachusetts. He is an international consultant to the brewing industry and a prolific writer, contributing to beer publications in North America and Europe. From 2002 through 2006, he was *Brew Your Own's* "Style Profile" columnist. Recently, in our October 2009 issue, he wrote about how to "imperialize" German beer styles.

In this issue, on page 26, Horst takes a look at one of the most interesting styles of beer — rauchbier (smoked beer) — and explains to readers how to brew this "liquid bacon."

Forrest Whitesides is a graduate of North Carolina State University and lives in Hopatcong, New Jersey. Forrest brewed his first batch of homebrew — an English brown ale — in the summer of 1995. These days, he is interested in and brews Belgian-style ales of all sorts.

Forrest has contributed many installments of our "Projects" column and returns this issue with a classic project — how to build a mash tun from an insulated picnic cooler. With a picnic cooler, some copper tubing and a hacksaw, you can build a combination mash and lauter tun to get yourself started in all-grain brewing (or scale up your current vessel). He also walks through an extract brew day on page 44.

for the water left behind in the mash tun. I usually calculate the amount of sparge water I'll need, and then add 5-10% to that number, just because it's easy to heat a bit of extra water and it's a pain if it runs out.

"The time it will take to ferment this beer depends on a number of factors. First and foremost, you need to make two healthy yeast starters, each 2-3 qts. (~2–3 L) — one for the Scottish and one for the Belgian yeast strain. These are hardworking yeast strains, but you need to pitch an adequate amount of yeast for this beer to ferment in a reasonable amount of time and to a reasonable final gravity.

"If you've pitched adequately, and aerated thoroughly, the beer can ferment fairly quickly, given the high starting gravity. In my case, fermentation took just a bit over two weeks. Watch the fermentation temperature early on and don't let it get away from you. Towards the end of fermentation, letting the temperature rise a bit will help you finish in a reasonable amount of time.

"I can't give a good estimate of minimum grain to glass time. I kegged the beer and let it sit a month before sampling and it was good at the first sampling. (I find that if you run a fermentation well, beers — even big beers — tend to condition fairly quickly.)

"Good luck brewing this beer. If you've brewed big ales before, everything should go fine. (If you haven't, just read the Step by Step section carefully. This beer just keeps getting better and better as it ages — I'll have to try to remember to save a bottle for BYO's *20th anniversary."*

All-grain brewing is easy

Thank you for the detailed article on all-grain brewing. ("From Grain to Glass," July-August 2010.) It can be very intimidating to extract brewers who don't know much about it. It was scary to me until I discovered Denny Conn's batch sparging method.

I brewed extract beer for five years, but for the last five years I've been making all-grain beers of all varieties. My brew day is typically 5 hours, only 2 hours longer than my extract brew days.

Even though you mention batch sparging in your article, I think it needs to be reiterated that all-grain brewing does not have to be difficult or complicated! If extract brewers have any interest in all-grain brewing, please look into it.

I know many of us are visual learners, and to that end, I made an "Easy All-Grain Brewing" for YouTube. In 6 minutes, I show a typical brew day. I get emails almost every day thanking me for the video, saying they never realized how easy it can be. If any of your readers might find such a video helpful, I hope they check it out

(no, I don't earn anything by more people watching!)

The extra equipment one needs to brew all-grain can be made fairly easily for low cost (mash tun, wort chiller). I have instructions on doing that too.

Don Osborn
St. Paul, Minnesota

Thanks, Don. A search for "Easy All-Grain" on YouTube brings up your video as the first result.

And we couldn't agree more — all-grain brewing does not have to be intimidating. Most all-grain brewers we've ever talked to fondly remember their first all-grain brew day. In most cases, something went wrong, as would be expected when you're just learning the ropes. But, almost everyone was impressed with how their first all-grain beer turned out. (The process is actually reasonably forgiving.)

There are, of course, advanced topics in all-grain brewing and it does take time to get to know your brewing equipment, but the learning curve is actually not that steep.

We also agree abut the equipment — in fact, check out page 67 of this issue for how to build a mash tun.

All-grain brewing with coolers

I read your article "Brew Your First All-Grain Beer." In the article there are pictures of all stainless steel (assuming) kettles. How would you work coolers such as RubberMaid (Northern Brewer has a 2 cooler system) into this process. I'm assuming during the mash-in. But was hoping to get more details about that.

Rich Surace
Mason, Ohio

When coolers are used in an all-grain system, they are usually used for the mash/ lauter tun and sometimes the hot liquor tank (HLT).

A mash tun does not have to be heatable, and an insulated cooler works well for this. The only drawback is that you cannot perform step mashes by directly heating the vessel. You can add boiling water each step, but you will progressively thin out your mash if you do. (Some thinning of the mash is not a big deal.) The big benefit to a cooler-based mash tun is the insulation.

A cooler can also be used for the hot liquor tank as well. Just keep in mind that the water needs to be heated first in a kettle. You will need to know how much the temperature will drop when transfering the water from the kettle to the HLT. Likewise, you will need to have all your sparge water in the HLT before you start running off the wort. (Alternately, you will need to have a separate burner and pot to heat water in.) BYO

homebrew nation

BREWER PROFILE

Brewer: Adam Best

Hometown/State: Cincinnati, Ohio

Years Brewing: Almost five years

Type of brewer: Partial mash and all-grain, it depends on the recipe

Homebrew Setup: 5-gallon (19-L) capacity. I brew in my basement (aka, man cave). Half of my basement is a home theater; the other half is where I brew. I brew using a 7-gallon (26-L) electric turkey fryer, 5-gallon (19-L) water cooler and 6.5-gallon (25-L) stainless steel pot.

Currently fermenting: Highlander Jedi Scotch Ale (recipe at right)

What's on tap/in the fridge: Jedi Dos Fiesta (Dos Equis clone), Dark Side Duff (Premium American Lager)

How I started brewing: I got a Mr. Beer kit for a Christmas present from my parents. From there I got the bug to brew more beer in larger batches. I also wanted to have more control than the malt extracts available from Mr. Beer. I started all non-hopped malt extract and boiled my own hops. I did that for a while then learned about partial mashing in *BYO* so I went out and bought a 2-gallon (7.5-L) cooler. I've stuck with partial mashing and occasionally try my hand at all-grain brewing from time to time.

byo.com brew polls

Have you ever considered going to brewing school?

Maybe someday 73%
Yes, I am planning on it 17%
No, I'm not interested 7%
Yes, I already went 3%

PROFILE RECIPE

Highlander Jedi Scotch Ale

(5 gallons/19 L, partial mash)
OG = 1.065 FG = 1.016
IBU = 28 SRM = 25 ABV = 6.3%

This is supposed to be similar to Sam Adams Scotch ale. I entered in a few competitions as Scottish ale. I really enjoy this recipe and its complex smokiness. The beer also gets better after a few months of aging.

Ingredients

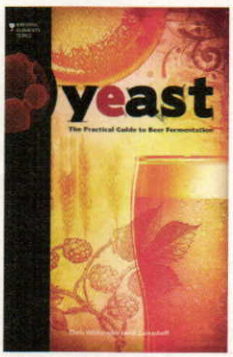
6.5 lb. (3.0 kg) Munich light liquid malt extract (LME)
2.4 lb. (1.1 kg) Munich malt (10 °L)
0.5 lb. (0.23 kg) crystal malt (60 °L)
0.5 lb. (0.23 kg) crystal malt (20 °L)
3.0 oz. (85 g) chocolate malt (350 °L)
4.0 oz. (113 g) white wheat malt (2 °L)
2.0 oz. (57 g) peat smoked malt (2 °L)
5 AAU East Kent Goldings pellet hops (1.0 oz./28 g of 5% alpha acids) (60 min.)
5 AAU Fuggles pellet hops (1.0 oz./28 g of 5% alpha acids) (15 min.)
1 tsp Irish moss (rehydrated) (15 min. boil)
Wyeast 1728 (Scottish Ale) (from a 1-qt. starter)
4.5 oz. corn sugar (priming)

Step by Step

Mash all the grains in 6.5 qts. (6.1 L) of 160 °F (71 °C) water for one hour. Sparge with 6.5 qts. (6.1 L) of 170 °F (77 °C) water. Make up the rest of the batch volume with 3 gallons (11 L) of water and boil for one hour. Add hops as per the ingredients. At the end of the boil, add the LME. Chill rapidly to pitching temperatures, aerate and pitch the yeast. Ferment at 65 to 68 °F (18 to 20 °C).

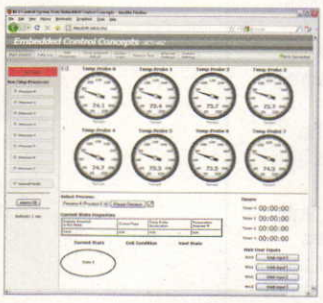
what's new?

Yeast: The Practical Guide to Beer Fermentation



BYO's "Style Profile" writer Jamil Zainasheff and White Labs' Chris White authored this yeast resource for brewers of all experience levels, available now from Brewers Publications. Covers yeast selection, storage and handling of yeast cultures, how to culture yeast and the art of rinsing/washing yeast cultures. Also includes sections on how to set up a yeast lab, the basics of fermentation science and how it affects your beer, plus step by step procedures, equipment lists and a guide to troubleshooting are included.
http://shop.beertown.org

Brewery Control System from Embedded Control Concepts



The BCS-462 temperature controller from Embedded Control Concepts enables a brewer to precisely and reliably supervise the entire brewing process for repeatable results. Integrate the BCS into your home network and monitor your brewery and fermentation temperatures from anywhere.
http://www.embeddedcontrolconcepts.com

Hobby Beverage Equipment fermenters now available in the UK & Europe

The Home Brew Shop in Hampshire, England is the new distributor of Hobby Beverage's MiniBrew line of small batch conical fermenters and the MiniMash Lauter Tun. Hobby Beverage ships worldwide, however, European customers can now expect better pricing and faster delivery.
Contact **homebrewshop@btconnect.com** for more information.

calendar

October 8-10
Goodlettsville, Tenneseee
Music City Brew Off

A BJCP sanctioned event. This year's speaker is homebrewing guru Dave Miller, author of *Dave Miller's Homebrewing Guide*. Register online.
Entry Fee: $7
Entry Deadline: 09/24/2010
Phone: (615) 504-7673
Email: bigjohn3957@gmail.com
Web: www.musiccitybrewers.com/brewoff.php

October 16-17
Santa Cruz, California
National Organic Brewing Challenge

A BJCP sanctioned event where organic brewers can compete head-to-head while raising awareness about organic brewing ingredients. Genetically modified ingredients are aiso not allowed.
Entry Fee: $7 first, $5 additional
Entry Deadline: 10/9/2010
Phone: 1-800-768-4409
Email: 7bridges@breworganic.com
Web: www.breworganic.com/Competition/index.html

October 27-30
Fargo, North Dakota
Hoppy Halloween Challenge

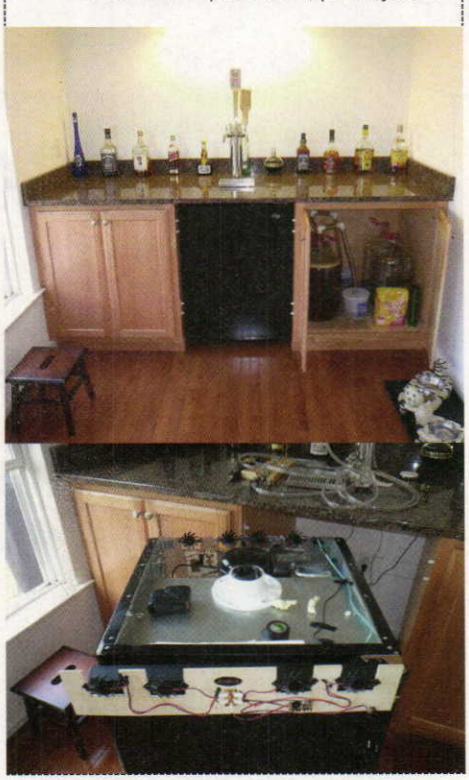
Each October, the Prairie Homebrewing Companions gather together the best homebrew from the best homebrewers to determine who is the 'Great Pumpkin' of brewers. Any beer with characteristics that would identify it as being made for, "and in the spirit of," Halloween is a qualifier for the Halloween Theme Beer category.
Entry fee: $7
Entry Deadline: 10/23/2010
Phone: (701) 467-0126
Email: tjroan@yahoo.com
Web: http://hoppyhalloween.com/

> "I always hated bottling, so I decided to convert my Sanyo to a homebrew kegerator."

homebrew drool systems

Kitchen Kegerator

mike miller • pottstown, pennsylvania



I have had a Sanyo bc1206 Kegerator for a long time. I had done a little homebrewing in college, and my brother recently started brewing, so I figured I would give it another shot.

I always hated bottling, so I decided to convert my Sanyo to a homebrew kegerator. The conversion was actually pretty easy. First I got a new tower and two taps. Then I drilled a third hole, and installed a third tap. I found that I could fit a 5 lb. bottle of CO_2 and three "Cornys" in the Sanyo if I cut one of handles off of one of the kegs.

For a year this worked, but it looked pretty ugly in my kitchen. I had an idea to get two custom cabinets and put the kegerator between them with a false door and a matching granite layer for the top. I wanted the cabinets to match the rest of my kitchen, and luckily the cabinet guy said he could do it for only $1,050!

The whole process took a little more than an hour once we got the cabinets in. It was then I realized, however, I did not allow anywhere for all of the generated heat to go — the granite behind the tower was as hot as a pizza oven. Then I had a great idea: CPU fans! I cut a 1" (2.54 cm) gap in the top and cut a 2.5–3" (6.4–7.6 cm) gap in the bottom of the door to allow for natural air circulation, and bought two 4-fan laptop coolers. I removed the fans and controllers, re-spliced the wires and mounted the fans to the plywood in various locations.

Finally, I attached sheet metal to the back of the wood and used super magnets to attach it to the front door. I got two USB-to-wall-plug adapters and fired the fans up. No heat issues! At the moment they run 24/7 and use only 4 watts, so I am not worried about the power usage. I would like to get a thermometer in there to turn on only when needed, but they are super silent and the controller is nice because you can adjust the speed.

The Little Engine That Could

don darst • salem, oregon

After retiring my trusty stainless steel Glatt grinder after fourteen loyal years, I decided to upgrade with this home-modified mill I built from a Schmidling Bare Bones MaltMill.

I enjoy building my own custom homebrew equipment, and I am an old hot rodder, so when I bought the Bare Bones MaltMill 10" two roller for under $100, I decided to house it in a hot-rodded, 4-cylinder engine block made from ¾" plywood.

Copper sheeting from a metal scrap yard adorns the top and exhaust flange. I used copper pipe for headers and copper tubing for the intake.

After the engine was finished with mill in place the pulley was an eyesore. I drilled 84 racer holes in the spokes and polished it out with my dremel tool. In the inside of the block I cut two boards to create a "V" and nail gunned them in place.

This creates a nice and controlled flow on the outtake. I increased the intake ball valve to a 1" and at 285 rpm, it grinds enough grain for an IPA in under two minutes!

Web extra:

Check out more homebrew equipment, sent in by BYO readers like you! Visit:

www.byo.com/photos/category/4

hop profile CASCADE

Cascade hops are derived from an open pollination of Fuggles (which is, itself a cross between Fuggles and the Russian hop, Serebrianker). They were released to the public in 1972, and became, not surprisingly, especially linked to West Coast brewing, and are the most popular hops in craft brewing to this day. Their great flavor and aroma make them welcome additions to many styles of beers, from pale ales to barleywines. Used for soft bitterness or as a finishing hop, Cascade exhibits distinctive floral, and citrus grapefruit notes, and tend to run in the 4.5 to 7% alpha and beta acid range.

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Email our editors at **edit@byo.com**

beginner's block

"NO BOIL" EXTRACT BEERS

by betsy parks

One of the easiest ways to start homebrewing is by making simple extract beers with liquid malt extract (LME). Making beers with extract eliminates the "mashing" stage of brewing, which shortens the brew day and requires less equipment. And the fastest, simplest way to make an extract beer is by using the "no boil" method.

What is the "no boil" method?

Malt extracts are forms of fermentable and unfermentable sugars extracted from malted barley by dissolving them in water. In other words, all extracts begin as common wort. Most homebrew recipes, whether all-grain or extract, require boiling, because holding the temperature of the wort at 160 °F (71 °C) for 15 minutes should kill any unwanted microbes. Wort also needs to be boiled to extract the bitterness from the hops.

There are, however, hopped liquid malt extracts, which are boiled with hops before they are condensed, so there is no reason to boil it a second time. The no boil method is simply dissolving a hopped liquid malt extract (LME) in hot water, cooling the wort to pitching temperatures and adding the yeast. Eliminating the boiling step also has the benefit of preventing the beer from darkening due to heating the extract.

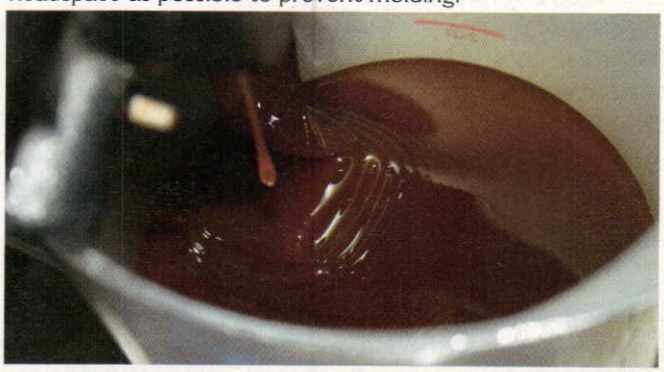
How it's done

Making a no-boil extract beer is much like brewing any extract recipe, only (of course) without boiling. The first step is to clean and sanitize all brewing equipment — just because you don't need to boil doesn't mean you can't introduce new microbes from your brewing environment. When you are ready to brew, start by dissolving the hopped malt extract in 2 gallons (7.6 L) of 180 °F (82 °C) water in a large pot (large enough to hold at least 3 gallons (11 L)). Stir with a sanitized spoon to encourage the extract to dissolve.

When the extract is fully dissolved, check the temperature of the wort. Bring the temperature to at least 160 °F (71 °C) and let it sit for 15 minutes to kill any possible lingering microbes or microbes introduced from your water, equipment, etc. After 15 minutes has passed, cool the wort to yeast pitching temperatures, which can vary from strain to strain, but is often in the 70 °F (21 °C) range. One of the best methods to do this is to chill the wort to a certain temperature, then transfer it to a sanitized fermenter and top it up to volume with cold water to hit pitching temperatures. When the wort is cool enough, pitch the yeast, aerate well and ferment according to the recipe's instructions.

Storing LME

While you can store LME refrigerated for a few months, it's a good idea to keep only as much LME around as you need for each brew. Like all brewing supplies, it is often cheaper to buy extract in bulk, but it's better to buy for your short-term brewing needs rather than store large quantities. When storing any excess LME from a brew day, keep your extract in a sealed container with as little headspace as possible to prevent molding.



Liquid malt extract is basically wort that has been dehydrated to 20% moisture. Brewers later add water back to reconstitute it for brewing.

by marc martin

DEAR REPLICATOR,

I LIVE IN CENTRAL IOWA. WHEN MY WIFE AND I VISIT THE AMANA COLONIES IN IOWA, ONE OF MY FAVORITE THINGS TO DO IS TO VISIT THE MILLSTREAM BREWERY IN MIDDLE AMANA TO ENJOY A PINT OR TWO OF THEIR SCHILD BRAU AMBER LAGER. I'M WONDERING IF YOU MIGHT BE ABLE TO GATHER SOME INFORMATION TO HELP ME TO BE ABLE TO REPLICATE THIS BEER?

DON LARSEN
DES MOINES, IOWA

I grew up in a small farm town in northwest Iowa and a favorite local trip was to visit the Amana Colonies. The Amana Colonies are a group of German Lutheran Pietist settlements that maintained a near self-sufficient local economy for almost eighty years, starting in the mid 1800s. I moved away from Iowa in 1984, and it seems I left the state one year too soon.

Millstream Brewing opened in 1985 as not only the first microbrewery in Iowa but one of the first in the nation. It all started several years before opening the brewery when the founding owner, Carroll Zuber, took a trip through Germany where he visited several small, local breweries. Every beer he tried was better than those he could get back home in Iowa. He thought, "if they can do that in small German towns, so can we." From there the brewery was born.

As for a brewer, Zuber contacted an old acquaintance, Joe Picket, who had run Iowa's last remaining commercial brewery, Dubuque Star Brewing. He was coaxed out of retirement to come to Amana and help get Millstream operational. That first year of business they entered the Great American Beer Festival and picked up a gold medal. Zuber purchased a duplicate gold medal and presented it to Joe. Locals like to tell the story about Joe wearing that medal in the casket at his funeral.

The current owners bought the brewery in 2001. With no experience in brewery operations, Tom and Teresa Albert partnered with brewers Chris Priebe and Aaron Taubman. Today, Tom and Teresa manage the hospitality portion of the business while Chris handles all of the brewery operations. Chris is also a former Dubuque Star Brewery employee from 1993 through 1998. The brewery felt he had great potential and agreed to send him to the Siebel Institute where he graduated in 1997. This year they are celebrating their 25th anniversary.

The Schild Brau Amber Lager is their flagship beer. The name Schild Brau essentially means "shield beer" in German. It can best be categorized as a traditional Vienna style lager. This style was first brewed by Anton Dreher in Vienna in 1841 using a new type of sweet, caramelized malt giving the beer a reddish, copper color and a somewhat sweet, biscuity finish. True to style, Millstream's Schild Brau exhibits a dark copper color with red hues highlighting the fine white head. The achievement of fourteen total medals since 1987 (six gold) and the most recent World Beer Cup gold medal serve as testament of its trueness to style and quality.

Dan, enjoy a pint of Schild Brau at home because now you can "Brew Your Own." For further information about the Millstream Brewing Company and their other fine beers visit the web site www.millstreambrewing.com or call them at 319-622-3672. BYO

Millstream Brewing Company Schild Brau Amber Lager

(5 Gallons/ 19 L, extract with grains)

OG = 1.054 FG = 1.015
IBUs = 16 SRM = 9.6
ABV = 5.0%

Ingredients

3.3 lbs. (1.5 kg) Muntons light, unhopped, liquid malt extract
1.75 lbs. (0.79 kg) light dried malt extract
14 oz. (0.39 kg) Munich malt (20 (L)
14 oz. (0.39 kg) crystal malt (60 (L)
1.5 lb. (0.68 kg) Vienna malt
3.2 AAU Magnum hop pellets (0.25 oz./7g of 12.8% alpha acid) (60 min.)
1.6 AAU Mt. Hood hop pellets (0.25 oz./7g of 6.5% alpha acid) (30 min.)
½ tsp. yeast nutrient (last 15 minutes of the boil)
½ tsp. Irish moss (last 30 minutes of the boil)
White Labs WLP 830 (German Lager) or Wyeast 2206 (Bavarian Lager) yeast
0.75 cup (150 g) of corn sugar for priming (if bottling)

Step by Step

Steep the crushed grain in 2.5 gallons (9.5 L) of water at 152 °F (67 °C) for 30 minutes. Remove grains from the wort and rinse with 2 quarts (1.8 L) of hot water. Add the malt extracts and boil for 60 minutes. While boiling, add the hops, Irish moss and yeast nutrient as per the schedule. Add the wort to 2 gallons (7.6 L) of cold water in a sanitized fermenter and top off with cold water up to 5 gallons (19 L).

Cool the wort to 75 °F (24 °C). Pitch your yeast and aerate the wort. Allow the beer to cool over the next few hours 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 (approx. 10 days). Transfer to a carboy, avoiding any splashing to prevent aerating the beer. Condition for two weeks at 42 °F (5 °C) and then bottle or keg. Allow to carbonate and age for four weeks.

Choosing a Mash

Matching malts and styles

by Betsy Parks

MANY AMATEUR AND PROFESSIONAL BREWERS USE A SINGLE INFUSION MASH REGIMEN TO BREW, BUT THAT DOESN'T MEAN THERE AREN'T MANY OTHER WAYS TO MAKE A GREAT BEER. IN THIS ISSUE, THREE EXPERTS WEIGH IN ON MAKING MASHING DECISIONS FOR YOUR NEXT HOMEBREW.

David Berg, August Schell Brewing Co., New Ulm, Minnesota. David graduated from the American Brewers Guild Craft Brewer's Apprenticeship Program in 1996. He has been the Assistant Brewmaster at August Schell since 2006.

At August Schell, we perform a step mash for all our beers. Generally, we mash in at a temperature in the maltose production range (140–148 °F/60–64 °C). After a rest at this temperature, we will ramp up to the saccharification temperature range (162–168 °F/72–76 °C). Following saccharification, we will ramp up to the mash out temperature (172 °F/78 °C). We use this method as we feel it gives us the best control of yield and fermentability of the wort.

If you want to experiment with different mashing programs at home, make the exact same recipe, changing only the mashing regime. Then you will be able to decide if a more rigorous program is worth the extra effort.

If you are a beginner, obviously, the simplest method to use is going to be an infusion mash. Indeed, it's probably the most common method of mashing even at a professional level, as most brewpubs don't have mash tuns that can be heated.

After you've mastered infusion mashing, try a step mash and perhaps even a decoction mash (be prepared for a long brew day!). Ultimately, you'll need to judge each method on its merits. Does it in fact improve your beer? Only you can determine that.

Whatever method you use, keep your malt in mind. Decoction mashing with highly modified malt may be an exercise in futility. Likewise, infusion mashing undermodified malt will most likely not give you the desired results. Match your method to your raw materials and equipment.

John Palmer is the author of *How to Brew* (2006, Brewers Publications) and a frequent contributor to *Brew Your Own*. By day, John is a metallurgical engineer.

The mash is a tool for converting starches to sugars, and more to the point, it is a toolbox with several different kinds of tools to help you with different kinds of jobs.

Choosing your mash method will depend on the beer style, recipe, and the malts you have. Look at it this way: you can build practically anything with 2x4s and plywood (or American 2-row base malt), but to really build some things particularly well, you need to buy certain materials and specialized tools or you end up wasting time and effort.

Different base malts perform better with different mashing techniques - the malt modification is the key. Well-modified base malts (Kolbach Index of 40-48%) have easily accessible starches, convert quickly and can be mashed using a single temperature infusion. But as the malt modification decreases (<40%), the starches are less accessible and need more specific mashing temperatures to degrade the protein-carbohydrate endosperm and achieve the best conversion.

So for example, if you want to try your hand at a Bohemian Pilsner, you can start out with the highly modified American 2-row and a single infusion mash and produce a wort that probably meets 90% of your goal — a clean, pale-colored wort with good malt flavor. If you want to build that Pilsner even better, then you will want to use German Pilsner malt and perhaps a multiple infusion mash to tweak the fermentability.

Horst Dornbusch is the author of *Prost! The Story of German Beers* (1997, Brewers Publications) as well as *Altbier* (1998) and *Helles* (2000) in the Classic Beer Style series. He is also a longtime contributor to *Brew Your Own*, including writing "Style Profile" from 2002 through 2007.

When I brew, I most often use a multi-step infusion. It makes for a more complex beer; better mouthfeel; best extract efficiency (especially if you allow for good grist hydration at low, high-viscosity dough-in); allows for compensation for variability in malt quality or for complete conversion even with large portions of enzyme-poor or no-enzyme grist components; versatility: allows me to control dry vs. full-bodied finish by varying temps and rest lengths as I ramp up.

The choice of other mash programs is style-driven, fun-driven, or necessity-driven. If there is plenty of time and inclination, a double decoction is a fine way to brew, but it is not necessary if the malt is good. For heavier beers (even British-style brews . . . try it for a barleywine!) I still think decoction with a high starting and a low finishing viscosity at the final decoction gives you the best (malty) flavor and the best extract efficiency. But with the best malts, the flavor difference is only marginal, if it exists at all. Basic rule: The best malt with the simplest mash regimen still makes better beer (always!) than low-quality malt with the most exacting triple decoction mash.

If you want to experiment, homebrewers can play with the same mash variables as do pros: grist-to-water ratio (i.e., mash viscosity); mash pH (Burtonize or acidulate); grist composition for color and flavor (cara-malts; floor malts; dextrin malts; roasted malts; de-husked malts; roasted barley; adjuncts); vary rest temps and times; fiddle with decoction; play with partigyle mashing for wee heavies, standard brews and milds or "two-penny" brews.

If you are new to brewing, choose a style based on your equipment. I don't believe in brew-technical baby talk. Step-mashing, and even decoction, is not that difficult to comprehend. And there are really good instructional books on the market. No need to play dumb. If you've got the hardware, go for it. And as you become more advanced, try all of the mashing styles! BYO

Enzyme Issues

One-way glass and "gushers"

by Ashton Lewis

Q I WOULD LIKE TO MAKE A PINEAPPLE HEFEWEIZEN BUT CAN'T FIND ANY RECIPES USING PINEAPPLE. IS THERE SOMETHING ABOUT THE ENZYMES IN PINEAPPLE (THE ONES THAT MAKE IT A GOOD MEAT TENDERIZER) THAT PREVENT IT FROM BEING A GOOD BEER ADDITIVE? ALSO, I KEG MY HOMEBREWS; I WAS WONDERING ABOUT THE BEST WAY TO BOTTLE SMALL AMOUNTS FROM THE KEG FOR TRANSPORT TO A PARTY WITHOUT LOSING ALL THE CARBONATION IN THE PROCESS? SHOULD I HYPER-CARBONATE PRIOR TO BOTTLING?

STEVE SCHALEKAMP
SEATTLE, WASHINGTON

A I am a little less adventurous when it comes to adding anything but malt, hops, yeast and water to my hefeweizen recipes. Maybe this stems from latent memories of a server explaining to the president of my company that our hefeweizen was flavored with banana liqueur. I am sure if Bobby had discussed the possibility of using pineapple in weizen, he would have been sure our weizen would have had some pineapple puree tucked away in the formulation.

Pineapple does contain the protease bromelain (actually a term used to describe two proteolytic enzymes belonging to the sulfhydryl protease group). The name bromelain comes from the fact that the pineapple is the fruit of a particular type of bromeliad plant. Protease enzymes can cause problems for beer and there is a real history behind this allegation.

Another plant protease is papain, from the papaya fruit. Some brewers used papain in the past to help prevent chill haze, but one of the downsides was a reduction in foam quality. If the beer is pasteurized soon after the addition of papain, the foam damaging results can be minimized; that is if the pasteurization treatment is intensive enough to denature all enzyme present.

I would not shy away from using pineapple, however. If you choose to use canned pineapple you should be free of bromelain because the heat treatment used for canning is far more extreme than that required for enzyme denaturation. Pasteurized pineapple juice could work, or if you want to use fresh fruit you could heat treat your own fresh fruit or juice.

Other fruits with proteolytic enzymes include papaya (the source of papain, the enzyme in most meat tenderizers), figs (source of ficin), and kiwi (source of actinidin). It looks like there is a pattern here . . . tropical fruits often contain proteases.

If you want to take small samples of your hefeweizen mit ananas (weizen with pineapple translated into German at least sounds less frutti tutti) from a keg to another location I would suggest using a growler like those used by so many brewpubs across the country. I personally don't like growlers for anything other than near-immediate use since beer will lose some carbonation, pick up some air and will oxidize relatively quickly after filling. Beer in a growler that was bottled a few days ago is too old for my fussy palate.

If you want to do something different you could buy or build a counter-pressure filler for bottles or buy a very small keg that you can fill under pressure and dispense using a small carbon dioxide bottle like those used for old-fashioned soda bottles.

Q RECENTLY WE STARTED BOTTLING OUR HOMEBREW IN INDIVIDUAL BOTTLES (SAVED FROM MICROBREWS WE DRINK). WE'VE HAD TWO OR THREE BOTTLES SUDDENLY COMBUST, AS IN THE BOTTLE EXPLODES! THEY WERE NOT ALL FROM THE SAME BATCH. DO YOU KNOW WHAT MAY CAUSE THIS AND WHAT WE CAN DO TO AVOID THIS FROM HAPPENING IN THE FUTURE?

WENDY LIN
NEW YORK, NEW YORK

A This question has a rather short, but important answer. Most breweries in the United States use "one-way" glass bottles for packaging. These bottles are lighter in weight compared to returnable bottles and are not intended to be used more than one time. Since the bottle filling and capping process can stress glass bottles, especially these lighter weight types, one-way glass is at greater risk of having bottle failure compared to the heavier returnable type of bottle.

While returnable glass at one time was common in the United States, little if any real use of returnable glass is seen today. There are several reasons for this including logistics of dealing with returnable bottles, the expense of cleaning and preparing for re-use, the unsightly scratches that develop over time and the generic form the bottles usually take. Furthermore, in-line scanners must be used to ensure that damaged glass is not re-used. All of these steps add costs to this type of package. Even European brewers are using more one-way glass because of the marketing advantages to using custom bottles with different shapes and embossed images on the glass surface.

My suggestion is to acquire heavy glass bottles that you know are intended for re-use. At one time this was easy, but today is more and more difficult as the use of returnable glass continues to decline. If you buy new specialty bottles, such as flip-top bottles or champagne bottles with beer bottle sized crown tops, you can use these heavier bottles with little fear of bottle grenades, provided that you have your priming procedures under control.

Q I LAGERED CHARLIE PAPAZIAN'S HEINE/STELLA RECIPE FOR FOUR MONTHS AT AROUND 38 °F (3 °C) IN THE SECONDARY FERMENTER AFTER PRIMARY FERMENTATION COMPLETED (MONITORED BY CHECKING FOR A CONSISTENT GRAVITY READING). I BROUGHT THE SECONDARY INTO THE KITCHEN, COOKED UP THE PRIMING SUGAR (¾ CUP CORN SUGAR), RACKED THE BREW AND SUGAR INTO ANOTHER CARBOY THEN STARTED BOTTLING. AFTER WAITING EIGHT OR NINE DAYS FOR CARBONATION I OPENED A FEW BOTTLES AND THEY WERE ALL "GUSHERS." SHOULD I HAVE WAITED FOR THE BREW TO COME UP TO BOTTLING TEMPERATURE BEFORE ATTEMPTING TO PRIME OR BOTTLE?

TI GEISS
SPOKANE, WASHINGTON

A There are a few things that lead to gushing. The big fear for commercial brewers is getting malt that is made from barley contaminated by *Fusarium* molds. Let me be clear; brewers and maltsters have extremely high standards and the notion of knowingly using raw materials with mold contamination is not practiced. However, during certain conditions, especially very wet seasons or crop years grown after severe flooding has occurred, mold growth can occur and not overtly ruin the crop. Today enzyme-linked immunoassays (ELISA methods) are used to screen crops for the protein products of mold growth.

If you are unlucky enough to brew beer using grain that has been exposed to mold you can have gushers. One thing for the homebrewer to keep in mind is that mold growth can occur in malt after it has left the care of the maltster. This is one reason to prevent mold growth in your malt. Of course you should be more concerned about aflatoxins associated with moldy grain than gushing bottles of beer.

I honestly do not think that this cause of gushing is the most likely cause of your problems. When I think of foaming homebrew, the first thing that comes to mind is overcarbonation, regardless how vigorously the brewer argues

> "When I think of foaming homebrew, the first thing that comes to mind is over-carbonation, regardless of how vigorously the brewer argues that the beer was not over-carbonated."

that the beer was not over-carbonated. Although you may swear the beer was not over-carbonated, I have my reasons for being skeptical. The first reason is that you describe adding ¾ of a cup of priming sugar to your batch of beer. For the past fifteen years I have made the occasional observation that brewing calculations use weight for solid ingredients and volume for liquid ingredients. Adding sugar by volume is an approximate method and one that I wish were not so common, but most homebrewers don't own very accurate scales for weighing small weights so volum ric measures continue to be useful for the homebrewer.

Furthermore, you did not reference the volume of bee you primed. Based upon the round number of ¾ cup I am going out on a limb and betting that your recipe instructed you to add this much sugar before bottling. Perhaps my biggest homebrewing pet peeve is when directions in recipes imply that brewing beer is as simple as mixing and waiting, mixing and waiting, mixing and waiting. I think that you probably had less than 5 gallons (19 L) of beer and that the ratio of sugar to beer was too high.

I have left bacterial contamination for the end because I highly doubt bacterial contamination is the cause of your problem. Why? Well you had gushers after eight days and most bacteria that spoil beer grow very slowly. If your beer tastes/tasted OK, that would further eliminate bacterial growth as the likely problem. BYO

Brew Your Own Technical Editor Ashton Lewis has been answering homebrew questions since 1995. A collection of his columns are available in his book, *The Homebrewer's Answer Book*, available online at www.byo.com/store. Do you have a question for the Wizard? Send it to wiz@byo.com.

California Common

More than Anchor Steam

by Jamil Zainasheff

California common is far from common on store shelves and at brewpubs. While you might find a few different examples with some searching, the most well known example of this style is Anchor Steam. During the California gold rush California common, or "steam beer," was the inexpensive beer of the working class. It was found almost everywhere along the West Coast and was brewed by as many as 25 breweries in San Francisco alone. Over the course of more than 100 years, however, steam beer almost completely disappeared. By 1965, the Anchor Brewery of San Francisco was the only brewery still producing steam beer. It was about to close its doors for good when Fritz Maytag came along to save it and the steam beer that they had been brewing since 1896.

California common has a moderately rich malt character and a dry finish. The malt character is obvious, with bread, toast, caramel and slight graininess, but it is never heavy in flavor or aroma. The hop bittering is quite firm, balancing the beer decidedly bitter, but not overwhelmingly so. In the Anchor example, Northern Brewer hops play a big role. They provide a moderate to high level of woody (some people say rustic or minty) flavors and aromas. The hops also help the beer finish dry and firm. Mouthfeel is medium and can have a slightly creamy feel. The carbonation tends to be higher than the average American ale, around three volumes. While the beer has some subtle, light fruity esters from fermentation, it shouldn't be any more than a trace.

The BJCP uses the classic Anchor Steam to define this style, and that makes it one tough category in which to compete, as the judges are often focused on finding only Anchor Steam. Certainly, you can just try to clone Anchor Steam, but that leaves little room for creativity. It would be better if judges looked for a variant of alt or German lager brewed under late 19th century conditions in California. With that sort of imagination, perhaps there would be more leeway in this category for creativity.

If you do want to brew something similar to the Anchor classic, it is best to focus on a fairly simple recipe. Domestic two-row or domestic pale ale malt plus about 10% of a mid-color crystal malt would be all the grist you would need. Follow that up with Northern Brewer hops, California common yeast from White Labs or Wyeast, fermentation around the mid-60s, and you are all set. Some sources claim that Anchor Steam bears only a passing resemblance to historic steam beer, because historic steam beer was an adjunct-heavy (about a third) beer colored with caramel sugar. While steam beer may have become adjunct-heavy at some later point, it is likely that steam beer during its heyday was all malt, as is Anchor Steam today.

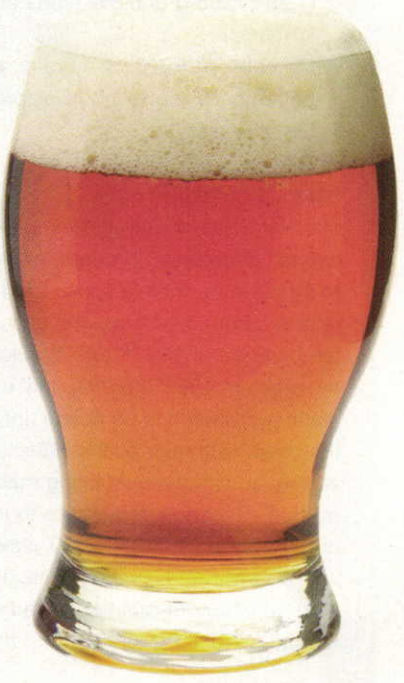
If you want to create your own example of the style, but still do well in competition, the safe thing is to try to play off a characteristic of the Anchor example, such as emphasizing the toasty, biscuit, or caramel character. You can also experiment with different hops, but I would avoid trying to play with the fermentation profile too much, as it is an important part of this style.

Historically, steam beer brewers used the local malt and hops available. In San Francisco, the malt would have been Bay Brewing barley, a six-row barley with plump kernels and low protein said to be similar to domestic two-row today. You have several good options for your base malt: domestic two-row, domestic pale ale, or domestic Pilsner malt. Domestic two-row will give the beer a clean, subtle background malt character. Domestic pale ale malt adds a slightly richer background malt character, somewhat of a

Continued on page 21

california common by the numbers

OG:	1.048–1.054 (11.9–13.3 °P)
FG:	1.011–1.014 (2.8–3.6 °P)
SRM:	10–14
IBU:	30–45
ABV:	4.5–5.5%



Uncommon Common
(5 gallons/19 L, all-grain)

OG = 1.054 (13.3 °P)
FG = 1.016 (4.1 °P)
IBU = 41 SRM = 11 ABV = 5%

Anchor Brewing Company has always been very generous to homebrewers. This recipe makes a beer similar in flavor to Anchor Steam, but a bit bigger in mouthfeel, hops and malt flavors. If you want a beer a bit drier and more like Anchor Steam, eliminate the Munich, Victory and pale chocolate malts.

Ingredients

9 lb. (4.1 kg) Great Western domestic two-row malt (or similar)
17.6 oz. (500 g) Durst Munich malt (or similar)
14.1 oz. (400 g) Great Western crystal malt 40 °L (or similar)
7 oz. (200 g) Briess Victory malt 28 °L (or similar)
1.75 oz. (50 g) Crisp pale chocolate malt 200 °L (or similar)
5 AAU Northern Brewer hops (0.77 oz./22 g of 6.5% alpha acids) (60 min.)
8 AAU Northern Brewer hops (1.23 oz./35 g of 6.5% alpha acids) (15 min.)
8 AAU Northern Brewer hops (1.23 oz./35 g of 6.5% alpha acids) (1 min.)
White Labs WLP810 (San Francisco Lager) or Wyeast 2112 (California Lager) yeast

Step by Step

Mill the grains and dough-in targeting a mash of around 1.5 quarts of water to 1 pound of grain (a liquor-to-grist ratio of about 3:1 by weight) and a temperature of 150 °F (66 °C). Hold the mash at 150 °F (66 °C) until enzymatic conversion is complete. Infuse the mash with near boiling water while stirring or with a recirculating mash system raise the temperature to mash out at 168 °F (76 °C). Sparge slowly with 170 °F (77 °C) water, collecting wort until the pre-boil kettle volume is around 5.9 gallons (22.3 L) and the gravity is 1.046 (11.4 °P).

The total wort boil time is 60 minutes. Add the bittering hops as soon as the wort starts boiling. Add the second hop addition and Irish moss or other finings with 15 minutes left. The last hop addition goes in 1 minute before the end of the boil. Chill the wort rapidly to 62 °F (17 °C), let the break material settle, rack to the fermenter, pitch the yeast and aerate thoroughly. The proper pitch rate is 2.5 packages of liquid yeast or 1 package of liquid yeast in a 3-liter starter.

Ferment at 62 °F (17 °C) until the beer attenuates fully. With healthy yeast, fermentation should be complete within a week, but do not rush it. Rack to a keg and force carbonate or rack to a bottling bucket, add priming sugar, and bottle. Target a carbonation level of 2.5 to 3 volumes.

Uncommon Common
(5 gallons/19 L, extract with grains)

OG = 1.054 (13.3 °P)
FG = 1.016 (4.1 °P)
IBU = 41 SRM = 11 ABV = 5%

Ingredients

5.5 lb. (2.5 kg) light liquid malt extract
1 lb. (440 g) Munich liquid malt extract
14.1 oz. (400 g) Great Western crystal malt 40 °L (or similar)
7 oz. (200 g) Briess Victory malt 28 °L (or similar)
1.75 oz. (50 g) Crisp pale chocolate malt 200 °L (or similar)
5 AAU Northern Brewer hops (0.77 oz./22 g of 6.5% alpha acids) (60 min.)
8 AAU Northern Brewer hops (1.23 oz./35 g of 6.5% alpha acids) (15 min.)
8 AAU Northern Brewer hops (1.23 oz./35 g of 6.5% alpha acids) (1 min.)
White Labs WLP810 (San Francisco Lager) or Wyeast 2112 (California Lager) yeast

Step by Step

Most Munich liquid malt extract (LME) is sold as a blend of Munich and Pilsner or two-row malts in different percentages. I specify 100% Munich LME in my recipe so you will know how much of your blend to use for your brew. When using a blend, replace the Munich extract in the recipe and enough of the two-row extract to match the percentage of the blend. If you want to use 100% Munich extract, the only current supplier I am aware of is Weyermann. If you cannot get fresh liquid malt extract, it is better to use an appropriate amount of dried malt extract (DME) instead.

Mill or coarsely crack the specialty malt and place loosely in a grain bag. Avoid packing the grains too tightly in the bag, using more bags if needed. Steep the bag in about 1 gallon (~4 liters) of water at roughly 170 °F (77 °C) for about 30 minutes. Lift the grain bag out of the steeping liquid and rinse with warm water. Allow the bags to drip into the kettle for 15 minutes while you add the malt extract. Do not squeeze the bags. Add enough water to the steeping liquor and malt extract to make a pre-boil volume of 5.9 gallons (22.3 L) and a gravity of 1.046 (11.4 °P). Stir thoroughly and bring to a boil.

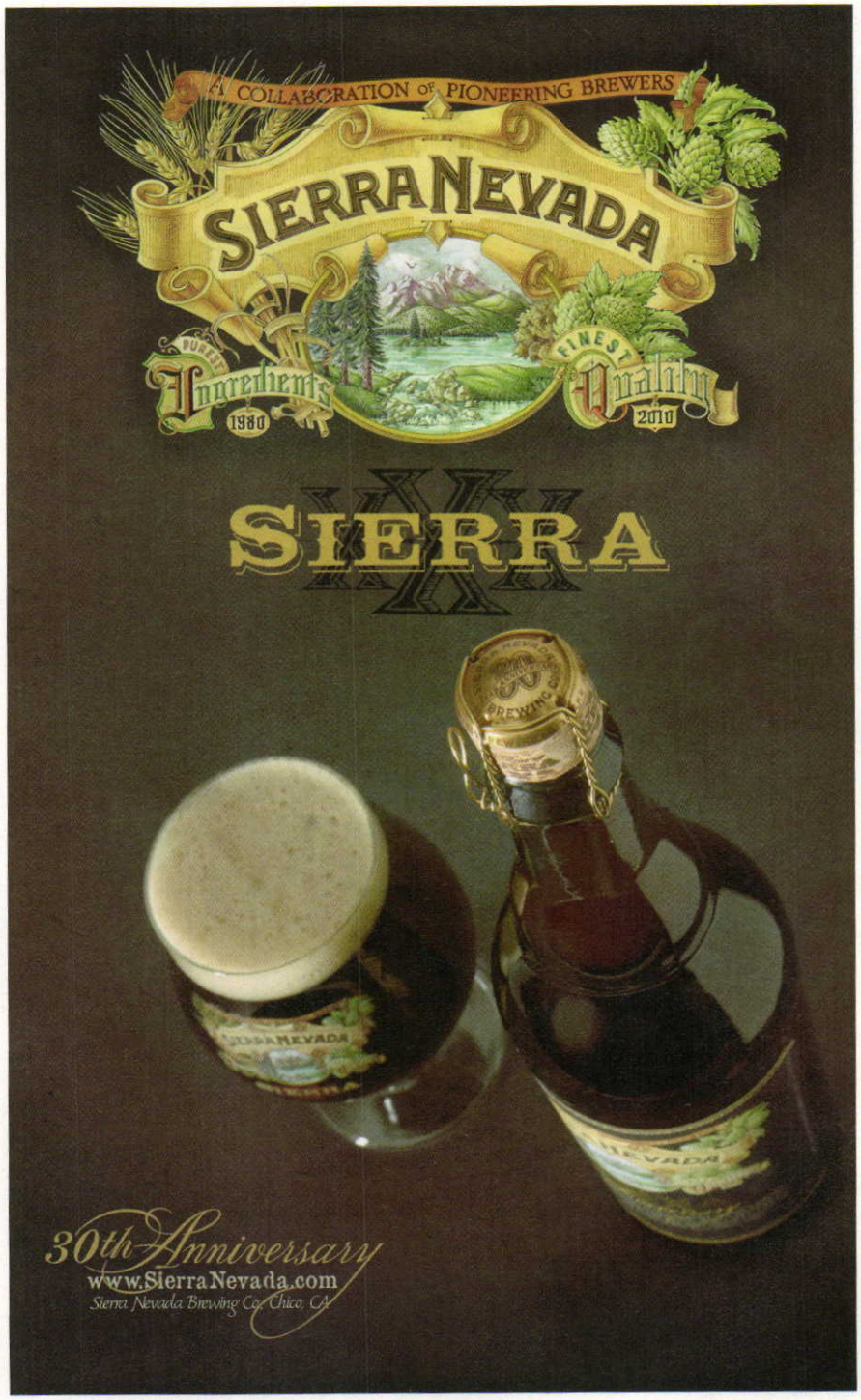
The total wort boil time is 60 minutes. Add the bittering hops as soon as the wort starts boiling. Add the second hop addition and Irish moss or other finings with 15 minutes left. The last hop addition goes in 1 minute before the end of the boil. Chill the wort rapidly to 62 °F (17 °C), let the break material settle, rack to the fermenter, pitch the yeast and aerate thoroughly. The proper pitch rate is 2.5 packages of liquid yeast or 1 package of liquid yeast in a 3-liter starter.

Ferment at 62 °F (17 °C) until the beer attenuates fully. With healthy yeast, fermentation should be complete within a week, but do not rush it. Rack to a keg and force carbonate or rack to a bottling bucket, add priming sugar, and bottle. Target a carbonation level of 2.5 to 3 volumes.

light bready, biscuit note. Pilsner malt lends a grainy malt character. You can use one of these base malts exclusively or blend them in any proportion you wish. I always thought ⅓ of each would work well for this style, giving it a slightly enhanced biscuit and grainy character, although I have never had a chance to try it. You can also bump up the background malt character of the beer with 10% or so of Munich or Vienna malt, which adds a subtle bready fullness. Extract brewers can use a light-colored extract and blend in English, Munich or Pilsner extract, but it is acceptable and easier to use a light extract with specialty grains instead. All-grain brewers can use a single infusion mash and should target a mash that will leave enough long chain sugars in the beer to help fill out the body. A temperature around 150 to 154 °F (66 to 68 °C) creates wort with a nice balance between fermentable and non-fermentable sugars. Use a lower temperature when using lower attenuating yeasts or higher starting gravities. Use a higher temperature when using higher attenuating yeasts or making lower gravity beers. Anchor's mash schedule is a secret, although reportedly it starts at 140 °F (60 °C). Historical steam beer brewers supposedly used a mash temperature of 158 °F (70 °C). If you are trying to copy the Anchor example, I would start at 140 °F (60 °C) and then raise the mash for a rest at 158 °F (70 °C).

The only specialty malt you really need for California common is crystal malt. You want to build a gentle but clearly evident caramel flavor and color. Use a mid-color crystal malt between 30 and 70 °L for up to 10% of the grist. If you want to develop more of a toasty/biscuity character, you can add a small percentage (< 5%) of toasted malts, such as Victory, biscuit or even pale chocolate. Pale chocolate (200–250 °L) imparts a more intense dark toasty note, which I like in this beer. If you use pale chocolate, keep it to a minor addition, around 1%. Stay away from malts darker than pale chocolate or use them in only the tiniest of amounts for color correction, not flavor. You do not want a roast character to come through in the beer. In general, keep the total of all specialty grain additions to less than 15%.

While there are some examples out there that use other hop varieties, making a beer similar to Anchor Steam requires Northern Brewer hops. If you want to experiment, avoid highly citrusy or fruity hops as they will overshadow the fermentation character, which is so important to this style. Finding other hop varieties that fit a judge's vision of California common can be tough. You will want to look for varieties that give a woody, earthy, or perhaps a spicy hop character. I have always thought Spalt would work well, with its interesting spicy and somewhat rustic character. You might also experiment with Cluster, Nugget, Perle, Santiam, Tettnanger or Liberty. Historically the hops would most likely have been California-grown Cluster hops.



When it comes to hop quantities, go bold on the flavor and aroma additions. It shouldn't be overwhelming and turn into an IPA, but the hop character, along with hop bittering, should be full and readily apparent to the drinker. For flavor and aroma, add two or three later additions around ¼ to ½ oz. per gallon (1 to 3 g/L). You can go lighter or heavier, just keep in mind the overall character you are trying to build. Target a bitterness-to-starting gravity ratio (IBU divided by OG) of 0.6 to 1.0.

While the original steam beer brewers did not have refrigeration, they did have a cool marine environment and took advantage of it by using large, very shallow, open fermenters to hold down fermentation temperatures. They also selected a yeast that gave good results at warmer temperatures. So it is no surprise that the key to making a great California common is using the proper yeast at the proper temperature. This will give the beer just the right profile, with a subtle fruity note and a dry finish. Many people wonder if the California common and altbier yeasts available today are really lager or ale yeasts. Chris White at White Labs told me that their WLP810 San Francisco Lager strain is a true lager yeast and that their alt strains are true ale yeasts. Even though most brewers today choose to ferment California common with a lager yeast, that does not mean historically the beers were fermented with a true lager strain. Perhaps an alt or Kölsch yeast would work well, given the possibility that altbier brewing was the genesis for the style. Some recipes suggest using various lager yeasts, but those that I have tried in the past just do not seem to produce the right character as well as a bit too much sulfur. The best choice if you want to produce something like Anchor Steam is White Labs WLP810 San Francisco Lager or Wyeast 2112 California Lager. Anchor ferments Anchor Steam in large, shallow, open fermenters housed in clean rooms supplied with sterile-filtered San Francisco air. The special fermenters allow the heat of fermentation to dissipate and hold the beer temperature lower than a tall cylindroconical fermenter under the same conditions. The few times I have looked into the fermentation room, the ambient temperature was in the range of 64 to 67 °F (18 to 19 °C). You might experiment with open fermentation as well, but when using a homebrew-sized closed fermenter, I find a fermentation temperature of 62 to 64°F (17 to 18°C) gives the best result. Follow that up with a month of cold conditioning and carbonation approaching three volumes and it will help you come a little closer to matching that wonderful Anchor classic. BYO

Jamil Zainasheff is host of "Can You Brew It," a show about cloning commercial beers and "Brew Strong," a show that answers technical brewing questions. Both are on the Brewing Network (www.thebrewingnetwork.com).

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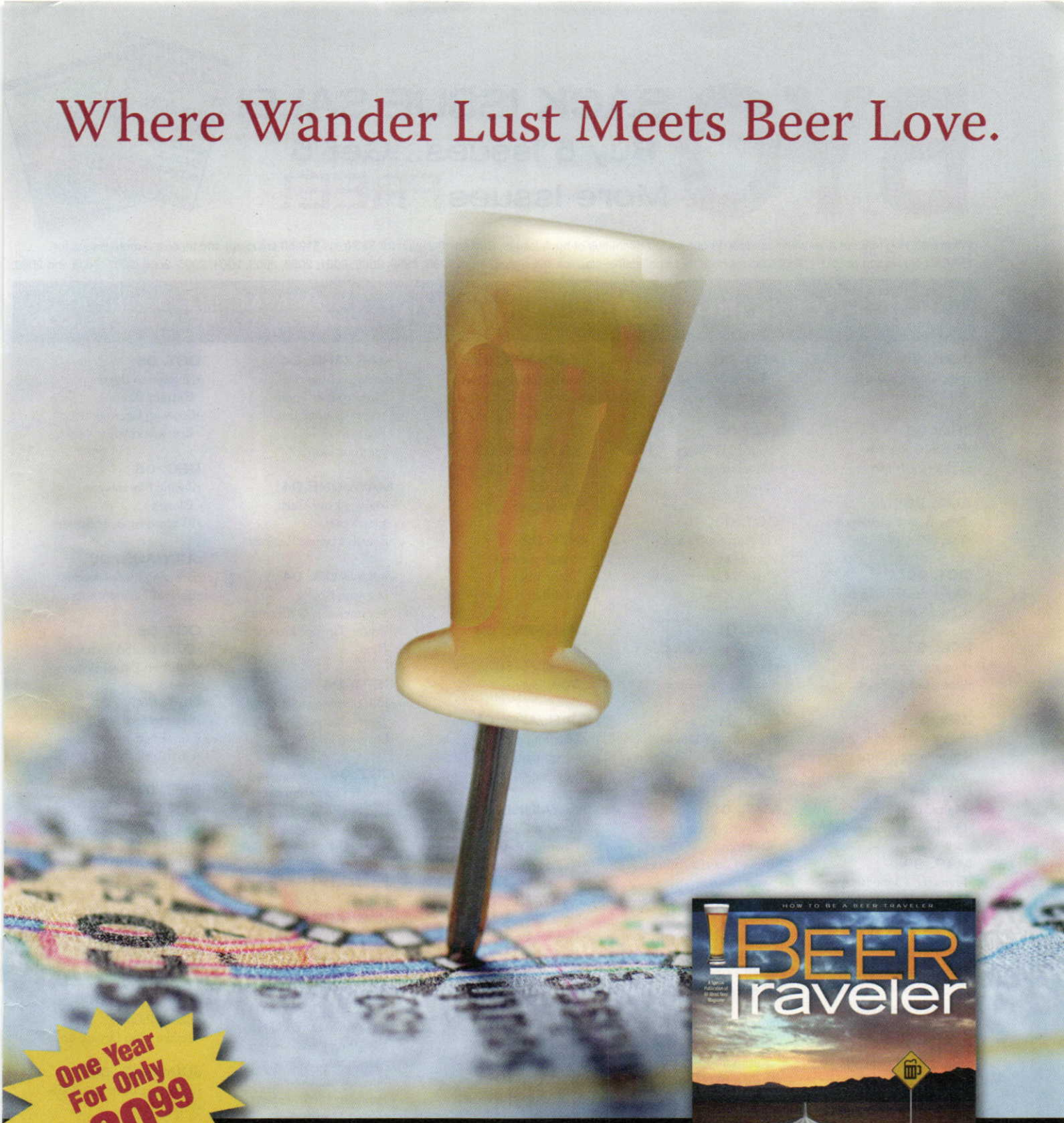

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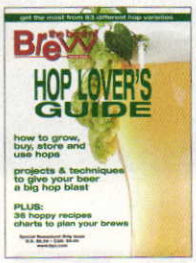

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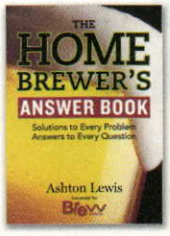

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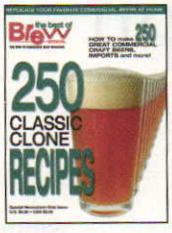

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Fire kilning and smoking of malt at Schlenkerla malting and brewery in Bamberg, Germany.

Photos courtesy of Schlenkerla

RAUCHBIER:
Brewing "Liquid Bacon"

Story by **Horst Dornbusch**

The historic Schlenkerla tavern, renowned for Aecht Schlenkerla Rauchbier.

Rauchbier is German for smoked beer, a smoky-tasting, barley-based, opaque and usually unfiltered lager that is brewed similar to a Märzen/Oktoberfest beer, which means it contains between five and six percent alcohol by volume and is well-lagered. Rauchbier-making has been a tradition in Bavaria ever since the Middle Ages, especially in Bamberg, a city in the region of Franconia. In those days, moist green malt was kilned over open fires, whereby the combustion gases of the kiln's fuel — usually wood, charcoal, coal or coke — dried the malt. Therefore, it stands to reason that all beers must have had a smoky flavor. In that sense, rauchbier, though an exotic specialty brew nowadays, was an everyday brew in a bygone era.

Most English-speakers seem to have some trouble with the German pronunciation of the "ch" in rauchbier. Between the "rau," which is pronounced like "cow" but with an initial "r," and the end syllable "beer" for "bier," the "ch" sound resembles not the English "sh" sound, but the throaty "x" sound in the word "Mexico," when that country's name is pronounced by a native speaker.

Today, most rauchbiers are made from "clean," un-smoked base malts, plus up to 30 percent two-row smoked malt that is still kiln-dried the old way over beech wood logs that have been seasoned for months, even years. This

SMOKE YOUR OWN

Most homebrewers also like to grill or barbecue. If this is the case for you, you can easily acquire the few extra attachments and devices needed to turn your grill or smoker into a malt smoking device. All you really need is some screen door material (available at any hardware store) cut to fit the size of the grates on your smoker and a spray bottle to mist the malt with water. If you have an accurate scale that weighs up to several pounds in increments of quarter ounces (5 g) or less, that is a big plus. Check to see that the screen material isn't painted or coated with anything.

The basic idea behind smoking malt is that you wet it slightly, then expose it to smoke. The smoke dissolves into the water, then gets attached to the malt when the water is dried from the heat of the fire.

Wood

Any type of wood used in barbecuing can be used to smoke malts. Beech is the wood used to smoke the malts for classic rauchbiers, but hardwoods such as alder, hickory, mesquite, cherry, pecan, oak and apple can also be used. Barbecue supply stores sell cured hardwoods of all types. Do not use soft woods, such as pine, scrap lumber, plywood or scraps of kindling from destroyed furniture.

Preparation

To prepare for smoking your malt, you should weigh out the malt you are going to smoke and record this weight. Fill your spray bottle with water that has been carbon filtered. Chloramines in water will react with the phenols in smoke to add nasty, band-aid like flavors to your smoked brews if you don't. Take a chunk or two of hardwood and soak it in water for at least two hours, but preferably overnight. If you remember, take the wood out of the water a few hours before you use it.

Smoking

One of the easiest ways to smoke your own malt is to piggyback your malt smoking session at the end of some grilling or smoking you had planned. The ideal temperature for smoking malts is fairly low, so you can easily grill or smoke some food first, then use the dwindling coals as a heat source for smoking the malt. So, build your fire — from hardwoods or charcoal — as you usually would and grill or smoke your food. When you get done, close the air vents almost all the way while you eat.

Once you're ready to start smoking, check the temperature of the smoker. The absolute ideal for smoking malts is fairly cold, around only 100 °F (38 °C). But it can be hard to maintain a temperature that low on a home smoker for any length of time. In reality, anything up to 185 °F (85 °C) will

work very well and this is only slightly cooler than the temperature most meats are smoked at (225–250 °F/107–121 °C).

Open or close the vents on your smoker to bring the temperature into the right range and place the soaked chunk of hardwood on the coals. Place the screen door material over the grates on your smoker and get ready to smoke the malt.

Once you are ready to go, you'll want to quickly wet the malt, weigh it (to see how much water it picked up) and place it on the smoker. For very smoky malt, you'd want to add quite a lot of water and smoke for a long time. For less smoky malt, you would add less water and smoke for less time. The first time you try this, the latter is the better option for several reasons. A smaller amount of water takes less time to dry and undersmoked malt is vastly preferable to oversmoked malt (which may also be overly darkened from the heat). More importantly, if you add a lot of water and don't completely dry the malt, you will almost certainly end up with moldy malt.

A light spraying of the malt leaves a coating of water on the surface, but not so much that it really soaks in. This layer of surface liquid dries quickly and — if your hardwood chunk is smoking nicely — you get some nicely-smoked malt without too much effort.

Smoke only as much as will fit on the screen material to a depth of roughly two kernels. (If you have a grill or smoker the size of a Weber grill, this is about 2.0 lbs./0.91 kg). Place the malt in a bucket and spray it with 1–2 oz. of water per pound of grain (30–60 mL/kg). Swirl the malt with your hands briefly to distribute the water as evenly as possible, then place it on the screen material in the smoker. Smoke for at least a half hour, then check the malt. If it seems fairly dry, weigh it. When the malt is nearly down to its initial weight, finish drying it in an oven at low heat (preferably under 200 °F/93 °C). When done, place the malt in a paper shopping bag and let it sit for at least a few days.

- Chris Colby

process of smoked malt-making is similar to making Scotch whiskey malt over peat moss. Beech is a hardwood tree and grows in abundance in Franconia. The smokiness from the beech wood imparts a bacony flavor to the beer. Rauchbier is brewed and aged similar to an Oktoberfest beer, but the color is deeper, in some versions almost black. On the color scale, rauchbier usually ranges between 20 and 30 SRM (approx. 50 to 80 EBC), though some rauchbiers may be as light as perhaps 10 SRM (25.3 EBC), while others may be a bit darker than most. In the name of authenticity, I prefer the darker versions because malts from medieval kilns were very uneven in color, with a good portion of the kernels very dark or even slightly scorched.

In the Middle Ages, prior to the Bavarian summer brewing prohibition decreed by Duke Albrecht V in 1553, rauchbier was probably an ale in the heat of summer, when top-fermenting yeasts would be dominant in the open fermenters then in use; it was probably a lager in the cold of winter when top-fermenting yeast would go dormant and only bottom-fermenting yeasts would still work. Today, with managed yeast strains, rauchbier is always a lager in Bavaria, while it is sometimes an ale in North America. (You can, for example, brew the rauchbier recipe in this article at ale fermentation temperatures, using a clean ale yeast, and get a beer that tastes similar to a smoky altbier.) Because of the strong, bacony smoke-flavor, the beer does not require aroma hops, just a dose of bittering hops. Bavarian noble hops such as Hersbrucker or Hallertauer are traditional. In the recipe presented here, I use Hallertauer Tradition at an average alpha-acid content of 5.5 percent. In modern commercial rauchbiers, bitter values may range widely, from 15 IBU to more than double that amount.

Schlenkerla: The Very Model of a Modern Major Rauchbier

Perhaps the Mecca of all rauchbier pubs is the Brauereiauschank Schlenkerla at Number 6 Dominikanerstrasse, in the cobblestoned old-town section of Bamberg. This venerable drinking establishment used to be a medieval brewpub known as Zum Blauen Löwen (At the Blue Lion). Its oldest known mention is in a document dating from 1405. Schlenkerla is one of the few breweries left in Germany — or anywhere — that still does all of its own malting. Its brew is called Aecht Schlenkerla Rauchbier. The word "aecht" is Franconian vernacular for "real" or "original," which is very fitting, because Schlenkerla is unique among rauchbiers in that it is the only one made from 100 percent smoked malt! It has an alcohol level by volume of 5.1% and is considered the gold stan-

Schlenkerla is one of the few breweries in the world to still malt their own barley. Kilned over beechwood, their smoked malt lends a distinctive bacon-like character to their beer. The grist for Schlenkerla is 100% smoked malt.

dard for modern rauchbiers.

The word "Schlenkerla" is local slang for a person who swings his arms while shuffling along with the lumbering gate. The patrons of the Blue Lion affixed that nickname to one of the pub's former owners and brewmasters, Andreas Graser, who took over this classic Bamberg watering hole in 1877. Soon the people began using the publican's epithet as a synonym for both the tap room and the smoky brew he dispensed there. Today, the Schlenkerla brewery is owned by the Trum family, and its official legal name is Heller-Bräu Trum KG. The Schlenkerla brew house and fermentation cellars are no longer inside the pub, but a short walk away, also in the old town of Bamberg. These production facilities, however, are not open to the public.

To many people, rauchbier is an acquired taste. There are those who love it and those who hate it. Few people seem to be indifferent to the style. As an accompaniment to food, rauchbier is excellent with smoked cheeses, smoked pork or smoked sausages. It is also is an ideal marinade for a pork roast or a leg of lamb. Try using it as a basting liquid for summer BBQs.

Smoked Malts

The signature smoky flavor of most rauchbiers in the entire world comes from Weyermann® Rauchmalz (smoked malt; 2 to 3.5 °L) that is made by the Weyermann® Malting Company of Bamberg, located only a half hour's walk from the Schlenkerla pub in the old town, past the old 1386 city hall in the middle of the

RECIPES

Rauchbier

(5 gallons/19 L, all-grain)

OG = 1.051 (12.75 °P)
FG = 1.012 (3 °P)
IBU = 20 SRM = 32 ABV = 5.2%

Ingredients

6 lb. 11 oz. (3.0 kg) Weyermann® Munich I malt
3 lb. 2 oz. (1.4 kg) Weyermann® Rauchmalz (smoked malt)
14 oz. (0.41 kg) Weyermann® Caramunich® II malt
5 oz. (0.14 kg) Weyermann® Carafa® Special Type I malt
5 oz. lbs. (0.14 kg) Weyermann® Acidulated malt
5.2 AAU Hallertauer Tradition hops (60 mins)
(1.0 oz./28 g of 5.2% alpha acids)
Bavarian-style lager yeast
1 cup corn sugar (for priming)

Step by Step

Mash in with approximately 3.5 gallons (13 L) of brewing liquor at 140 °F (60 °C). (Brewing liquor should be carbon filitered or treated with 1 Campden tablet per 20 gallons (76 L) to remove chloramines.) Rest the mash for 20 minutes. Apply heat to raise the mash temperature to 147 °F (64 °C) for a beta-amylase rest of another 20 minutes. Raise the mash temperature to 162 °F (72 °C) for an alpha-amylase rest of about 30 minutes. Finally, raise the temperature to the mash-out temperature of 172 °F (78 °C). Recirculate the run-off for perhaps 10 minutes. Sparge for about 90 minutes. Stop the sparge when the kettle gravity reads about OG 1.045 (11.25 °P). Boil the wort for 75 minutes. Add the bittering hops at 15 minutes into the boil.

At shut-down, take a gravity reading and, if necessary, liquor the wort down to the target OG of 1.051 (12.75 °P). Whirlpool for about 30 minutes. Then heat-exchange the wort to the selected yeast's temperature range — usually around 50 °F to 54 °F (10 °C to 12 °C). Ferment the brew at this temperature until complete, about 14 days. Rack and lager it for at least another 14 days at a temperature as close to 34 °F (1 °C) as possible. Longer lagering, up to about one month, makes the beer taste smoother. Rack the brew again. Then prime it for bottle conditioning or force carbonate it with CO_2 in the keg.

Rauchbier

(5 gallons/19 L, partial mash)

OG = 1.051 (12.75 °P)
FG = 1.012 (3 °P)
IBU = 20 SRM = 32 ABV = 5.2%

Ingredients

5.0 lbs. (2.3 kg) Bavarian Amber LME
2 lb. 8 oz. (1.1 kg) Weyermann® Rauchmalz (smoked malt)
14 oz. (0.41 kg) Weyermann® Caramunich® II malt
5 oz. (0.14 kg) Weyermann® Carafa® Special Type I malt
5 oz. lbs. (0.14 kg) Weyermann® Acidulated malt
5.2 AAU Hallertauer Tradition hops (60 mins)
(1.0 oz./28 g of 5.2% alpha acids)
Bavarian-style lager yeast
1 cup corn sugar (for priming)

Step by Step

Crack the rauchmalz and specialty grains (44% of the grain bill, by weight) and place them in a large steeping bag or several smaller steeping bags. Mash the grains for about 45 minutes in about 5.5 qts. (5.2 L) of brewing liquor at about 152 °F (67 °C). Rinse the bags or sparge the grain bed (depending on your partial mash setup) with 170 °F (77 °C) water and collect approximately 12 qts. (11 L) of wort. Add water to your kettle to make the largest pre-boil volume you can manage. Heat this wort to a boil. Once boiling, turn off the burner and stir in roughly half of the liquid malt extract (or all of it if you are performing a full-wort boil). Bring the mixture to a boil again. Boil for 60 minutes, adding bittering hops at the beginning of the boil. Add remaining malt extract (if any) for the final 15 minutes of boil. Cool wort and transfer to a fermenter. Top up to 5 gallons (19 L), if needed, and aerate wort. Pitch yeast. See the all-grain recipe for fermenting and conditioning instructions.

The classic rauchbier is a smoked Märzen/Octoberfest style lager. But other styles of beer, such as bocks (pictured here) and weizens, are also produced in smoked versions. In North America, smoked porters are popular.

River Regnitz.

Peat-smoked malt is available in many homebrew shops, but it is not the right type of smoked malt to use in a rauchbier. Peat-smoked malt is much more intensely smoky and the peat smoke has a different character than beechwood-smoked malt. A small amount of peat-smoked malt (1–3% of the grist) can be used in porters or other strongly-flavored beers, but for the "bacony" flavor of rauchbier, use rauchmalz.

The recipe in this article (see page 31) is for a classic rauchbier in the traditional Märzen/Oktoberfest style. It is similar to Schlenkerla, but not meant to be a clone of that beer. (Schlenkerla uses 100% rauchmalz, which they malt themselves.) For depth of color and some hefty body and mouthfeel, I selected Weyermann® Munich I (approximately 6 °L) as a base malt (57%). For some nuttiness and additional body, I selected about 10 percent Weyermann® Caramunich® II (42 to 49 °L). For darkness and just a touch of roastiness, I added about three percent de-husked Weyermann® Carafa® Special Type I (300 to 375 °L).

It is preferable to use a de-husked roasted malt for rauchbier, because it contributes color without any phenolic, acrid, burnt flavors that are normally associated with black patent malt, for instance. Such harsh notes would be in conflict with the dominant, smooth and bacony beech wood smoke flavor from the rauchmalz.

Finally, I added three percent Weyermann® Acidulated Malt (1.7 to 3.2 °L) to the mash. This specialty malt

serves as a substitute for an acid rest, a step that was common in the mashes of medieval times in Bavaria.

For hops and yeast, there are no surprises. Any German-style noble hops will do, as well as any authentic Bavarian lager yeast.

Other Smoked Styles

Any beer style can be brewed with rauchmalz substituted for part of the grain bill to make a smoky version of that style. Smoked bocks and weizens are brewed in Bamberg for example. In North America, smoked porter is the most common of the smoked beer styles, but there are many others. Although the term "rauchbier" simply means smoked beer, other smoked beers are generally not called rauchbiers, as that term is usually reserved for the Märzen/Octoberfest based brew. (The BJCP, for example, categorizes other smoked beers in a separate sub-category from classic rauchbier.)

Whatever you call your smoked beer, when writing and tweaking your recipe, balance should be the goal. The smoke character should enhance the beer's flavor, not obscure it. Conversely, if you are going to add the label "smoked" to your beer, it should contain enough rauchmalz (or peat-smoked malt) to give the beer a recognizable smoked character.

Process

The smoky character of a rauchbier comes from the rauchmalz, not anything you do on brew day. As such, brew your rauchbier as you would any lager. Though obviously decocted in days gone by, rauchbier is now usually made by a multi-step infusion process. You can also perform a single infusion mash. For all extract brewers, there is an unhopped Weyermann® Bamberg Rauch liquid malt extract on the market. Do not attempt to use liquid smoke to add or touch up the smoke character in your beer. Once the beer has aged, enjoy the beechwood smoke character and perhaps a little taste of brewing history. BYO

Horst Dornbusch is a frequent contributor to Brew Your Own.

Extract Brew Day
a pictorial guide

story and photos by **Forrest Whitesides**

Whether you are just starting with homebrewing, have been brewing for awhile and are curious how others do it or are planning to teach a friend to brew, a picture can be worth a thousand words. If you don't belong to a brew club or otherwise have the opportunity to sit in on a fellow brewer's brew day, here's your chance. In this pictorial guide to an extract brew day, we outline — step by step — one tried and true way to brew beer using malt extract. (Actually, two ways — we include both the "partial boil" method and boiling the full-wort.) Let this outline be your guide to planning, or perhaps refining, your extract brew day.

To get the brew day started, you need two main things: equipment and ingredients.

Brew Day Equipment

REQUIRED
- Kettle (16-qt/16-L minimum)
- Heat Source
- Stirrer
- Thermometer
- Hydrometer
- Racking cane
- Primary fermenter
- Airlock
- Sanitizing agent

OPTIONAL (but recommended)
- Wort chiller
- Racking cane and tubing OR a large funnel
- Hop straining bags
- Measuring cup
- Scissors
- Pliers or channel locks

Most folks start off with a "beginner" equipment kit from a homebrew supplier, so the above required (and some optional) items are almost certainly covered by the kit. The standout exception is generally the kettle, which you will need to buy separately.

Ingredients

- Water
- Malt extract — dried or liquid
- Hops — pellet, plugs or whole leaf
- Yeast — dried or liquid
- Steeping grains (optional)
- Spices/flavorings (optional)
- Irish moss (optional)

Always check that you have the proper ingredients before you begin the brew day.

A batch of beer fermenting happily the day after the yeast was pitched.

Step 1: Collect and Heat the Water

Each brew day starts with water. If your tap water tastes good to you, then use it. If not, filter the tap water or buy water that is already filtered. The cheapest way to go when buying is to get store-brand filtered water in 3-gallon (11-L) or larger containers.

Collect enough water to account for losses during the boil and for volume left behind in the kettle when the finished, cooled wort is transferred to the fermenter. The target batch volume is 5 gallons (19 L), so you'll need to start with about 7 gallons (26 L) of water. Some volume will be lost through evaporation during the boil, some will be retained in the grains and hops, and some will be lost when transferring to the fermenter.

Partial Boil If you are boiling indoors on a stovetop, start with about 2.5 gallons (9.5 L) of water in the kettle. This

Boiling less than the full amount of wort is called a partial boil.

is called a partial boil. All but the most industrial stovetop burners will struggle to get more than 3 gallons (11 L) of water to boil in a remotely reasonable amount of time. Most beginners will start with a smaller kettle (16 or 20 quarts/15 or 19 L) and a partial boil because it requires less equipment and the smaller kettles are cheaper and easier to source locally.

Full Boil For outdoor, propane-fueled brewing, start with about 6 gallons (23 L) of water in the kettle. This is called a "full boil." If you have a little extra cash in your brew gear budget, I highly recommend you acquire an inexpensive turkey fryer setup (approximately $75), which will have a 7- or 8-gallon (26- or 30-L) kettle and a

propane burner on a sturdy stand. Of course, the larger boil volume will also necessitate the purchase of a wort chiller. (Do not attempt to use a propane burner indoors; apart from the fire hazard, carbon monoxide is a combustion byproduct. Use propane only in an open, non-enclosed area with adequate ventilation.)

Start heating the water. It will take a while (half an hour at least, and perhaps a good deal longer) to bring the water to a boil.

Step 2: Add the Steeping Grains

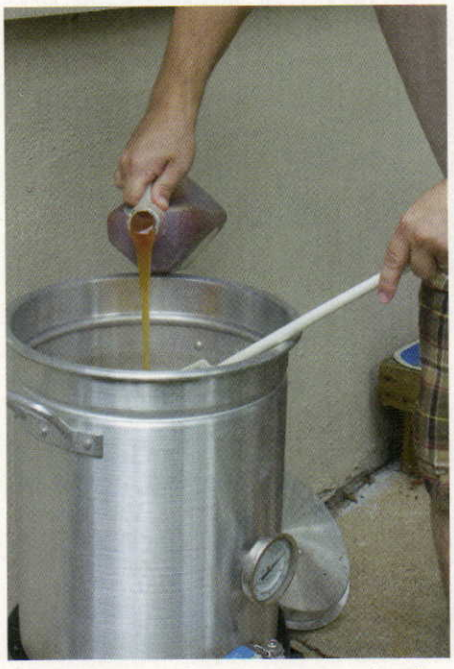
If your kit contains steeping grains, put the grains in a straining bag. If your kit does not call for steeping grains, you can skip to the next section.

Begin steeping the grains when the water temperature reaches approximately 140 °F (60 °C). Remove the steeping grains when the temperature reaches approximately 170 °F (77 °C) or after about 20 minutes, whichever comes first. Leaving the grains in too long (or when the water is too hot) can sometimes cause tannin extraction, which may result in off flavors in your finished beer. (If you do experience astringency, you can also steep the crushed grains in a smaller volume of water, then add the "tea" to the brewpot.)

The crushed grains are placed in a bag and steeped as the water heats.

Step 3: Add the Malt Extract

When the water temperature has reached approximately 180 °F (82 °C), begin adding the malt extract. With liquid extract, use a large spoon or stirring rod to stir the water continuously as you pour in the extract. Pay careful attention that it doesn't pool up on the bottom of the kettle. The direct heat from the burner on the bottom of the kettle can cause the extract to scorch. This is a bigger issue with a partial boil than with full boil. Keep the stirring action going until all the extract is dissolved. If you are using dried malt extract, add the extract slowly, making sure each small addition is dissolved before adding any more. If you add too much at once, the powder can start to clump together and form dough-like balls that resist dissolving. If this happens, don't fret. You can break up the clumps with a sanitized spoon.



Malt extract is added to the brew kettle once the water is hot.

For partial boils, add approximately half of the extract before boiling. The rest will be added near the end of the boil. For full boils, add all of the extract before boiling. Once the extract is added, you have wort.

Step 4: Watch for the Boil-Over!

A few minutes after the wort begins to boil, a thick head of tan foam will

develop. When you see this thick, frothy head form, back off on the heat just a bit. Watch carefully, because a boil-over can happen in just a few seconds. If this happens, you'll end up with a big sticky mess to clean up.

The rising foam action is caused by the coagulation of proteins in the wort. This happens early in the boil, and once past this so-called "hot break" stage, a boil-over is far less likely to happen. The critical period for a boil-over is generally in the first 10 minutes or so of the boil.

Turning down the heat, combined with vigorous stirring, will help prevent a boil-over.

Step 5: Add the Hops

Once the wort is at a rolling, vigorous boil, it's time to add the bittering hops. A straining bag is not required, but it can make cleanup easier, especially with pellet hops. I prefer to use a straining bag with pellets or plugs, but I like to add whole hops straight to the kettle.

When the bittering hops are in the kettle, that's the starting point of the 60-minute boil time. Use a wristwatch, clock, or timer to keep track of the length of the boil.

Follow the recipe instructions with regard to the timing of the additions. The timing of hops and other kettle additions are usually specified in a "countdown" style notation, where 60 minutes is the very beginning of the hour-long boil, and 0 minutes (sometimes also called "flameout") is the very end. Many recipes will call for bittering hops to be added at 60 minutes, flavor hops to be added at 30 minutes, and aroma hops to be added at 15 minutes or less.

Pellet hops can be added directly to boiling wort, or enclosed in a nylon hop bag.

Step 6: Add Other Adjunct Ingredients

If any other ingredients are called for in your recipe instructions, add them at the specified time and manner. Spices, adjunct sugars and other flavor additives are generally added towards the end of boil. You may also want to add Irish moss during the last 15 minutes of the boil. This fining agent will aid in clarifying the wort. Use Irish moss at a rate of 1 tsp. per 5 gallobs (19 L) of wort.

The timing of hops and other kettle additions are usually specified in a "countdown" style notation, where 60 minutes is the very beginning of the hour-long boil, and 0 minutes (sometimes also called "flameout") is the very end.

A hop bag allows the spent hop material to be easily separated from the wort.

Step 7: Add the Rest of the Extract

If you are doing a partial-volume boil, add the remainder of the extract with approximately 5 minutes remaining in the boil. This is just enough time to dissolve and sanitize the extract.

Step 8: Chill the Wort

Once the boil is complete, the wort should be brought down to below 80 °F (27 °C) as soon as possible. Chilling quickly has two main benefits: it reduces the chance of off flavors from dimethyl sulfide (DMS) production, and it causes a more effective "cold break." A good cold break results in a clearer finished beer.

I recommend a copper coil immersion chiller, which you can either buy or make yourself. It is relatively inexpensive and very effective.

For a partial boil setup, you can also use an ice bath to chill the wort. Fill a large sink with ice and water and lower the kettle in. You'll need to

A copper immersion chiller will quickly cool the wort after the boil.

refresh the ice frequently, and this method will take quite a long time, but it works just fine.

Tip: When using an immersion chiller, I like to save the first 5 gallons (19 L) of the warmest water from the chiller. I use this water later during cleanup.

Step 9: Sanitize!

While the wort is cooling, begin sanitizing the primary fermenter, stopper, airlock, tubing and any other equipment that will come into direct contact with the cooled wort. I prefer StarSan sanitizer, but any food-grade sanitizing agent will work just as well. Just be sure to let the equipment have the req-

uisite amount of contact time with the sanitizer (as specified on the product labeling).

Step 10: Transfer the Wort to the Fermenter

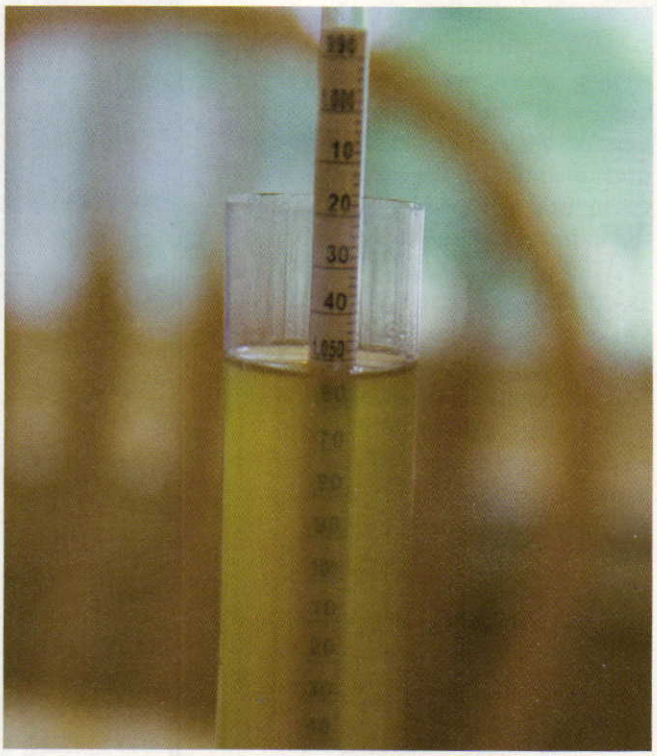
Everything that will contact the post-boil wort should be clean and sanitized, for example with Star San or iodophor.

When the wort is at 80 °F (27 °C) or below, transfer it to the primary fermenter. There are at least a few ways to do this. If you are using a bucket as a fermenter, you can simply pick up the kettle and pour in the wort. For carboys, you can also pour from the kettle with the aid of a large-mouth funnel.

You could also use a racking cane and tubing to siphon the wort from the kettle into the fermenter. This a better solution for full-boil setups.

For maximum ease, use a kettle with an attached ball valve to drain the wort. Adding a valve to a brew kettle is inexpensive and simple, and will save a lot of time and effort over the long haul.

Tubing for racking the wort and a stopper are soaking in a shallow bath of sanitizing solution.



Take a hydrometer reading of your chilled, post-boil wort and record it in your log. Note the wort volume, too.

Once the wort is chilled and aerated, pitch the yeast. Then seal the fermenter and wait for fermentation to begin.

Step 11: Aerate and Pitch

With the cooled wort in the fermenter, give the whole thing a good shake for a few minutes. This helps aerate the wort in preparation for the yeast.

Now sanitize the outside of your yeast package (whether it is dried or liquid), and carefully open it. I recommend sanitized scissors to open dry yeast or "smack pack" liquid yeast packaging. Note: Follow the directions of your recipe for preparing liquid yeast, as some types require steps that happen before the brew day starts.

> Add the yeast (called pitching) to the wort in the fermenter. Soon, the wort will be transformed into beer!

Now simply add the yeast (this is called pitching) to the wort in the fermenter. Soon, the wort will be transformed into beer!

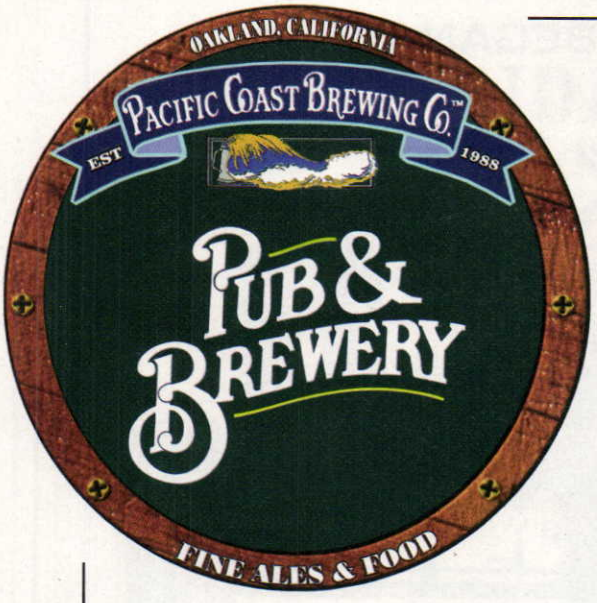
Add the stopper and airlock to the fermenter (or just the airlock if using a bucket) and move it to a cool, dark place for the remainder of the primary fermentation process.

Step 12: Cleanup Time

Cleaning up takes almost as long as all the rest of the brew day processes. It's not fun, but keeping your gear clean is of primary importance. Use warm water and elbow grease to get the kettle squeaky clean. Soap or detergent is not required and could even leave behind a film that could negatively impact future brew sessions.

Your brew day is complete! Enjoy a homebrew (or perhaps a store-bought libation) and admire your handiwork as you wait for the airlock to begin bubbling, signalling the beginning of visible fermentation — which usually starts 8–24 hours after pitching. BYO

Forrest Whitesides is a frequent contributor to Brew Your Own.



USE MALT EXTRACT LIKE A PRO

Story by **Glenn BurnSilver**

Some homebrewers claim that it's not possible to make great beer using malt extracts. Good beer, yes, but not the highest quality brews.

In part, this idea stems from the fact that very few commercial breweries worldwide — less than one-hundredth of one percent — brew utilizing extracts as a base. All-grain is the industry standard.

Don Gortemiller doesn't subscribe to such thoughts. As the owner of Pacific Coast Brewing in Oakland, California, he admits that he "fights that perception daily," despite that fact that he has been producing award-winning beers since 1989 — all with malt extracts.

Winning beers at the Great American Beer Festival (GABF) include the brewery's flagship Blue Whale Ale, along with Killer Whale Stout, Belgian Triple, Code Blue Barleywine, Gray Whale Ale, Columbus IPA and Leviathan Imperial Stout.

Gortemiller, who, along with partner Steve Wolff, opened the brewery in 1988, has been brewing with extracts since the beginning. Part of the reason is that they didn't have space for an all-grain brewhouse and, "we got the equipment at a good price," he says.

He believes it is possible to master the art of extract brewing. The proof, he says, is in the GABF awards.

More support for this belief comes from the fact that many homebrewers switch to all-grain and suddenly start producing better beers. Gortemiller notes that there is more to this idea than meets the eye. Frequently, he says, brewers making the jump to all-grain also improve their equipment at the same time, adding wort chillers, full-sized brew kettles and maybe a refrigerator to control fermentation temperatures.

These provide benefits independent of the switch in fermentables.

"Incorporating these changes with extract beers will show a significant increase in quality also," Gortemiller says.

"In fact, unless you are using an inferior quality extract, these changes will typically have more influence in the finished product than going all-grain."

Use Fresh Extract, Stored Properly

If you have brewed with malt extract before, but been unhappy with the results, what might you do?

"Get a better extract," says Gortemiller.

He also recommends avoiding extracts for which the ingredients are unknown. Also, extract quality deteriorates over time, so avoid extracts with an unknown storage history.

If bulk extracts are available at your local brewshop, a good rule of thumb is to ask which are the most popular. These will have the fastest turn around time and should be the freshest. Liquid malt extracts should be used within a few months. Dried malt extracts can be stored up to a year. Liquid extracts are fine when fresh, but darken faster than dried malt extracts over time. Warm storage conditions will accelerate this deterioration. All Pacific Coast brews begin with a base of Alexander's Pale Malt Extract, extract from a manufacturer local to them.

"Use the palest and freshest malt extract you can find! By using an ultra pale malt extract you will have

the final say on the flavor in the beer you are making." Specialty grains, he adds, can be steeped to achieve the desired flavors and colors of your extract brew.

Making Adjustments

Gortemiller notes that brewing with malt extracts means making some concessions for the available extract, and by default the beer styles one can produce. For example, making extremely light beers — such as Pilsners— can be more difficult to produce even when starting with extra pale malts.

"Extract brewers are going to find it very difficult to brew extremely pale and delicate beers," he says, adding that they will have more success brewing stronger and darker beer styles if they use the "standard" extract brewing process.

However, adaptations can be made for lighter beers. Gortemiller recommends modifying boil times to minimize some of these limitations. By decreasing the boil time, the extract will become less caramelized and lighter colors can be realized. (*Brew Your Own* recommends adding half or more of your malt extract late in the boil.)

Shorter boils, however, will affect hop efficiency. Larger additions of hops will be needed to adjust for this deficiency. Additionally, selection of hop varieties will be more crucial since with a shorter boil, "the aromatic and flavor qualities will be enhanced," he says.

For darker beers, however, proceed with your brewing as normal.

Of course, burnt flavors are possible if the extract is not fully dissolved in the wort before the boil begins.

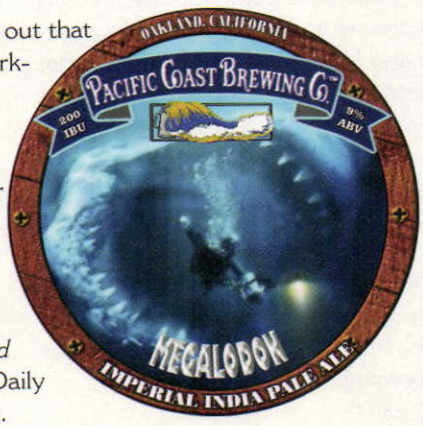
"It is very important to get your wort fully mixed to prevent scorching," Gortemiller says. This is especially true when using liquid extract, which sinks to the bottom of the brewpot.

Once the boil is complete, chill and oxygenate the wort. The final step is adding the yeast. Gortemiller noted that "the extra processing of extract can have a negative effect on the nutrient quality of your wort." To overcome this, he recommends adding a yeast nutrient rich in nitrogen and B vitamins.

"Brewing with extract will give better results if you use a yeast nutrient," he says. "Without it, you will find stuck fermentations and poor attenuation to be a problem."

Of course, Gortemiller points out that it is important to have a clean workplace and clean brewing habits.

With these professional tips, no one can say it's impossible to make not just good beer, but your own great award-winning beer, from extracts.



Glenn BurnSilver is a frequent contributor to Brew Your Own *and Features Editor for the* Fairbanks Daily News-Miner in Fairbanks, *Alaska.*

Megalodon Imperial IPA clone

(5 gallons/19 L extract with grains)

OG = 1.090 FG = 1.023
IBU = 202 SRM = 5.6 ABV = 9.0%

Ingredients

11 lbs. (5.0 kg) light liquid malt extract
11 oz. (0.30 kg) Gambrinus honey malt
22 oz. (0.63 kg) white cane sugar
21 AAU Nugget hops (60 mins) (1.7 oz./47 g of 13% alpha acids)
18 AAU Horizon hops (60 mins) (1.7 oz./47 g of 11% alpha acids)
24 AAU Columbus hops (60 mins) (1.9 oz./55 g of 12% alpha acids)
11 AAU Centennial hops (60 mins) (1.4 oz./39 g of 8% alpha acids)
0.83 oz. (24 g) Horizon hops (dry)
1.4 oz. (39 g) Columbus hops (dry)
1.4 oz. (39 g) Centennial hops (dry)
Danstar Nottingham dried yeast

Leviathan Russian Imperial Stout clone

(5 gallons/19 L extract with grains)

OG = 1.098 FG = 1.024
IBU = 67 SRM = 42 ABV = 9.8%

Ingredients

11 lbs. (5.0 kg) light liquid malt extract
9.0 oz. (0.25 kg) domestic crystal malt (120 °L)
7.0 oz. (0.20 kg) Castle debittered black malt
9.0 oz. (0.25 kg) chocolate malt
13 oz. (0.38 kg) roasted barley
27 oz. (0.76 kg) honey
13 AAU Nugget hops (60 mins) (1.0 oz./28 g of 13% alpha acids)
11 AAU Chinook hops (60 mins) (0.97 oz./27 g of 12% alpha acids)
ale yeast (your choice)

Step by Step (for both)

Steep grains at 152 °F (67 °C) for 45 minutes. Boil roughly 6.3 gallons (24 L) of wort down to 5 gallons (19 L) over 60 minutes. Add adjuncts (sugar or honey) near end of boil. Ferment at 68 °F (20 °C). BYO

Story by **Bob Hansen**

Malt Extract Experts Roundtable

Tips for Brewing Better Beer with Malt Extract

Many professional brewers started their brewing career as homebrewers and many continue to brew at home. Some professional brewers use extract as part or all of their process to create award-winning beers. Given their wealth of information and success at commercially brewing beer, what advice would they give the homebrewer that uses extract? I interviewed several professional brewers who are also homebrewers from breweries that use different brewing techniques and assembled comments and suggestions along with those that we get from brewers every day.

The Brewers:

Don Gortemiller
Don is Brewmaster and co-owner of Pacific Coast Brewing in Oakland, California. His brewery uses malt extract as their primary source of wort and has won multiple GABF medals. He made his first batch of homebrew (an extract recipe) in the winter of 1976. (For more about Dan's beers, see page 42.)

George Bluvas
George is director of Brewing Operations for Water Street Brewery,

> "Essentially, malt extract is condensed wort"

Milwaukee, Wisconsin. Water Street operates two breweries, one extract and one (soon to be two) all-grain, as well as contract brewing on 200-bbl and 60-bbl systems. They have won multiple GABF medals for extract and all-grain brewed beers. George is responsible for making sure that beers brewed via each method match company standards regardless of the brew ing methods. He's been a homebrewer for 17 years.

Dr. Bob Widmaier

Bob is the Quality Manager for Redhook, Woodinville, Washington. He has been in the malting and brewing industry for over 17 years. He has worked mainly in research and development and quality control. He and his son Dan are avid homebrewers.

The Background:

Before we get to the questions, let's review what malt extract is and the basics of how it is made.

Essentially, malt extract is condensed wort. Most of the malt extract produced in the world is used in the food industry, but a small portion of it is made as brewery grade malt extract. Specific production methods and equipment vary, but the process of making malt extract can be thought of as involving two steps — wort production and concentration.

In the wort production phase, the grains are milled and mashed, and then the wort is separated from the spent grains. These steps are very much like what would happen at a brewery. One exception is that relatively little sparge water is used as any water added to the wort would just have to be removed later. The amount of sparge water added is a compromise between obtaining a high degree of extract from

the grains and the costs of removing that liquid later in the process. The specific gravity of worts destined to become malt extract are between 1.064 and 1.098 (between 16% and 24% solids).

When producing (unhopped) brewery grade malt extract, the manufacturer boils the wort to produce the hot break, volatilize the precursors of DMS (DiMethyl Sulfide) and sanitize the wort. The wort is boiled just long enough to achieve these goals. For unhopped malt extracts, the boil stops when the proteins are coagulated.

After the boil, the wort is sent to a whirlpool where the hot break — and in some cases also the cold break — is removed.

After the wort is produced and whirlpooled, it is sent to the evaporator. There are different kinds of evaporators, and for a more detailed explanation of this step, see "Making Malt Extract" in the May-June 2008 issue of *Brew Your Own*. However, they all share some common features.

Evaporators concentrate malt extract (and other food products) by boiling them in a partial vacuum. The low pressure means that the liquid boils at a much lower temperature than at atmospheric pressure.

Depending on the design of the evaporator, as much as 25–30% of the water in the extract may be removed in a single pass through a section of the evaporator. Evaporation occurs very quickly. The wort may pass through all the stages of the evaporator and exit as malt extract in as little as 15 minutes. This means that wort can go from 16% solids (corresponding to a specific gravity of 1.064) to 80% solids (SG 1.380) in only 15 minutes, boiling at an average temperature of 120 °F (49 °C).

If the extract is destined to become dried malt extract, its next step is the dryer. Typically 90% of the water in the wort is removed by vacuum evaporation and the remaining amount is removed by drying. One drying method used in making brewery grade malt extract is spray drying. In it, liquid extract is sprayed into a chamber as a fine mist. Air in the chamber is heated to 250–400 °F (121–204 °C), but with very low relative humidity. The fine drops give up their moisture and fall to the floor of the chamber as powder. Although the chamber is hot, the extract temperature rises by only about 20–30 °F (11–17 °C). And that is how extract is made.

The Questions:

Which beers styles do you think can be made most successfully using extract?

Dr. Bob Widmaier

Beers that are light in color or flavor are challenging. If you are a rookie and don't have a good understanding or good equipment, you should stay away from the lightest flavored or colored beers. You should shoot for pale ale or darker, anything from a Copperhook®

> "I would say anything from a pale ale on up is easy."

(10.7 SRM) on up basically. If you are going to brew a light beer, use tricks to keep color and flavor development to a minimum. Limit your boil to the bare minimum and use a wort chiller.

Don Gortemiller

I would say anything from a pale ale on up is easy. The hardest are pale and light beers. Ultra light beers are almost impossible. We've won a GABF medal for our tripel, which is a big beer that is light in color. We had to use all the tricks to be able to do that. We used fresh extract and light beet sugar.

We've done very well concentrating on more full-flavored beers at our pub. We use yeasts, various hopping techniques and things like wood aging to make our beers unique and excellent. Our customers and medals attest to our success with this technique.

George Bluvas

I've had successful beers of almost every style. Truly ultra light beers are hard. However there was a small brewpub north of here that made a light (low calorie) beer using malt extract, corn syrup and enzymes that was actually pretty decent. At our breweries, our two biggest selling beers are lighter styles that we brew with extract. We have a honey lager that is ⅓ honey and a German weiss beer. The lager is about 3 SRM and the weiss is about 5 SRM. They are a little bit darker than when we brew them all-grain, but it doesn't hurt their sales. Weissbier is a style that is easy to brew with extract. I just had some Hacker Pschorr last night and it was the typical orange color. Granted we are able to do some things that homebrewers can't such as buy our liquid extract direct from the manufacturer. I think homebrewers who get fresh extract or use dried (which doesn't darken) can achieve similar results.

I would say the opposite of most people in that I believe that some of the darker beers are hard to brew with extract alone. We build all our extract beers by starting with the lightest extracts and then steeping or mini-mashing grains for flavor. Beers with really intense malt characters or rich, intense pure malt flavors are difficult to achieve. This is because it is difficult to steep in enough specialty grains to get really intense flavors. There are some specialty extracts made with lots of specialty grains, but you really need to know what you're working with and what's in it. We brew all our Octoberfests and dopplebocks using all-grain methods. In order to get the malt flavor intensity that I like, we have to mini-mash so much Munich malt that we're not saving any time, mess or labor.

What advice would you give for selecting the right extract to work with?

Don Gortemiller

Use the palest, freshest extract for

minimal color and flavor. I think it's a mistake to expect an extract to do everything. We build all our worts by using specialty grains. Definitely scrutinize the freshness. If you can't find a date on the extract, stick with dark beer styles because you can't count on it being reliably light.

Dr. Bob Widmaier

Freshness and quality are the most important characteristics. The fresher the better. Also make sure to buy from a quality supplier. If the homebrew shop sells bulk extract, they should be able to tell you who made the bulk extract and how old it is.

Also, don't try to save money by buying a lot of extract and storing it around your house. Use it right away or keep it cool. I've stored it in wintertime in my garage, which is basically refrigerated at that time. I wouldn't do this in the summer, however.

What tips would you have for homebrewers using extract as part of their process?

Don Gortemiller

When you are first starting out, experience with different styles and recipes is more important than the method of production. Simply, the more batches you do, the better you get.

Get rid of the work of bottling and buy a Corny keg. Use extract and steeping when possible instead of all-grain. You'll be able to finish an entire batch in 4–5 hours as opposed to 12–16 for a bottled batch of all-grain.

You are better off doing a lot of beers to learn the process, perfect your yeast handling and sanitation and get

KEYS TO A GREAT EXTRACT BEER

- Use fresh extract and store properly
- Pick the right extract for the job
- Know the limitations of the extract you are using against the style you want to brew
- For increased malt character and malt aromatics, add specialty malts
- Shorten boil time to reduce color development on lighter colored styles
- Quick wort chilling will also reduce color development

good at understanding the balance of the ingredients. This will get you to better beer faster.

What is your advice for how to best add liquid extract to a brew kettle and avoid scorching?

Dr. Bob Widmaier

Warm the container before you pour. Heat your water to 170 °F (77 °C). Turn the heat off and stir vigorously, then add the extract.

George Bluvas

Make sure the extract is fully dissolved before you turn the heat on or you'll be scrubbing forever.

What tricks do you use when homebrewing with extract?

Dr. Bob Widmaier

When all-grain brewing really big beers like dopplebocks or imperial styles I always use extract to boost gravity. It's just not worth the headaches, poor lauters, mess and yield loss to try to pack all that grain into my equipment. Plus it's easier to make a stronger wort and limit the boil to a reasonable time.

Don Gortemiller

Do full kettle brews and don't try to simplify the process too much. Reduced volume boils or no-boil extract beers can work, but can be more likely to have defects. You can't take all the work out of it and have excellent beer. Other than that I can say that one of the biggest improvements in my beers came when I started using a wort chiller. This was true of all-grain and extract beers, but especially relevant for extract brewing. Also I make sure I know my limitations. Make sure you have good temperature control and sanitation when trying beer styles like lagers that require special conditions.

Input From Others

Other professional brewers interviewed had a few additional tricks to offer. Ken Belau, head brewer at Bell's Brewery in Michigan had this advice to

offer. "In absence of a working wort chiller, I've used near full kettle boils and used ice at the end of the boil to get the wort temperature quickly down" he said. It's mainly important to get the wort out of the critical 160 °F (71 °C) plus zone where color development occurs.

Another professional brewer said, "When using malt extract, I limit my kettle boils to 15 minutes, just enough time to extract my flavor and aroma hops. I use hop extract for the bulk of my bitterness." Though this trick has practically been only available to professional brewers with access to these ingredients, several homebrew suppliers have begun to carry pre-isomerized bittering extracts.

"I use Fermcap® during the boil to keep from having my kettle boil over. We use this at the brewery in our fermenters and it works great," added another. Kettle and fermenter antifoams are widely used in the brewing industry to control foam and increase hop extraction. They are also becoming available from some homebrew shops and distributors.

Another added, "For lighter flavored styles, where mineral balance is important, I always use distilled water or at the very least add some acidity to the beer to make sure the pH is low enough and the beer is crisp. For stouts, I don't bother."

Conclusion

The professional brewers interviewed for this article all fondly relayed stories of failed recipes, cracked glass fermenters, ceilings coated with blow off residue and other disasters at their home and professional breweries. It's nice to know that even the pros have boil overs and a bad brew day from time to time. BYO

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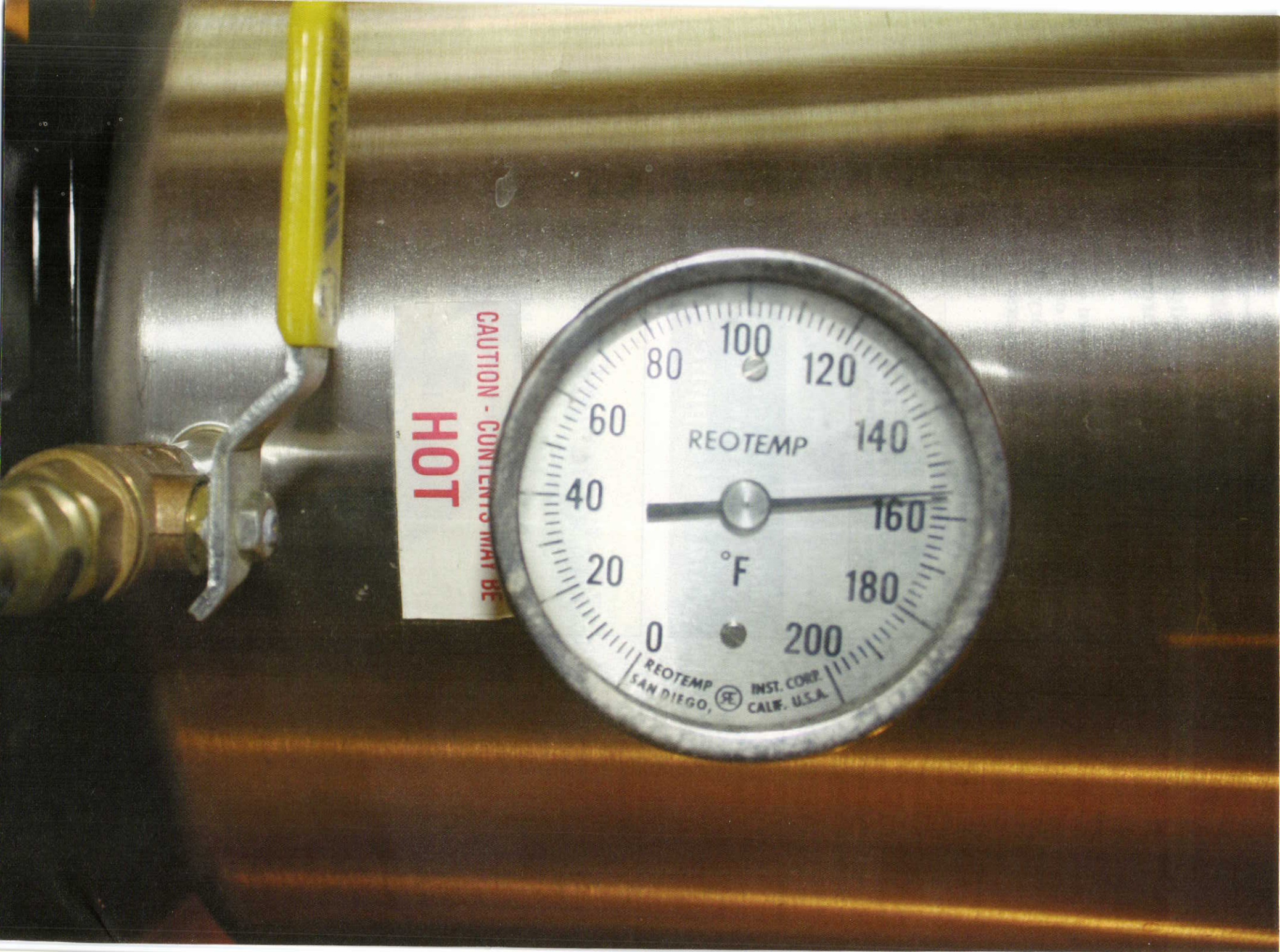
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Story by **Bill Pierce**

MASH TEMPERATURE CALCULATIONS

THERMAL MASS AND YOUR MASH TUN

All-grain brewers are very concerned — some might say obsessed — about temperature. Because the various malt enzymes are most effective only at certain temperatures, brewers seek specific temperatures for their mash regimes. From the initial strike water temperature to the temperature for sparging, there are multiple factors to consider and a significant amount of calculation involved.

While it is certainly possible to brew by the "seat of your pants," many brewers today use software to help with the calculations. The various formulas are built into several popular brewing software applications, although with varying degrees of accuracy. Additionally, some brewers take a "roll your own" approach and have constructed brewing spreadsheets or programmed formulas into handheld devices.

For those who use their own formulas, as well as to facilitate a better understanding by all who value accuracy in brewing, it is worth a detailed examination of the calculations and the numerous formulas that assist in achieving the desired temperatures. With full knowledge of the concepts and factors involved, very precise results can be achieved.

It's impossible to avoid mathematics in this process, so if you are truly math-averse you may wish to stop reading here. However, this is brewing, not rocket science, and the math involved is no more difficult than what would be encountered in a second-year high school algebra class. Furthermore, if you want to accept the formulas included here on faith, and merely plug them into your own brewing spreadsheet, you are more than welcome to do so. It's not necessary to delve into the derivation of each formula unless you wish to.

Becoming Massive

Among the variables in the temperature formulas is "thermal mass," which as it

relates to mashing is the resistance of the water, grain and vessel to changes in temperature, thereby requiring additional heat to effect a temperature change. As many homebrewers know, this is the reason, along with the ambient temperature, why the strike water must be significantly hotter than the desired initial mash temperature. It's also a factor in infusion, decoction or cereal mash calculations, but to a lesser extent because the temperature differences are less pronounced.

Quite a few brewers are acquainted with the thermal mass value from the popular brewing software application ProMash. The Help file mentions that it can be set to a predetermined value between 0 and 1.0, and suggests a value of 0 if you preheat the mash tun. If not, it suggests initially setting the value to 0.3 and later adjusting it according to the accuracy of the results. I could not find any specific formula for calculating the thermal mass in this way.

There are suggestions of a ProMash thermal mass approximation that involves an experiment with a cold mash tun and hot water. Heat the amount of strike water you would use for a typical recipe to a typical strike water temperature, for example, 13 quarts (12.3 L) at 162 °F (72 °C) for a 5-gallon (19 L) batch. Add it to the mash tun, cover, wait 5 minutes and measure the temperature. Then open the ProMash Strike Water Temperature Calculator, set the weight of grain to 0.00001 (the smallest allowed) and the grain temperature to the ambient temperature of the mash tun. Set the water amount to the volume you used, and the desired strike temperature to the value you measured after adding it to the mash tun. Finally, gradually increase the value of the mash tun thermal mass in the calculator from zero until the initial mash water temperature equals that of the strike water you used. That value, at least as it is defined in ProMash, is what should be used for future calculations.

The problem is that ProMash is somewhat misleading in its use of this term. In thermodynamics, thermal mass is defined in terms of the amount of energy necessary to effect a change in temperature, rather than a kind of "fudge factor" in the calculations. Indeed, if we examine what thermal mass really means with regard to mashing, we discover that the actual mass of the vessel is involved, along with that of the grain and strike water.

Mixing It Up

An accurate formula must take into account the resistance of the vessel to the change in temperature. Such a formula is a variation of the so-called "mixing formula" commonly used in brewing calculations, that is:

$$Aa + Bb = Cc$$

The upper case values represent the first quantity and the lower case values the second quantity, while the A and B values represent the properties being measured. And the C values are the result when the two quantities are combined. With a little algebra, we can rearrange the equation to solve for any one of the values if the others are known. We use a variation of this formula, for example, to calculate the specific gravity when water is added to wort or beer, or to determine the post-boil and/or pre-boil gravity to account for boiling losses. The upper case values are the volume and the lower case values are the gravity points. In the case of thermal calculations, A represents temperature and B represents the mass.

Multiplying temperature times mass results in what can be called "thermal points," which are akin to the gravity points in specific gravity calculations. In reality these are either BTUs (British Thermal Units), the amount of energy required to raise or to lower the temperature of 1 pound of water 1 degree Fahrenheit, or if using metric units the result is in kilogram-calories, the energy required to raise or lower 1 kilogram of water 1 degree Celsius. One kilogram-calorie is equal to 3.9683 BTUs, the result of multiplying the weight of 1 kg in pounds (2.20459) by the 9/5 ratio of 1 degree Celsius to 1 degree Fahrenheit. Among the factors in the thermal equation is the mass of the vessel, which adds to the total mass that must be raised in temperature. The thermal mass is partially dependent on the mass (weight) of the vessel, and also on the material the vessel is constructed from, because different materials have different heat capacities. By convention, water is often defined as having a heat capacity of 1.0, and other materials are valued relative to water. The heat capacity is multiplied by the mass (weight) to determine the thermal mass.

Calculating Thermal Mass

This discussion raises the question of what is the mash tun's thermal mass value. Apart from some suggestions in the ProMash Help file and elsewhere, there is little published about this subject. However, it is possible to determine this value empirically, using your mash tun, hot water, and an accurate thermometer capable of measuring the temperature of the water and the ambient air temperature. This method applies to any brewing vessel.

To determine a vessel's thermal mass, first measure the temperature of the empty vessel. Normally this is the same as the ambient air temperature. For maximum accuracy, heat the volume of strike water for a typical batch to a typical strike water temperature. Carefully measure the water temperature. Add the hot water to the unheated vessel. Cover, wait five minutes and again measure the water temperature.

Use the following formula to calculate the vessel's thermal mass:

$$ThM = ((T_s - T_f) * 2.0372 * V_w) / (T_f - T_v)$$

where:

ThM = Thermal mass of vessel (BTUs per degree F)

T_s = Temperature of strike water (degrees F)

T_f = Final temperature of water in vessel after addition of strike water (degrees F)

V_w = Volume of strike water (quarts)

T_v = Temperature of vessel (degrees

F — unless it is preheated, this is the ambient air temperature)

The 2.0372 coefficient in the formula is the weight in pounds of 1 quart of water at a typical strike water temperature of 162 °F (72 °C). It should remain relatively accurate for strike water in the range from 149 to 167 °F (65–75 °C). If you brew with large volumes measured in gallons, use 8.1489 as this coefficient. Among the unusual properties of water is that its maximum density occurs at 4 °C (39 °F). Metric brewers can substitute degrees C for degrees F, kilograms for pounds and liters for quarts. If you are using liters, use 0.9765 as the coefficient for the decrease in mass from 4 °C to 72 °C. Conveniently, the metric system is based on 1 liter of water weighing 1 kilogram at its maximum density.

Examining the formula in detail, the difference between the strike water temperature and the temperature after the strike water addition is multiplied by the mass of the water. The result is the decrease in thermal points (or heat energy in BTUs or kilogram-calories) by the strike water. Going back to the mixing formula, thermal mass is equal to thermal points divided by temperature, so the decrease in thermal points of the strike water is divided by the increase in the temperature of the vessel in order to arrive at the vessel's thermal mass.

You may wonder why the calculations involve water only, rather than both water and grain as in actual mashing. We will explain this in more detail shortly, which involves the fact that water and grain have different heat capacities.

The thermal mass calculations require rather accurate measurement of temperature to be of value. That means using an accurate thermometer. Because the influence of the vessel's thermal mass on the strike water temperature is relatively small compared to that of the grain and water itself, a small variation in temperature can produce quite a large difference in the calculated thermal mass. Changes of even 0.1 degree F affect the results noticeably, although an accura-

cy of 1 degree F (0.56 degrees C) is sufficient to be useful.

Slaking, Not Stirred

There is yet another variable among the factors that affect the mash temperature calculations. When the starches from the grain are hydrated — that is, water is added — a chemical reaction occurs. In terms of the chemistry, the components of a water molecule, a hydroxyl group (OH^-) and a hydrogen ion (H^+), react with the two carbon atoms of a carbon-carbon double bond in the chain of starch molecules. This is an exothermic reaction, in other words, it releases heat. This heat, which potentially can increase the mash temperature when mashing in, has been historically referred to by brewers as slaking heat.

The amount of slaking heat is a matter of some argument. The phenomenon is mentioned in *Malting and Brewing Science: Volume 1* by Briggs, Hough, Stevens and Young (Kluwer Academic/Plenum Publishers; 2nd Edition, 1981), from which the following formula is adapted:

$$H_s = 2.0*[(T_f*(MTh+0.4)) - (MTh*T_s) - (0.4*T_g)]$$

where:
H_s = Slaking heat of malt (gram-calories per degree F)
T_f = Final temperature of mash after addition of strike water (degrees F)
MTh = Water/grain ratio (thickness) of mash (quarts per pound)
T_s = Temperature of strike water (degrees F)
T_g = Temperature of grain (degrees F)

The 0.4 coefficients represent the heat capacity of malt relative to water. At a typical moisture content of 4.0 percent, the heat capacity is 0.4. In other words, water has a heat capacity 2.5 times (the inverse of 0.4) that of malt. We will discuss the 2.0 coefficient shortly.

For malt with a heat capacity of 0.4 at a temperature of 70 °F (21 °C), a final mash temperature of 150 °F (65 °C) and the mash thickness range of 1.25–1.5 quarts per pound (1.2–1.4 liters per kilogram), a value of 18.8 gram-calories per degree F (33.8 gram-calories per degree C) can be used for the slaking heat. This will produce reasonable results for almost all homebrew mashes.

To convert gram-calories to BTUs, multiply by 0.0039683 (18.8 gram-calories per degree F is equal to 0.0746 BTUs).

Of particular interest is the 2.0 coefficient in the previous equation derived from Briggs et al. This suggests that the mash temperature calculations use one-half (0.5 is the inverse of 2) the value of the slaking heat. I could find no explanation of this in the literature, only speculation that it may be the result of empirical measurement. None of the standard homebrewing texts or software discusses or uses this concept in their calculations. The extent to which it applies to small batches has been the subject of debate in online discussions and forums; my own personal experience is that the slaking heat is small but indeed real.

Now that we understand all of the factors, we can rearrange the mixing formula to solve for the temperature of the strike water to achieve a desired target mash temperature. This produces the following equation:

$$T_s = [(T_f*(ThM+(2.0372*V_w) + (0.4*W_g)))-(T_g*0.4*W_g)-(T_v*ThM) (0.5*0.0746*T_f*W_g)]/(2.0372*V_w)$$

where the additional variable not already discussed is:
W_g = Weight (mass) of grain in mash (pounds)

If you preheat the mash tun, either by flushing it with hot water or direct heating, enter the same value for both the target mash temperature and the temperature of the vessel. Metric brewers can directly substitute the temperature values in degrees C, the weight (mass) in kilograms and the volume in liters, and use 0.9765 as the coefficient (use 8.1489 if your volume units are in US gallons) for the change in water density. Use the metric slaking heat value of 0.0338 kilogram-calories per degree C.

Examining the strike water temperature formula closely, you can see that it sums the mash tun thermal mass, the mass of the strike water and the thermal mass of the grain. This sum is multiplied by the desired target final mash temperature, resulting in the total "thermal points" (or heat energy in BTUs or kilogram-calories) of the mash. Subtracted from this are the thermal points supplied by the grain (the grain temperature times its thermal mass) and the mash tun (the mash tun temperature times its thermal mass), and by the slaking heat from hydration of the malt starches (one-half the heat value in BTUs or kilogram-calories times the weight of the grain times the mash temperature). The result is the total thermal points that must be supplied by the strike water.

Applying the mixing formula, temperature is equal to thermal points divided by thermal mass, so the strike water thermal points are divided by its mass in order to arrive at the strike water temperature necessary to achieve the desired mash temperature. The benefit of this formula over others is that it takes into account the thermal mass of the mash tun, the mash tun temperature and the slaking heat of hydration of the malt. A deficiency of some brewing software is that the strike water temperature calculations can be in error if the mash tun is not preheated and is either very hot or very cold, for example, in the summer or winter. Accounting for the thermal mass and temperature of the mash tun resolves this issue. While the slaking heat is a smaller value, it, too, can alter the result by as much as 3–4 degrees F (2 degrees C).

Putting It All Together

A couple of points are worth reviewing. The first is that the true thermal mass is an actual value in BTUs or kilogram-calories rather than an internally derived factor such as is used in ProMash. You should not use the true thermal mass value in ProMash and expect accurate results, nor should the ProMash value be used in the above formulas. If you have your own brew-

ing spreadsheet or calculator, use the formulas and enter the actual thermal mass value in BTUs or kilogram-calories. Secondly, if you preheat the mash tun with hot water prior to mashing in, the effective thermal mass of the vessel is nearly zero, because the temperature of the mash tun is already very near the initial mash temperature. This is true, for example, if a converted keg is directly heated and the grain is added to the hot strike water, or if a cooler is preheated by flushing it with very hot water. For infusion multi-step mashing, decoctions and cereal mashes, where additional hot water or a portion of the mash is added, the thermal mass remains a factor. For strict accuracy, the mash tun's thermal mass should be included in the formula. However, because the temperature difference is less than when initially mashing in, the potential error is far less, typically only 1–2 degrees F (1 degree C). If you do not use the thermal mash value, it is possible merely to add or subtract a degree or two to/from the calculated temperature. This is what occurs if you use the mash and strike water calculators in ProMash; they use the thermal mass (its own factor rather than the true thermal mass) when calculating the strike water temperature, but not for additional infusions or decoctions.

With these formulas, relatively accurate measurement and a little effort in determining the thermal mass of the mash tun, it is possible to achieve very accurate mash temperatures, even more so than with some of the popular brewing software applications, within 1 degree F (0.56 degrees C) of the target value when mashing in. I typically brew outdoors, and I find this to be true no matter what the ambient air temperature, from below freezing to above 90 degrees F (33 C). Of course it's also possible to adjust the mash temperature with the addition of hot or cold water, but it's very satisfying to know you are likely to be on target from the beginning. BYO

Bill Pierce is a frequent contributor to BYO *and this the first in a two-part article on mash temperature calculations, to be concluded in the next issue.*

Want a Better Body?

Mastering mouthfeel

by Terry Foster

Don't worry I'm not going to recommend a course of exercise or a change of diet. I just want to discuss some ways in which you can give your beers a little extra oomph. Body, or mouthfeel as it is often called, is difficult to describe but very noticeable if absent in a beer. A beer that lacks mouthfeel will be unbalanced or "thin," often with one flavor that dominates all others. For example if you have a highly-hopped pale ale which is short on body all you will taste is the hop bitterness and nothing else. In such a beer there is no complexity and no layers of flavor to be savored as the liquid goes along the tongue and down the throat.

The temperature approach

So how do you get this magic property of mouthfeel into your beer? The simplest approach is to vary your mash temperature. The two major enzymes involved in mashing are alpha- and beta- amylase, and broadly speaking it is beta-amylase that has the most effect on fermentability of wort. But this enzyme rapidly loses its activity as mash temperature increases above 150 °F (65.6 °C), so that the higher your mash temperature the lower your wort fermentability.

Lower fermentability means a higher proportion of dextrins in the wort. Dextrins are sugars which are higher in molecular weight than fermentable sugars such as glucose or maltose, and they increase the viscosity of beer as well as add to its mouthfeel. So, if your beers have been thin, try increasing the mash temperature by 2–3 °F (1–2 °C). Raise it again on the next brew if you are still not satisfied, but don't go higher than 156–158 °F (68.9–70 °F), or the wort will contain too high a proportion of unfermentables, and the result will be an over-sweet, low-alcohol beer. However, I do recommend that you try this first before tackling the other approaches I'll be covering.

The specialty malt approach

The "standard" way to get more body in your beer is to use some crystal malt along with the base malt (usually up to about 10–15% of the total). I say standard because there are so many recipes along these lines out there – I have even written a few myself! In part this is because the home and craft brewing revolution that began here in the 1970s and 1980s had its roots in British brewing practice. By this I mean that since we largely lost the tradition of craft beer in this country (in good part as a result of the great experiment of Prohibition), many of these brewers looked to English brewers and their beers for inspiration. And English brewers considered then that the only specialty malts were crystal, and high roasted malts such as black and chocolate.

So what's wrong with that? Well, crystal malt has its uses, and I still use it, sometimes as my only extra malt beyond the base malt. But when I am looking for something more than just caramel sweetness, and for more body and complexity in my beers I go for specialty malts. You see, as the North American home and craft brewing movement matured, brewers and maltsters looked to other brewing nations — notably Germany and Belgium — for inspiration. And soon a whole new range of specialty malts became available to us. Some of these, such as smoked malts, oat malt and wheat malt have fairly specific applications. Others have much wider application and can be used in a whole range of beers.

In order to make some sense of such a wide range of malts I have made a very subjective and idiosyncratic classification of them. Broadly, I like to split these up into what I call "additive" and "substitutive" malts. The former are those that have no enzymes, such as black, chocolate, roast barley, as well as crystal and

> "The 'standard' way to get more body in your beer is to use some crystal malt along with the base malt . . ."

One of the ways to add more body and compexity to your homebrew is to include some specialty malts in the grain bill.

caramel malts, which are added in relatively small amounts (5–15% of the total grist), and are usually added to produce specific flavors in beer. These are added to a grist consisting of a base pale malt; they generally add fairly strong flavors, with the exception of the lighter-roasted crystal malts.

What I call substitutive malts fall into two sub-groups. The first includes those that contain a significant amount of enzymes and can produce sufficient fermentables so that they can act as a substitute for base pale malts. Notable among these are Munich, Vienna and mild ale malts. Rye malt also comes in this subgroup, but would be used in smaller proportions than the others because of its stronger flavor, because it can gum up your mash due to reduced lautering speed and efficiency — unless of course you specifically want to brew a rye beer. The second consists of those that contain little or no enzymes, therefore they can only be partial substitutes for base malt. The rate of substitution varies according to the other components of the grist but is unlikely to exceed 20% of the total. Generally, this group includes malts that do not have powerful flavors such as Victory® amber, Special B and Belgian Caravienne. These malts usually enhance body by adding subtle caramel, roasty, biscuit notes, but without adding sweetness. Brown malt fits this category in terms of lack of enzymes and usage rates, but has a somewhat stronger flavor. Note that all of the malts in the substitutive category are more highly colored than pale malt, and allowance must be made for this in formulating a grist containing them.

I don't intend to deal with all these malts, only those which I have found suitable for improving the body of beer by adding toasted, nutty, caramel and lightly roasted flavors. Prime among these are Munich, Vienna, Victory®, Special B and Briess Ashburne® Mild for pale and intermediate colored beers, and brown and amber malt for dark beers. Taking the latter two last, both can be used to advantage in stouts and porters. In the case of stout, other than the dry version, you can add up to 30% of the grist as amber to give a slightly sweet palate fullness, nicely balancing roasted flavors from black malt. Brown malt has a stronger flavor and can also be used for stout, although you should keep the proportion down to a maximum of 15–20%.

Brown malt also works well in porters. There are two important points about it, the first being that the modern version is produced by a different process than the malt originally used for porter in the 18th century. The second is that although it contains no enzymes it does contain a significant proportion of starch, and if a high percentage of it is used in the grist it is likely to cause set mashes. We have used up to 50% brown in the grist, but this produces a strong, almost metallic flavor, which will not be to everyone's taste. I have also tried a combination of 33% each of

pale 2-row malt, amber malt and brown malt, this being a popular recipe for porter in the late 18th through early 19th centuries. This resulted in a more pronounced flavor than you normally expect in a brown porter. I find it difficult to describe this flavor as it doesn't match anything else I know; it's almost a smoky, even Band Aid flavor, but stops short of being either! The good thing was that this formulation resulted in a high finishing gravity — about 1.018 (4.6 °P) as opposed to the around 1.012 (3.0 °P) I was expecting from the starting gravity of 1.052 (12.9 °P). In short, using brown and amber malt gave a significant addition to body and mouthfeel of the beer.

For a robust porter you will need some (up to 5%) high-roasted malt (usually black), but the beer will still benefit by substituting some brown for the base pale. In this case you do not want to overdo it; 10–15% of the total will be enough.

An example

Let's look at some other specialty malts. You might have been surprised to see mild ale malts in general and Ashburne® Mild in particular listed above. Surely mild malts are meant for making brown and not pale beers?

After all, Ashburne® Mild has 5.3 °L, compared to as low as 2 °L for many pale malts. But we are not looking to substitute pale malt with mild entirely, only to add some body to the beer, and using, say, an 80:20 mix of pale-to-mild will not change the beer color very much, and will add some caramel flavor to it. Such a mixture will also give full starch conversion and will not affect wort fermentability.

Turning to the others I mentioned, Munich, Vienna, Victory® and Special B, there are any number of combinations of these with pale and other malts that you can use, according to the style of beer you are after. In order to simplify this and to give you an idea how this works, every year we brew an IPA at Bru Rm@BAR (in Hartford, Connecticut) in celebration of my birthday. This year we aimed for 7.3% ABV and 73 IBU and we needed some body to balance these factors, so the grist consisted of seven malts:

Maris Otter	32.5%
2-row Pale	23.7%
Bonlander® Munich	17.8%
Crystal 40 °L	6.5%
Victory®	6.5%
Durst Rye malt	6.5%
Special B	6.5%

So how did it turn out? Very well indeed, for this combination of malts worked exactly as we had wished for this beer. It had plenty of body and all the roasty, toasty,

caramel, nutty, biscuit flavors you could ask for. It also had a nice balance, despite the relatively high hop bitterness and alcohol content. The Special B was a newcomer to this brew, replacing the Vienna malt we had used in its precursors. It added nice a nice warm redness to the beer, although the color was a little too dark for a true IPA. Another example is a beer from BAR that was relatively low in alcohol (around 4% ABV), but which would resemble an IPA in its malt flavors and body as well as its hop character and bitterness. We decided that a good grist for this would be a 1:1:1 ratio of Munich, Vienna and Victory® malts, and went ahead and brewed it (recipe at right).

Body by brewer

I have dealt with ways to get more body in your beer by playing with the malts you use. I have not touched on using different yeasts for this purpose because of space restrictions. Nor have I dealt with extract brewing, although you could use these specialty malts as partial substitutes for base extract if you employ the partial mash approach. But, my real aim was to get you thinking outside the box and not limiting yourself to the "pale base plus crystal plus a little high roast malt" approach. Informed imagination is the key to brewing really good and distinctive beers. BYO

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

SMALL IPA

(5 gallons/19 L, all-grain)

OG: 1.045 (11.2 °P) FG: 1.013 (3.3 °P)
ABV: 4.1% IBU: 35 SRM: 24

Ingredients

3 lbs. 10 oz. (1.6 kg) Durst Munich malt
3 lbs. 10 oz. (1.6 kg) Durst Vienna malt
2.5 lbs. (1.13 kg) Briess Victory® malt
9.3 AAU Simcoe pellet hops 0.8 oz./22 g 12.0% alpha acids (90 mins)
1.0 oz. (28 g) Saaz pellet hops 2.9% alpha-acids (0 mins)
1.0 oz. (28 g) Saaz pellet hops 2.9% alpha-acids (dry-hop in secondary)
White Labs WLP 002 (English Ale) yeast

Step by Step

Use a single-step infusion mash at 152–154 °F (66.7–67.8 °C) for one hour. Boil collected wort for 90 minutes, with addition of Simcoe and Saaz hops as indicated. Pitch yeast starter, ferment for three to five days, then rack to secondary, adding Saaz hops in a weighted, sanitized hop bag. After seven to fourteen days rack into keg or bottle in the usual manner using 2 oz. (56 g) corn sugar as priming. Alternatively, you can rack direct from the primary into the keg, add the dry hops as before, and force carbonate the beer.

Thermometers

The options for modern homebrewers

by Chris Bible

Many temperature-measurement options are available for the modern brewer. Each of the available options has strengths and weaknesses that must be evaluated in order to select a temperature measurement device that is suited for a particular job in the home brewery.

Bulb thermometer

Bulb thermometers consist of a glass tube with a reservoir that contains a fluid, generally mercury or an alcohol/dye mixture. They work based on the principle that substances expand when heated and contract when cooled. Because of this, the volume of the liquid in the thermometer changes in proportion to its temperature. As temperature increases, the volume of liquid increases and the liquid then rises higher within the glass tube.

Bimetallic strips

Bimetallic strip thermometers are commonly seen in home breweries in the form of dial thermometers. These thermometers are generally easy to read and respond relatively quickly to temperature changes, so they are often a good choice when control of temperature is important.

Bimetallic strip thermometers are comprised of two different metals that are joined together to make up the bimetallic strip. The two different metals expand and contract in proportion to the temperature (just like the liquid in a bulb thermometer), but they expand and contract at different rates. Because the metals expand and contract at different rates, the joined metal strip bends in response to temperature changes. The bimetallic strip is mechanically linked to gears that turn the pointer on a dial thermometer. Dial thermometers usually contain long bimetallic strips that are coiled into spirals. By coiling a very long strip it becomes much more sensitive to small temperature changes.

Electronic thermometers

Electronic thermometers are comprised of a sensor and electronic components that turn the sensor output into a digital readout of temperature. The most common sensor is a thermoresistor (or thermistor). In a thermistor, resistance to the flow of electricity changes with temperature. A computer or other electrial circuit measures the resistance and converts it to a temperature that is displayed on a liquid crystal display.

Electronic thermometers are inexpensive, accurate, widely available, and usually easier to read than a bulb thermometer. Some electronic thermometers also offer additional features like timers and set-temperature alarms. Negative attributes of electronic thermometers are that they require batteries to operate and may be less durable than desired for use in a home brewery (especially if they are not liquid-proof).

Thermocouples

In 1822, an Estonian physician named Thomas Seebeck accidentally discovered that the junction between two metals generates a voltage that is proportional to the temperature at the junction. Thermocouples rely on this "Seebeck effect." The magnitude and direction of the current depends upon the types of metals used, and the temperature difference between the hot and cold ends.

Although almost any two types of metal can be used to make a thermocouple, a number of standard types of metals are used because they possess predictable output voltages across a broad range of temperature gradients. For instance, K-type thermocouples use nickel-chromium and nickel-aluminium alloys to generate voltage. K-type thermocouples can accurately measure temperatures across a −200 °C to +1350 °C (-328 °F to +2462 °F) range.

> "Each of the available options has strengths and weaknesses that must be evaluated in order to select a temperature measurement device. . ."

Photo courtesy of Blichmann Engineering

Before choosing a thermometer for your homebrewery, weigh the pros and cons of the available options.

HOW TEMPERATURE AFFECTS THE BREWING PROCESS

What Temperature Affects	How Temperature Affects	Why it Matters
Rate of chemical reactions • Biochemical reactions • Oxidation reactions • Isomerization (Iso-α-acid) reactions	Higher temperature = faster reactions Lower temperature = slower reactions	•Alteration of yeast metabolism produces different flavor compounds •Oxidation off-flavors are generally undesirable •Hop bitterness derived from Iso-α-acid
Solubility of compounds in beer • Cold-break	Higher temperature = increased solubility Lower temperature = decreased solubility	Good cold break means less chill-haze
Beer physical properties • Viscosity • CO_2 equilibrium	Higher temperature = lower viscosity, lower CO_2 equilibrium concentration Lower temperature = higher viscosity, higher CO_2 equilibrium concentration	Higher viscosity means fuller mouthfeel. CO_2 provides flavor sensations that depend upon how CO_2 is released during consumption.
Vapor pressure • of flavor / aroma compounds in beer • of CO_2	Higher temperature = increases vapor pressure of flavor/aroma compounds & CO_2 Lower temperature = decreases vapor pressure of volatile flavor/aroma compounds & CO_2	Higher consumption temperature generally means more flavor & aroma Higher temperature means increased rate of CO_2 release from solution (fizzy)

Thermocouples are very accurate and respond quickly to temperature changes. Thermocouple probes are generally very durable and well suited for homebrewing applications. Thermocouples require a voltage source (i.e. a battery) and an electronic multimeter or other circuit in order to convert the voltage output into a temperature reading. Because of this, thermocouples can be expensive.

Liquid crystal thermometers

Liquid crystal thermometers (sometimes called plastic strip thermometers) are used as adhesive thermometers that are attached to fermenters to monitor fermentation temperatures in home breweries.

Liquid crystal thermometers use chiral nematic liquid crystals. These are long, asymmetric molecules that are arranged in orderly spirals within the liquid. When light strikes these spiral structures, some of it reflects. But the reflection is strongest when the light's wavelength is an integer or half integer multiple of the spiral's pitch (the distance between adjacent turns of the spiral). Since light's wavelength is related to its color, the light reflected by these liquid crystals is colored. Because the pitch of a chiral nematic liquid crystal changes with temperature, so does its color. Slightly different liquid crystals are inserted behind each number on the thermometer so that each number becomes colored at a different temperature.

EMISSIVITY FOR COMMON SUBSTANCES

Material	Emissivity
Asphalt	0.93 to 0.95
Ceramics and brick	0.80 to 0.95
Cloth	0.95
Concrete	0.94 to 0.95
Glass	0.76 to 0.85
Metals, unoxidized	0.02 to 0.21
Painted surfaces	0.74 to 0.96
Paper	0.50 to 0.95
Rubber	0.95
Sand	0.90
Snow	0.82 to 0.89
Soil	0.90 to 0.98
Steel, iron, oxidized	0.65 to 0.95
Steel, stainless	0.10 to 0.80
Water	0.93
Wood	0.89 to 0.94

Liquid crystal thermometers are very inexpensive and have several excellent applications within a home brewery.

They are reasonably accurate, but much less accurate than bulb, electronic or thermocouple based thermometers.

Infrared thermometer

Infrared radiation is a type of electromagnetic radiation with a frequency that is lower than the frequency visible light. As objects get hotter, they emit more infrared energy, and may even start to emit visible light (heated objects can glow red, orange or even white hot). Infrared thermometers measure the infrared radiation (energy) that is emitted by objects.

Infrared thermometers work by focusing the infrared radiation from an object on to a sensor called a thermopile. The thermopile absorbs the infrared radiation and converts it into heat. The more infrared energy, the hotter the thermopile gets. Heat from the thermopile is then converted into electricity and sent to a detector. The temperature of the object at which the infrared thermometer is pointed is proportional to the amount of electricity that is flowing into the detector.

Infrared thermometers are often configured into a pistol shape and some offer a laser pointer so specific areas can be pinpointed. The temperature is usually indicated on a small digital readout.

Emissivity plays a key role in infrared temperature detection. Emissivity is defined as the ratio of the amount of radiation emitted by a surface as compared to the radiation emitted by a blackbody at the same temperature. Something that is black in color has a very different emissivity than something that is very reflective such as chrome or silver. It is necessary to know the emissivity of an object in order to accurately determine its temperature using an infrared thermometer. Infrared thermometers are available with fixed and adjustable emissivity settings. Most organic materials and painted or oxidized surfaces have an emissivity that is close to 0.95, but emissivity for other substances varies widely. Please see the table on page 65 for a list of emissivities for common substances.

Infrared thermometers are easy to use and respond rapidly to temperature change. They are generally much more expensive than other options and are potentially much less accurate unless calibrated to the specific emissivity of the object that is being measured.

Conclusions

Temperature plays an important role in the brewing process (as summarized in the table on page 64.) The best way to measure temperature is largely a matter of personal preference, but knowing how thermometers work can guide the homebrewer to making an appropriate decision. BYO

Chris Bible is BYO's *"Advanced Brewing" columnist.*

Build a Mash Tun

Ideal for batch or fly sparging

by Forrest Whitesides

The heart and soul of any all-grain homebrewing system is the combination mash/lauter tun. "Mashing" is the hot water steeping process that results in sweet fermentable wort, while "lautering" is the process of separating the wort from the spent grains.) A third critical step in the process is sparging (technically a part of the lautering process), which is the post-mash rinsing of the grain in order to capture as much as fermentable sugar from the barley as possible. (For some ideas on building a continuous sparging system, go to www.byo.com/component/resource/article/360. For more information about sparging, go to www.byo.com/component/resource/article/1016.)

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

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

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

> "A cooler with thick, well-insulated walls is ideal."

parts and equipment list

Hacksaw
Sandpaper
Pliers

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

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

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

A Coleman Xtreme cooler makes an excellent mash tun with a few copper pipe and fittings modifications.

1. CONVERTING THE COOLER

Once you've chosen a well-insulated cooler with an existing drain plug or spigot, it's time to install a ball valve. This is a major step in converting a mere cooler into an indispensable piece of homebrewing gear. For the sake of simplicity, I highly recommend purchasing a "cooler conversion kit" from your local homebrew shop or an online homebrew supplier. These kits are composed of two main parts: a bulkhead fitting and a ball valve. The bulkhead is further composed of gaskets and washers that fit together to form a water-tight seal through which your wort will flow when lautering and sparging. A hose barb is then added to the ball valve to allow the connection of tubing. Follow the directions that come with whichever cooler conversion kit you purchase. Or you can make your own with the parts listed on page 67.

2. ASSEMBLE THE VALVE

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

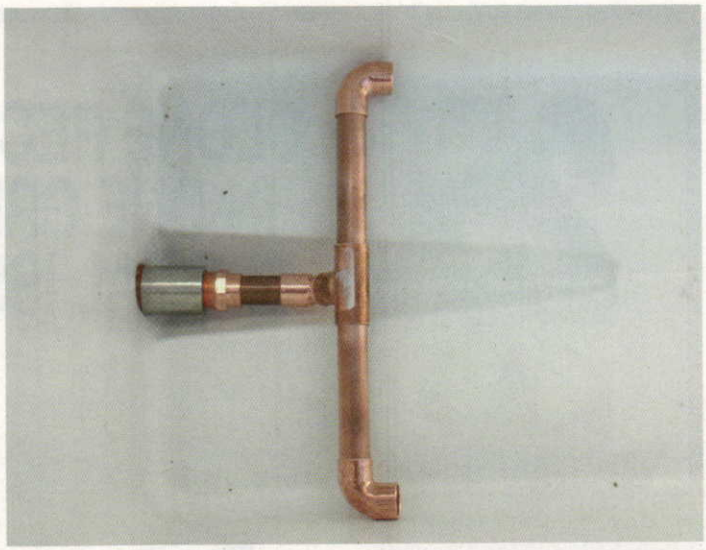
3. BUILDING THE MANIFOLD

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

4. MANIFOLD FABRICATION

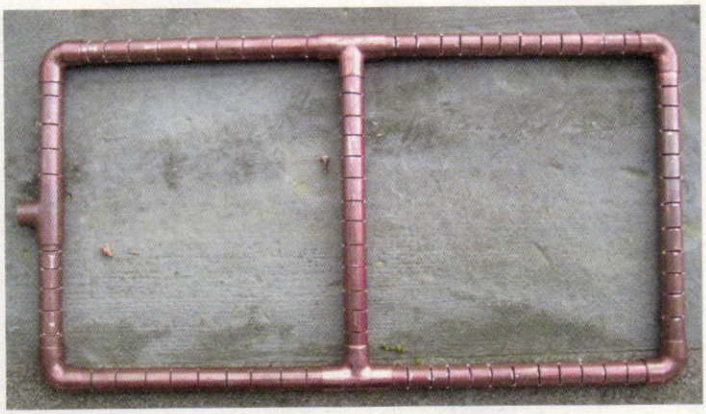
You should test the integrity of all the connections before your first brew day with your new mash tun. Put at least 2.5 gallons (9.5 L) of water in the cooler and let it sit for 30 to 45 minutes. If you notice a leak — even a slight one — you need to work backwards through the installation, retighten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

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



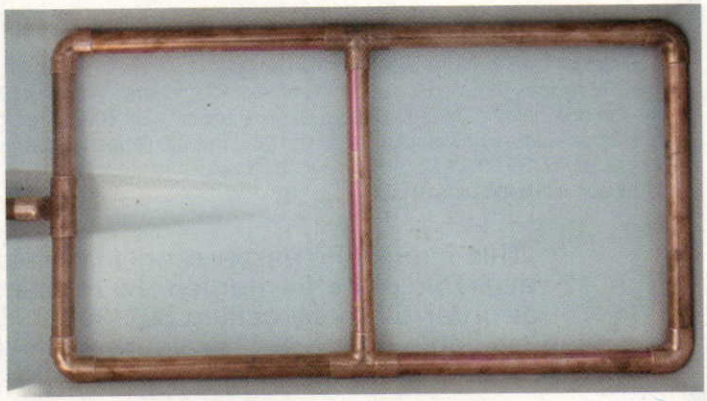
5. MANIFOLD ASSEMBLY

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



6. FINISHING THE JOB

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



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Married to the Hops

A homebrew man "how-to"

by Erin Pelicano Cauble • Adamstown, Maryland

It's official, after two years of my husband's intense homebrewing, I am married to the hops.

Embracing my husband's love affair with brewing has taken some effort on my part. His interest in Belgian-style beers began when he worked as a chef intern at a Belgian restaurant while enrolled in culinary school. The relationship blossomed with the discovery of local craft brew beers. With a combination of culinary creativity and pure beer love, his homebrew hobby was born. Nine years later it is part of our family. It is the two of us + 3 kids + 1 dog + The Brew. Since I became married to the hops, here is what I've learned.

I have learned that a homebrew man isn't born — he is made. It takes a combination of certain factors. First, he can't just be a beer man. We all know there are many levels of beer, so the homebrew man has to be a refined beer man. As Ritchie "the Monk" (as I call him) puts it, an enthusiast of "good" beers. While "good" beers is subjective, apparently it equates to four of these magically good beers costing the same as a case or two of the "other" beers, they have about twice as much alcohol as their less expensive cousins — oh, and they must have wonderful complex flavors.

> "I have learned that a homebrew man isn't born — he is made."

Erin Pelicano has found a way to welcome homebrewing as a member of the family.

Next, a homebrew man has to be competent in the kitchen or a man on a mission. Your average PB&J, or one-dish specialty kind of man will need some work. Even this chef (who incidentally does not cook all the time as many fantasize, he walks in the door asking "what's for dinner?"), had to read up on homebrewing to teach himself the methods. The homebrew man also has to love the brew so much that he can dedicate the time to craft it.

Finally, (not required, but it sure is nice), the homebrew man should be capable of cleaning up after his brewing mess. Disposing of all evidence ensures trouble won't follow. I recommend a careful calculated clean up - this is one area Ritchie "the Monk" is improving on. To clarify, that doesn't mean only clean and return all brewing equipment and ingredients to their proper storage places. All evidence means CSI wouldn't be able to identify what happened in there. The sticky splashes and spray of brewing that tends to hit every surface of the kitchen — counters, the sink, floors should all be clean. Closest to my heart is the stovetop. It amazes me how every brew day leaves a boiled-over sticky mess on the range (as I write this our stovetop has a "CLEAN ME" sign waiting for attention). Would-be homebrew men take note: keeping the stove clean goes a long way toward continued household enthusiasm for the hobby.

While married to the hops, the brew at times feels like the other woman in the relationship . . . always lingering in the background. I happily taste amazing and experimental brews, agree date night dinners need to include a "decent" beer menu, listen to copious talk about beer history, new brewing ideas and resist utter panic at the huge messes made in my kitchen (at least for a few hours). At every opportunity, the homebrew is also invited. Holidays, birthdays, cookouts, even made-up social gatherings are an excuse to taste the latest matured batch.

I'm no dummy though; homebrewing makes a great negotiating tool for everyone's happiness (most importantly, mine). A brew afternoon on his day off equals an uninterrupted, lock-myself-in-the-bathroom tub time for me. Choosing restaurants based on the beer menu can be negotiated for a movie of my choosing (plus we both get an awesome meal out of the deal). I have yet to work in a brew negotiation for a massage or house cleaning — though, I dream of it. BYO

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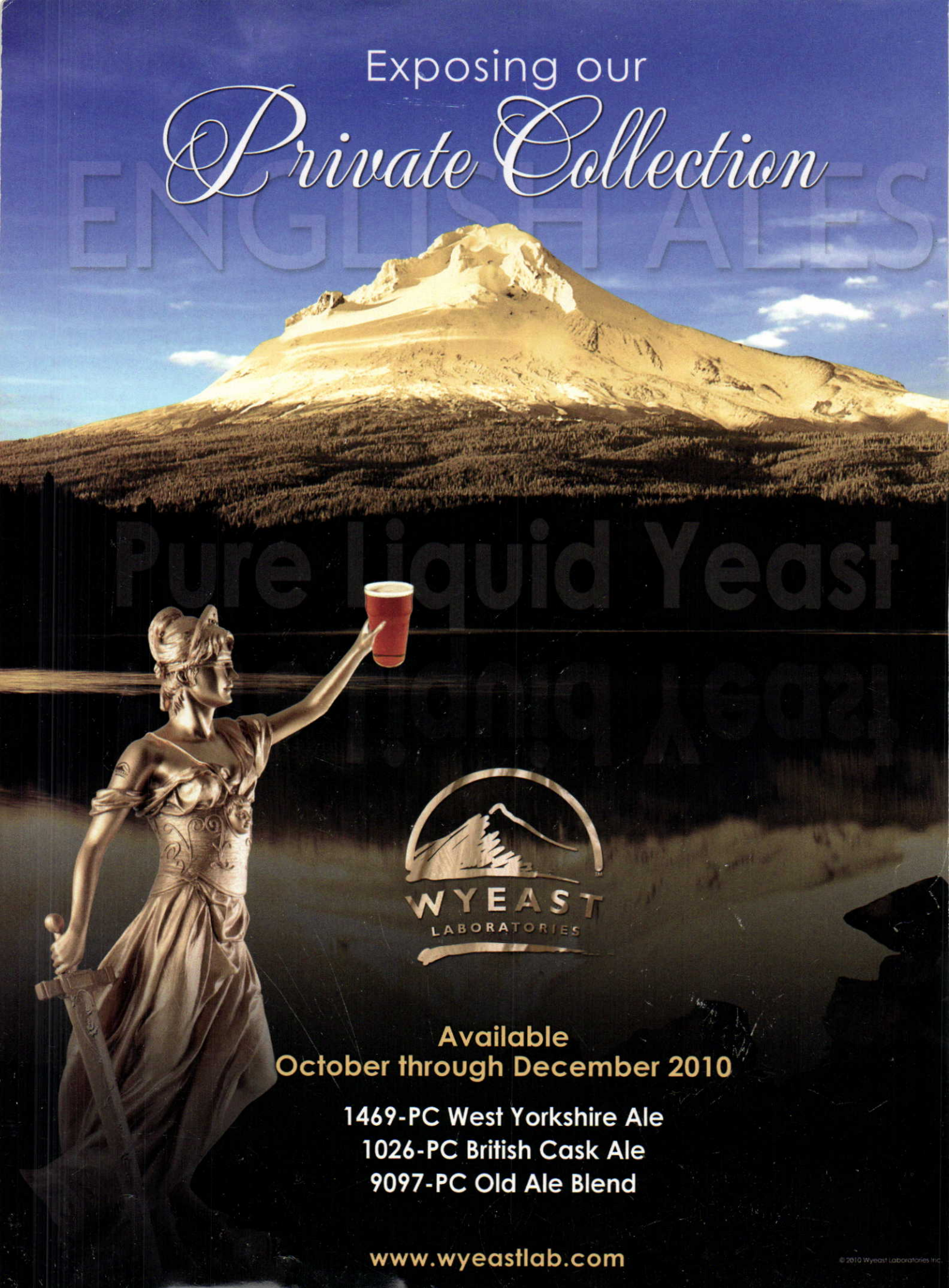
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