HANDY HOP CHART INSIDE! 63 VARIETIES

BrewYour Own

MARCH-APRIL 2003, VOL.9, NO.2

THE HOW-TO HOMEBREW BEER MAGAZINE

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keg your homebrew
big and small options

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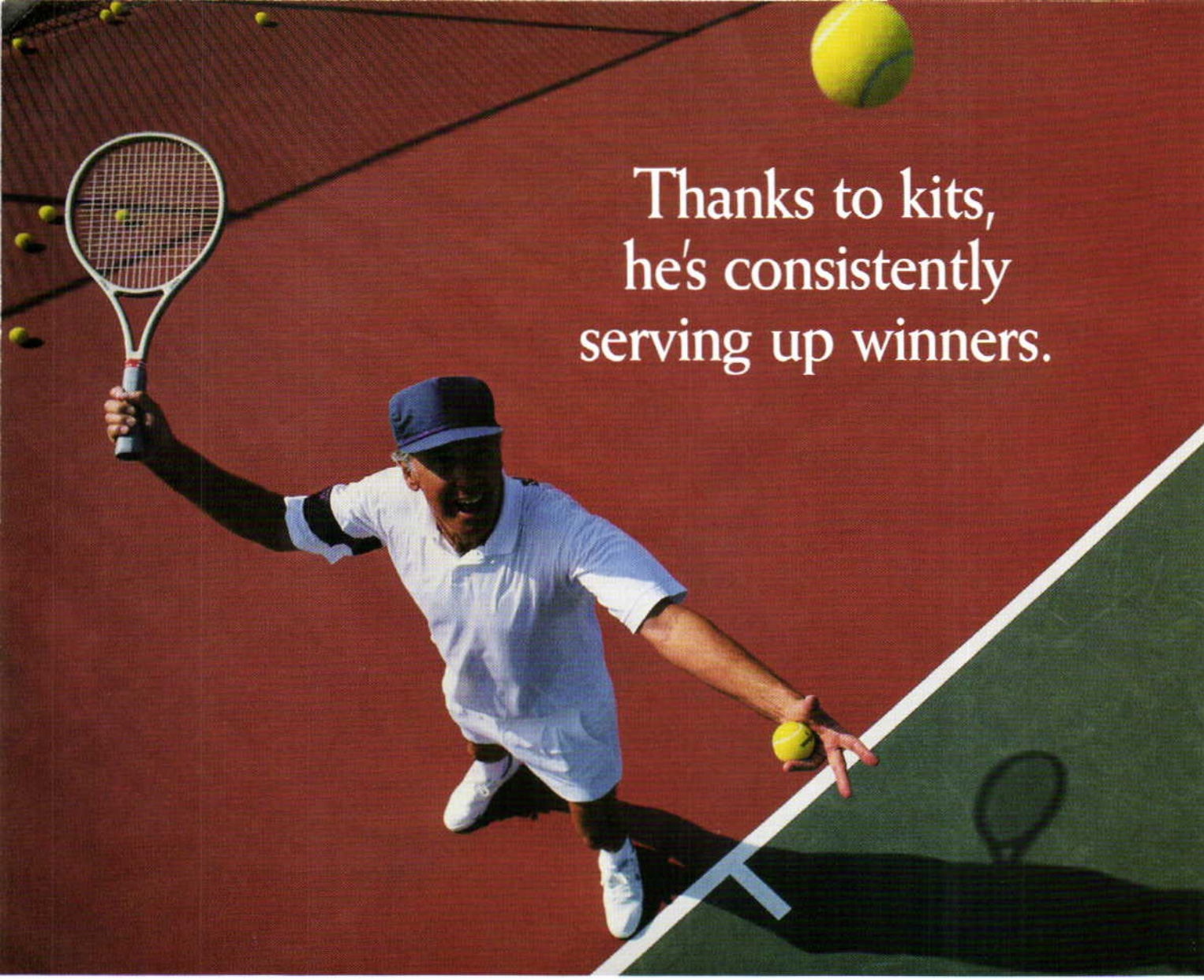

"It tasted just as good - if not better - than many a pint I've drunk in London pubs."

Richard Neill
'Weekend Telegraph' (April 99)

"I wouldn't have believed that a kit beer could be so good"

Roy Bailey - Beer Correspondent
CAMRA's 'What's Brewing' magazine (April 2000)

"It resulted in as good a home-made beer as I have ever tasted"

Maximum 5-point rating in kit review
'Bizarre' magazine (September 99)

This man is a dedicated brewer. But he also loves to play tennis.

More and more his brewing was keeping him at home when he wanted to be out in the sun. Then he discovered Smugglers Special Premium Ale, Old Conkerwood Black Ale and Midas Touch Golden Ale - the Premium Gold range of brewkits from Muntons.

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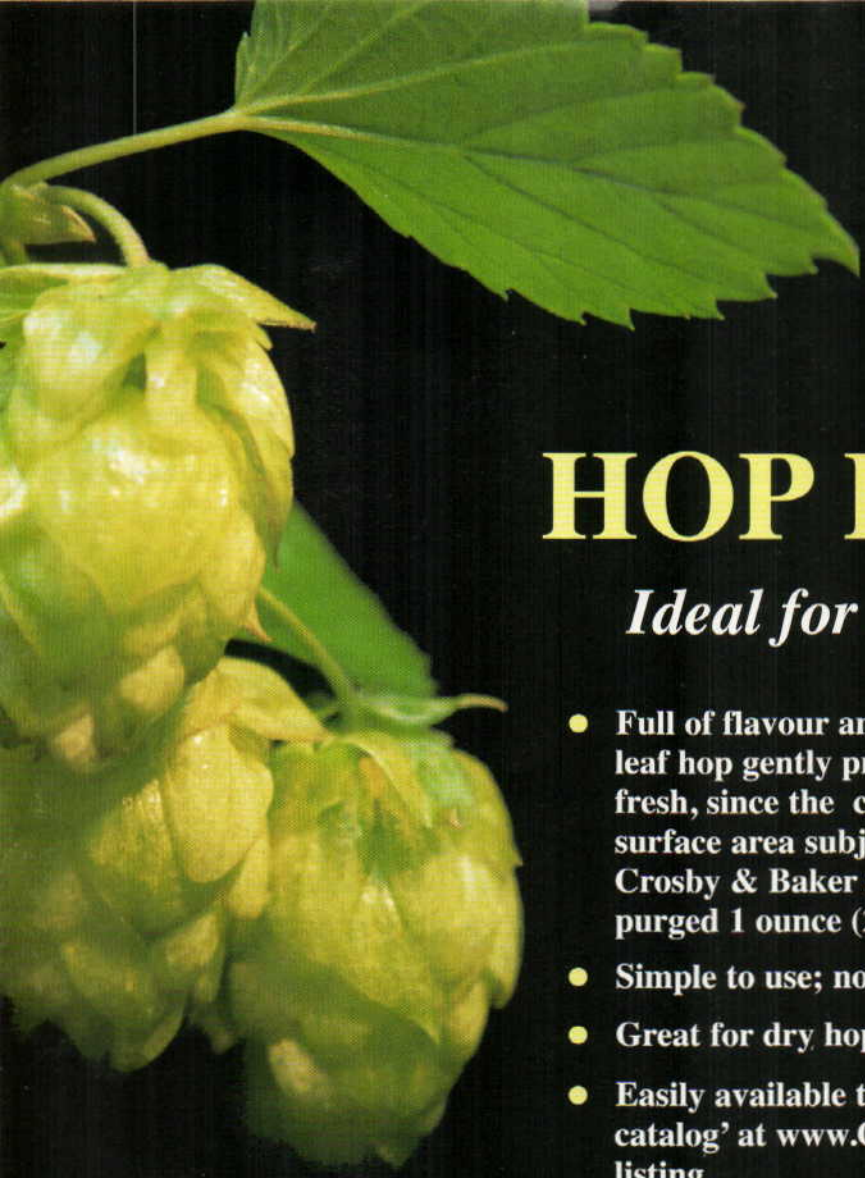

Hops from England

HOP PLUGS

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- **Hallertau - the classic German hop.**

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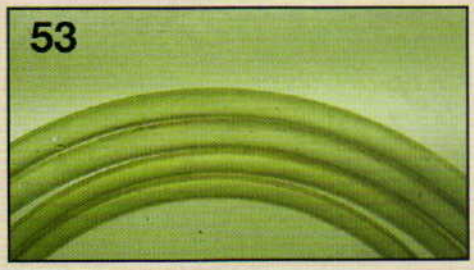
MARCH-APRIL 2003
Volume 9 Number 2

BrewYour Own

Departments



Features

Where to find it

COVER photography: **Charles A. Parker**

THE EYES LOVE IT.

THE MOUTH AGREES.

We're talking total agreement of the senses here. Which shouldn't be surprising, given AmberBock's rich, full flavored taste and unexpected smoothness. Isn't it time for a serious beer that tastes as good as it looks? ***Rich in color. Smooth in taste.***

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Brew Pot Thermometer

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(3) 10-packs of cartridges

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(1) Party Pig kit, (1) Activation Pump,
(1) Filling Support Stand and
(1) Foam Cooler

The Pumphouse
90-bottle Rotating Drainer Tree

Steinbart Wholesale
Alcobase kit, a carbon filter system and a selection of Still Spirits flavors

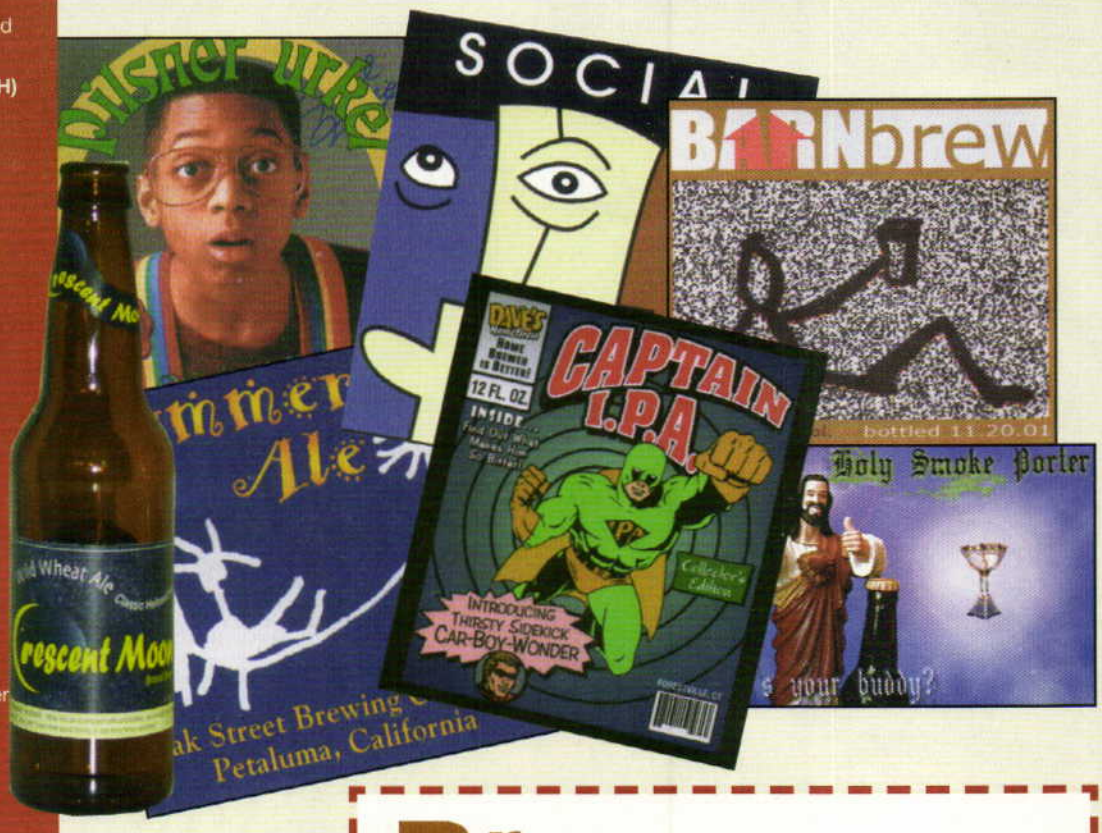
Taphandles Inc.
(2) 10" Black Runner tap handles

White Labs
(1) BYO/White Labs Homebrew Nation Messenger Bag (1) White Labs Polo Shirt, (4) 5-Packs of White Labs yeast coupons

FORGET YOUR TAXES!

(...there's a more important deadline this April 15th)

Send your entries to **Brew Your Own's 8th Annual Homebrew Label Contest** by tax day (**April 15, 2003**) for a chance to win some of these great prizes donated by **BYO** advertisers and retailers! Enter as often as you'd like, but you can only win one prize. Winners will see their artwork featured in the July-August 2003 issue of the magazine.



Rules: Entrants can send labels or labels that are already stuck to bottles. No digital or electronic files will be accepted. All other rules are made up by the editors of *BYO* as we go along. Labels are judged in one category, open to graphic artists and amateurs alike, so ultimate bragging rights are on the line. When submitting your labels, tell us a bit about the artwork and its inspiration. Is it hand-drawn? Created on a computer? Send us your best labels, tell us how you made them, and good luck!

BrewYour Own
THE HOW-TO HOMEBREW BEER MAGAZINE

Label Contest Entry Form

Name _____

Address _____

City _____ State _____ Zip _____

E-mail _____

Phone _____

Send your entry to:

BYO Label Contest
5053 Main St., Suite A
Manchester Center, VT 05255

DEADLINE: April 15, 2003

Brew Your Own
THE HOW-TO HOMEBREW BEER MAGAZINE

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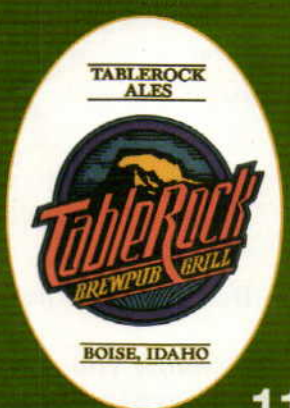

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Contributors

don million

Don Million got started in homebrewing when his wife bought him a Mr. Beer kit for Christmas about eight years ago. His wife, Gail, looks back on that as "the year I created a monster!" Don now has about a third of their basement set aside for brewing gear. He doesn't enter competitions very often, but did win a first place in the Iowa State Fair a few years back. He pays the bills by working for a mutual fund company as a database administrator. Besides brewing, Don enjoys hiking in the summer, snowshoeing in the winter, hunting in the spring and fall, and spending time with his family all year long. Starting on page 34 of this issue, Don explains the basics of kegging, including what equipment you need and how to do it.

ian mackenzie

Ian Mackenzie is a Scottish-descended, British-accented, Indian-born photographer who lives in Vermont. He is a self-taught photographer whose love for capturing images began in the high country. While galivanting around the mountains of Europe, he landed a job shooting for the British national ski team. He then worked as a freelance sports photographer until, one day, his viewfinder rested on his fabulous bride-to-be — professional snowboarder (and former *BYO* managing editor) Betsy Shaw. She lured him to New England, where, as Ian says, "the mountains are small and the beer is weak." Ian's work has been published in travel brochures, *British Ski*, *Snow and Rock* catalog, the *London Sunday Times* magazine, *Fit*, *Transworld Snowboarding*, *Snowboard Life*, *Canadian Ski Press*, and, of course, *Brew Your Own* and *WineMaker*.

john weerts

Brew Your Own welcomes a new member to our review board — John Weerts. John has been a homebrewer since 1992 and is a long-time member of the Kansas City Bier Meisters homebrewing club. John has brewed many award-winning beers and brings a wealth of practical homebrewing expertise to our review board, as well as a thorough understanding of the art and science of brewing. From 1999 to 2001, "Weertsie" was the restaurant manager of the Molokai Brewing Company in Hawaii. Now back in the Midwest, John is serving as the Webmaster for the Bier Meisters (see the club's site at www.kcbiermeisters.org). He also edits the club's monthly newsletter, Bier Notes.

Mail

Sight Glass for Corny Keg?

Your article on adding a sight glass to a brew kettle *(Projects, January-February 2003)* got me thinking ... I would love to add a sight glass to my kegs, but wonder if that's a bad idea because the vessels are pressurized.

Ken Johnson
Lancaster, Pennsylvania

Projects author Thom Cannell responds: "I'd be willing to bet that the braided hose suggested in the story would suffice. After all, it is rated to 100 psi (5,200 Torr) and keg pressures are about 2–14 psi (100–720 Torr). And temperature is not a problem.

"I would think that you could modify the keg using welded-in stainless tubes (I wouldn't want brass in contact with the beer for weeks) and clamping with Oetiker high-pressure clamps.

"Another consideration would be the location of the stainless sight-glass tubes. Corny kegs are made of three pieces — a cylindrical tube, a top and a bottom. You'd have to locate each tube 1 inch (25 mm) from the juncture of the cylinder and the top or bottom to avoid overheating the previous weld."

Plastic Bottles I

I am writing in response to Dan Wold's letter about plastic bottles *(Mail, December 2002)*. Our homebrew supply store carries plastic bottles. You can visit our Website at www.things-beer.com or call (517) 521-2337.

Mike Earnheart
Things Beer
Webberville, Michigan

Plastic Bottles II

Much like Dan Wold, I too enjoy outdoor activities such as hiking, camping and canoeing. On most rivers I float, it is illegal to have glass containers, so I have used the plastic beer bottles with good success. They are available new in one-quart amber bottles with caps from Mr. Beer (www.mrbeer.com).

Rob Heidrick
via email

Plastic Bottles III

Dan Wold wanted plastic bottles. He can find them at www.ebrew.com. They also have the tamper-proof caps.

Steve Conner
Wingo, Kentucky

Um ... It's a Dark Red?

I noticed that both the red ale in the January-February 2003 Style Profile and the oatmeal stout in the December 2002 issue have the same style guidelines. What's up?

Tony Simmons
Pagosa Springs, Colorado

Whoops, you're right. The text in the "Style Guidelines" box for Style Profile did not get updated for the January-February issue. Here are the numbers for red ale:

IRISH RED ALE by the numbers	
OG	1.040–1.048 (10–12 °P)
FG	1.010–1.014 (2.5–3.5 °P)
SRM	some as low as 11, but best at 16–18
IBU	22–28
ABV	rarely less than 4% or more than 4.6%

Monstrous Malt Manipulation

I've been reading and referring to your great magazine for many a brew. In his article on monster beers *("Monster Holiday Beers," December 2002)*, Chris Colby specifies adding malt extracts during the last 15 minutes of the boil in many of the partial-mash recipes. I've always been under the impression that a full 60-minute boil was required for malt extracts for clarity, as well as for a variety of other

chemical transformations. Are there advantages to such a short boil time? I'm curious, as I plan on brewing a few of these beers soon.

Joseph "Maze" Maszle
Carlisle, Pennsylvania

Author Chris Colby responds: "Wort made from an all-grain mash needs to be boiled for a variety of reasons, including sterilization, hot-break formation and elimination of DMS. However, many liquid malt extracts (LMEs) are condensed from wort that already has been boiled. Boiling them a second time is not required. (Many malt extract kits even give no-boil options for making the beer.)

"Steve Bader introduced me to the late LME addition method in his article 'Boil the Hops, Not the Extract' (October 2002). I adopted it for most of the big-beer recipes for two reasons:

"First, excess wort darkening is a common problem in extract beers and more of a problem in high-gravity beers than normal-strength beers. Adding the LME late helps keep the wort from getting too dark for the beer style.

"Second, hop utilization is decreased in high-gravity beers. Boiling the hops in a lower-gravity wort for awhile, then adding the LME, should help get more bitterness in these ultra-big beers."

A Bitter Chocolate Slip

In the December 2002 issue, the recipe for Buzz'ard Double Chocolate Espresso Stout called for Ghirardelli "Select Brown" chocolate powder. Ghirardelli does not make a "Select Brown" powder. What should I use?

Bradford Bonnell
Akron, Ohio

Author Glenn BurnSilver responds: "According to Ghirardelli spokeswoman Cathy Ray, the 'Select Brown' powder does not exist. Try substituting Ghirardelli's 'Sweet Ground Chocolate and Cocoa Powder.'"

Get the Lead Out (of Brass)

In his November 2002 column, Mr. Wizard states that brass contains no lead. There are many alloys of brass available. The only alloys that do not include lead are also not machinable. They are usually cast or forged. The alloy of most of the fittings sold today, including all hardware-store fittings, are required by law to have less than eight percent lead. I am told by a manufacturer that they have just under eight percent lead.

Colin Kaminski
Beer, Beer and More Beer
Concord, California

Mr. Wizard responds: "Unfortunately, when I did my checking into brass, I got the generic definition that brass is an alloy of copper and zinc. I have experience with brass and metallic flavors and this information gives me a stronger reason to suggest switching all brass fittings to stainless-steel fittings. Thanks, Colin!" ■

homebrewer PROFILE

Phillipa Jarrett • near Bathhurst, Australia

PHOTOS COURTESY OF PHILLIPA JARRETT

Phillipa Jarrett's wood-fired kettle contributes smoky flavors to her outback homebrew.

Greetings! I live in Australia and I am a full-mash brewer with a twist — my wort is boiled on a wood-fired boiler. Let me tell you a bit about my brewery in the Australian bush.

Our farm is a one-hour drive from our local town, Bathurst, which is in turn a three-hour drive from Sydney. Basic necessities must be carefully planned for, and it is an eight-hour drive for specialty brewing ingredients.

After I switched to all-grain brewing, my husband David and I decided to try boiling our wort over a fire. We bought a stainless-steel boiler (an old electric laundry boiler) and, after propping it up on some oversize bricks and building a fireplace underneath, we filled it with water and did a test boil. Success! However, as a consequence, there is some smoke flavor in my brews. It's not excessive, but it's definitely detectable. My husband David loves the job of supervising the boil and, of course, drinking a nice cold beer. David is the chief taster, brew equipment maker and brew assistant. He has made a great mash tun and lauter tun of stainless steel. Our batch size is 40 liters (10 gallons) and everything is mashed, sparged, boiled, fermented and kegged in stainless steel.

The weather forecast is important to the brewday. Light showers are okay, but heavy rain puts the fire out. Last winter, it snowed on a boil. Some days, the mash and boil have to be deferred due to a total fireban.

Some of our beer is stored on the veranda on the shady side of the house. One day, the dog alerted me that there was a snake nearby. I heard one of the bottles fall over in the beer cupboard, and there was the snake — a red-bellied black. Most of the snakes here are deadly, so it's best not to tangle with them. I decided to lock the pets inside and let the snake vacate of its own accord, which eventually it did.

Our house, which we designed and built ourselves, is solar powered. There is only enough power in the budget to run one fridge. For serving cold beer from a keg in summer, we have extended and modified the beer line to include a copper coil which sits in an efficient 12-volt camping fridge. In winter it is cold enough on the veranda to keep beers at drinking temperature. Winter is lager-brewing time with plenty of space — the whole outdoors, essentially — in which to lager.

In the garden, we have four hop plants growing and a patch of barley. One day we will be drinking beer brewed from home-grown and home-malted grain with home-grown hops.

Crikey! Will the Crocodile Hunter save this snake-bitten batch of brew?

reader RECIPE

Tony Capocelli's StoutWeizen
(5.5 gallons/21 liters, all-grain)
O.G. 1.045 F.G. 1.015 IBU 13

Ingredients
4.75 lbs. (2.2 kg) Vienna malt
5 lbs. (2.3 kg) dark wheat malt
1 oz. (28 g) chocolate malt
0.25 lbs. (0.11 kg) Briess special roast (50 °L)
2.9 AAU Hallertauer hops (0.75 oz. (21 g) of 3.9% alpha acid) (60 mins.)
0.98 AAU Hallertauer hops (0.25 oz. (7 g) of 3.9% alpha acid) (20 mins.)
0.98 AAU Hallertauer hops (0.25 oz. (7 g) of 3.9% alpha acid) (steep 10 mins. after boil)
Wyeast 3068 (Weihenstephan Wheat) or White Labs WLP300 (Hefeweizen) yeast

Step by Step

Mash in dark wheat and Vienna with 7.8 quarts (7.4 L) of water at 110 °F (43 °C) to get 102 °F (39 °C). Hold 20 minutes, then step up to 122 °F (50 °C) for 20 minutes with 2.2 quarts (23.1 L) of boiling water. Next, step up to 147 °F (64 °C) with 4.6 quarts (4.4 L) boiling water. Mash for 30 minutes, then decoct 1/4 of mash and return to get 158 °F (70 °C). Mash for 30 minutes, then boil a thin decoction of 1/3 of mash to bring to 170 °F (77 °C). Add dark grains ten minutes before return of mashout decoction, along with small infusion of boiling water to maintain mash temperature. Sparge with 20 quarts (19 L) of 170 °F (77 °C) water. Boil for 70 min., then rack into fermenter. Ferment for 7 days at 68 °F (20 °C), then rack to secondary for 7 days at 68 °F (20 °C). Keg and force carbonate.

BEER basics

Hops and Bitterness

Hops supply bitterness, flavor and aroma to beer. Brewers use the cones of the female hop plant *Humulus lupulus* in the brewery. Hops come in many forms, including whole leaf, plug and pellet.

Whole-leaf hops are simply dried hop cones. Plug hops are whole hops that have been compressed into small cylinders. Pellet hops are hops that have been ground and pressed into small pellets. The pellets are held together with binder material. (*BYO* recipes use pellet hops, unless otherwise noted.)

Most of the hop bitterness comes from compounds called alpha acids. The aroma from hops comes primarily from oils. The amount of alpha acids in a hop varies between different kinds of hops and between hops of the same variety grown at different times and places. Alpha acid ratings range from around 3% to 15% or higher.

Brewers boil hops to extract bitterness from them. The longer they are boiled, the more bitterness they confer. Hops boiled for one hour yield up to 30% of their alpha acids. Boiling beyond an hour increases bitterness only slightly and alpha acids can eventually be broken down in very extended boils.

Hops are added at different times during the boil for different effects. Hops added toward the beginning are called bittering hops and supply most of the bitterness to the beer. Hops added with 5–20 minutes left are called flavor hops because these add some flavor and aroma, but less hop bitterness than hops boiled for longer amounts of time. Hops added in the last 5 minutes, or immediately after the boil, are called aroma hops. Aroma hops contribute little bitterness or flavor, but their volatile oils lend hop aroma to the beer. Hops can also be added to finished beer to supply aroma. This is called dry hopping.

homebrew calendar

March 8th
Urbandale, Iowa
Iowa Brewers Union Open
This contest is sponsored by the Iowa Brewers Union. The deadline for entry is March 2 and each entry costs $5. The competition-specific category is the IBU Challenge — each beer must have one IBU of bitterness per gravity point. For more information, contact Bill Van Zanteat by phone at (515) 253-2240, email vanzantewm@yahoo.com or visit www.iowabrewersunion.org.

March 13th–22nd
St. Cloud, Minnesota
March Mashness
This contest is sponsored by the Cloudytown Brewers. All BJCP beer styles will be accepted for submission between Feb. 26 and March 12. Each submission costs $6. Best of Show judging will take place March 22nd at the Granite City Food and Brewery. For information, contact Darin Dorholt at (320) 656-0899, itsusfolks@aol.com or visit www.cloudytownbrewers.org.

March 22nd
Warrenville, Illinois
5th Annual Drunk Monk Challenge
The Urban Knaves of Grain present the largest single-club-sponsored homebrew competition in Illinois. Contest submissions are accepted March 3 through 15. Entry fees are $5 per entry online or $7 on paper. All BJCP styles are accepted, plus an additional category, "The Menace of the Monastery." The Drunk Monk Challenge, held at Two Brothers Brewing Co., is an MCAB qualifying event. The Best of Show winner will have the opportunity to brew his beer at Glen Ellyn Brewing. Best "MOM" entry can be brewed at Govnor's Brewpub. For more information, contact Jeff Hertz or Mike Bock at (630) 858-6593 or (630) 942-1140 or email jhertz@wideopenwest.com or visit www.sgu.net/ukg/dmc.

March 29th
Salem, Oregon
6th Annual Slurp and Burp Open
The Slurp and Burp Open is sponsored by the Strange Brew Club. The organizers promise quality judging of all beer, mead and cider categories without collapsing categories and all entrants will receive quick feedback. Plus, you can win a 15-gallon stainless brew pot. Entries are accepted March 10 through 25 for a $6 entry fee. For more info, contact Ted Hausotter at phone number (503) 538-9501 or by email at tednjodie@msn.com or visit the members.aol.com/slurpnburpor.

April 5th
Richmond, Virginia
11th Annual Dominion Cup
Sponsored by The James River Homebrewers. Judging will be held at Legend Brewing. The window for submissions is March 19 through April 3. The entry fee is $5. For more information, contact Joel Trojnar at (804) 556-1136, joel@trojnar.com or visit the website jrhomebrewers.org.

April 5th
Albany, New York
8th Annual Knickerbocker Battle of Brews
The Saratoga ThoroughBrews present the 8th annual Knickerbocker Battle of the Brews. All BJCP beer styles, meads and ciders will be accepted from March 17 to 29. The entry fee is $5. George DePiro will select one of the Best of Show entries to brew at his brewpub, the Albany Pump House. For more information, contact Reed Antis by phone at (518) 583-0434 or email him at reedmary@capital.net.

April 5th
Berkeley, California
9th Annual Bay Area Mashers World Cup of Beer
The Bay Area Mashers present the World Cup of Beer 2003. The deadline period for entries is Feb. 15 to March 15. Entry fee is $7 with online registration available. All BJCP styles are accepted and this contest is an MCAB qualifying event. Final judging, awards ceremony and party will be held April 5 at Golden Pacific Brewing. Contact Lee Shephard at (510) 336-1546, email lshephard@earthlink.net or visit the website www.bayareamashers.org.

April 25th–May 4th
Multiple sites (to be announced)
AHA National Homebrew Competition, First Round
Judging for the first round of the AHA National Homebrew Contest will take place April 25 through May 4. Submit entries April 9 through 18. Entry fee is $8 for AHA members and $12 for non-members. For more information, contact Gary Glass at (303) 447-0816 ext. 121 or gary@aob.org.More information to come at www.beertown.org.

replicator TABLEROCK NUT BROWN ALE

by **Steve Bader**

Dear Replicator,

Every summer, business takes me to Boise, Idaho. Each trip I look forward to visiting the TableRock Brewing Company, a local microbrewery that makes the best nut brown ale I have ever tasted. I would appreciate very much the opportunity to make a batch or two to hold me until my next visit. Can you help?

Arden Seely
Bluffdale, Utah

I spoke to brewer Robert McSherry at the TableRock brewpub about how to make this nut brown ale. Robert, a *Brew Your Own* reader, has been brewing at TableRock for over seven years, after "volunteering" at the brewery until they hired him!

Nut brown ales are a bit elusive for many homebrewers, because they are not included in the BJCP beer style guidelines. Brown ales have long been a common beer style in Britain. A few of these are a bit more robust, and were given the name "nut brown ales" for the slight hint of "nuttiness" in the flavor profile. Nut browns tend to be very malty, with a low hop flavor and — as the name indicates — a faint flavor of nuts.

Robert said this beer can be described as a slighty sweet beer with a toffee-like flavor and a slightly roasted finish. The slightly sweet flavor comes from the dextrin and crystal malts, which contribute non-fermentable sugars to the beer. The toffee flavor comes from the Carastan malt and the slightly roasted flavor comes from the chocolate and black patent malts. Hop bitterness is low for this beer and hop aroma is very low because TableRock does not use any aroma hops.

For more information, call TableRock Brewing at (208) 342-0944.

TABLEROCK ALES

TableRock BREWPUB GRILL

BOISE, IDAHO

TableRock Nut Brown Ale

(5 gallon/19 liter, extract with grains)
OG = 1.054 FG = 1.015 IBUs = 18
Alcohol 5.3% by volume

Ingredients

6 lbs. (2.7 kg) Briess light extract syrup
1 lb. (0.45 kg) dextrin malt
0.5 lb. (0.23 kg) Carastan malt
6 oz. (168 g) brown malt
4 oz. (112 g) crystal malt (120 °L)
2 oz. (56 g) black patent malt
2 oz. (56 g) chocolate malt
5.8 AAU Willamette hops (bittering hop) (1.0 oz. (28 g) of 5.8% alpha acid)
1 tsp. Irish moss
White Labs WLP001 (California Ale) or Wyeast 1056 (American Ale) yeast
O.75 cup of corn sugar (for priming)

Step by Step

Steep the six crushed grains in 3 gallons (11.4 liters) of water at 150 °F (66 °C) for 30 minutes. Remove the grains from the wort, add malt syrup and bring to a boil. Add Willamette (bittering) hops, Irish moss and boil for 60 minutes.

When done boiling, add wort to 2 gallons (7.6 liters) cool water in a sanitary fermenter, and top off with cool water to 5.5 gallons (20.9 liters). Cool the wort to 80 °F (27 °C), heavily aerate the beer and pitch your yeast. Allow the beer to cool over the next few hours to 68–70 °F (20–21 °C), and hold at these cooler temperatures until the yeast has fermented completely. Bottle your beer, age for two to three weeks and enjoy!

All-grain option:

Replace syrup with 9 lbs. (4 kg). pale malt, mash your grains at 158 °F (70 °C) for 60 min. Lower the Willamette hops to 0.75 oz. to account for full-wort boil.

reader tip

Counter-Pressure Bottling

You can use your counter-pressure bottler for brews you want to bottle-condition too. The main advantage to this is minimizing oxygen contact with your beer. Your priming bucket will be your "Corny" keg. Sanitize it as usual, as well as all the bottles you will need, then boil your priming sugar with a couple cups of drinking water. Cool it down in an ice bath and dump the sugar solution into the keg. Seal the keg and purge the oxygen with carbon dioxide. Now transfer your beer from the secondary into the keg. Next, hook up your counter-pressure bottle filler as usual. The pressure on the tank will only need to be 3–5 psi. Before you fill each bottle, purge the oxygen from it as normal. You won't need to pressurize the bottle, though, because the beer is not yet carbonated and foaming won't be a problem. Cap each bottle as you finish filling it. This technique is especially helpful for beers like barleywine that you will be laying down to age. Also, you won't have to deal with keeping a siphon going or putting your priming bucket at a higher level than your bottles.

Josh Jensen
Los Angeles, California

SEND YOUR STUFF!

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Send ideas to edit@byo.com or 5053 Main Street, Suite A, Manchester Center, VT 05255. If your story gets published, you'll get a cool White Labs baseball cap and a groovy BYO Euro sticker.

homebrew SYSTEMS that make you DROOL

It's Miller Time

• Chris Miller, Boulder Creek, California

I started brewing in 1989 with a Coopers stout kit from a local liquor store. In 1993, my brewing partner and I started brewing all-grain with a ten-gallon converted keg setup and a bare minimum of equipment. This amount didn't last long between the two of us and our brewing time was not abundant. Rather than run two breweries in tandem, we decided to find larger vessels.

A winemaking friend sold me a pair of 55-gallon stainless-steel drums and I built a frame around them. I designed the brewery using features found on other systems and collected the pieces from specialty stores on the Internet and local hardware stores.

The brewery boiler is fired with three 150,000-BTU burners and features a fifteen-gallon hot-liquor tank with a heat exchanger for recirculation mashing. Both the boiler and insulated mash tun drain into a stainless food-service tub used as a sump tray as well as a hopback. On the way to the fermenters, our hot wort is pumped through a built-in wort chiller, a temperature gauge and an inline oxygenation stone.

It took a year and $2,500 from concept to completion. While there are some design flaws, we're pleased with how well it works. One lesson we learned is that mash tuns are supposed to be shallow and wide. A tall, narrow mash tun causes grain compaction when recirculating the mash, making step mashes difficult.

Brewing forty-five gallons of beer is quite an adjustment from ten gallons. The ingredient adjustments are not linear — you can't simply add proportionally more malt or hops. Our recent experience has forced us to become better brewers, not only because of the advanced recipe formulation, but because it has piqued our interest in the science behind the brewing process.

Brewing in higher volume requires a healthy and viable yeast culture. We pitch a two-gallon stirred culture prepared a week in advance. Another benefit was achieved during our club brews with the Silicon Valley Sudzers. Each member receives five gallons of unfermented wort, each to become a distinctly different beer. Last year we brewed a Belgian dubbel using ten different yeasts; this year it was an IPA with two yeasts, and hops added at cooling (in the hopback) and dry hops.

These experiments have allowed us to understand the wide variation in tastes made possible by changing a single component, in addition to what type of hops or yeast work well for a specific style of beer. So what's next for the brewery? In the short term we will experiment with steam injection for step mashing. Long-term plans may include attaching a computer to track and possibly automate the entire brewing process.

Chris (right) and his brewing partner, Joe Zimmerman, toast their brewery.

The lower section of the brewery houses the chiller, sump and burners.

To make cleaning easier, the mash tun can be tipped for dumping out grain.

The hot-liquor tank on top can be removed when transporting the rig.

Here's a look at the oxygen injection system, disassembled.

Lift-off! Here are three 150,000-BTU burners being fired under the kettle.

Recipe Formulation

Every great beer starts with a great plan

by Thomas J. Miller

This month's professional brewers dispense some sage advice on recipe formulation. From the basic task of learning your system to some very specific brewing formulae, these tips will take you beyond the standard brewer's recipe-formulation software to creating your recipes by hand (with the help of basic algebra). It will also link the art to the science of brewing.

Brewer: Jason Dunson Todd has been brewing for Paper City Brewery in Holyoke, Massachusetts since January 1997 and became Head Brewer in September 1997.

When I formulate recipes, I rely on my brewing experience but still use my senses. All brewers should taste and smell samples of malt and hops — these are what become the final product. I also suggest to not be bound by tradition. Use tradition only when it is beneficial. For example, if you like British crystal over German varieties, use British instead. Also, simplicity is often underrated. One of our most-loved winter recipes consists of 98% pale and 2% roasted malt. It is a delicious and flavorful brew.

I'll walk you through the formulation of our India Pale Ale. Paper City's IPA falls somewhere between a West Coast IPA and a traditional British version. I decided a good healthy original gravity was important to balance an ample amount of hops. After some experimentation, I settled on 81% two-row pale (all our beers are based on two-row — even the lagers — in a single-infusion system), 9% light Munich and 10% light crystal malt (about 26 degrees Lovibond).

I determine my grain weights for a five-gallon batch by multiplying the percent of the grist each grain comprises times the extract "dry basis course grind" (DBCG) for that grain times the brewhouse efficiency.

DBCG can be found on any malt statistics sheet or it can be estimated if it's not available. DBCG is the closest yield expected to what will happen in the brewhouse, although this is still high and will be modified by the brewhouse efficiency. For our IPA, we have:

(% Grist) x (DBCG) x (Efficiency) = X

Pale malt: 0.81 x 0.78 x 0.70 = 0.442
Munich: 0.09 x 0.76 x 0.70 = 0.048
Crystal: 0.10 x 0.74 x 0.70 = 0.052

These numbers (the Xs) are then added together. In our example, the sum is 0.542. This value, let's call it Y, can now be plugged into a second simple formula.

[Original gravity x volume] / [Y x 46.31] = total grist weight (in lbs.)

I decided I wanted a starting gravity of 1.053 and my volume will be five gallons, so: [53 x 5]/[0.542 x 46.31] = 10.56 pounds as the total grist weight. (Note: DBCG is given in English units, but the final weight can be converted to kilograms by multiplying by 0.454.)

This total can be multiplied by each grain's percentage of the grist, giving us: 8.6 lbs. pale malt, 0.95 lbs. Munich malt and 1.1 lbs. crystal malt.

Hop prediction is similar to the grist formula. For each addition I use:

(% of hop bill) x (% alpha acid) x (boil efficiency) x 7490 = X

You should always know the alpha acid levels of your bittering hops. I wanted 60 International Bittering Units (IBUs) in this IPA and a hop flavor throughout. I also wanted a hop presence that was subtler than the more aggressively hopped beers available. East Kent Goldings were chosen because of its classic use in English ales. More importantly, it is not a robust hop. It is mild and floral. The alpha acids are often a moderate four to six percent. I believe a lower alpha acid hop variety allows for a nicer development of flavor and a gentler bittering of the beer. Because I wanted a nice aroma as well and enjoy Golding hops, I stuck with them after the boil for dry hopping.

Using two hop additions of the same hop, the formula then follows:

0.80 x 0.05 x 0.30 x 7490 = 89.88
0.20 x 0.05 x 0.28 x 7490 = 20.97
and Z = 89.88 + 20.97 = 110.9

The variable Z goes into the formula (IBU x Volume) / Z = weight (in oz.).

(60 x 5) / 110.9 = 2.7 oz. (ounces convert to grams by multiplying by 28.4)

This is then broken down by the percent of the bill. The first addition at 80% will be 2.16 ounces. The second at 20% will be 0.54 ounces. It's better to add dry hops later in the fermentation — in the secondary — for this beer.

Yeast is the workhorse of the brewery and should be pampered. For our IPA we use one of four in-house strains. Because this beer is somewhere between West Coast and English, an American ale yeast does well. Classic British yeast is a good choice, too. Mineral profiles or dryness from yeast will only accentuate the hop bitterness — and that's not a bad thing in an India Pale Ale.

Brewer: David Wollner began homebrewing in 1980 while in college. He attended several craft-brewing conferences and brewing programs from 1987 to 1997 and opened Willimantic Brewing Company and Main Street Café, located in Willimantic, Connecticut, in 1997.

The recipe for our Rail Mail Rye has evolved from a German rye beer to an American rye pale ale. The grain bill has changed just as much as the hops. I'll introduce both styles side by side for the sake of comparison. Both beers have an OG of 1.052-1.054 and an FG of 1.010-1.012.

The color in the German rye should be a deep reddish garnet from dark crystal malts (we use crystal 60 and 150 °L) and should have a distinct caramel and raisin sweetness. The color of the American rye will be amber and have a more sugary sweetness from crystal 30 °L malt. Runnings should be nearly identical since the Pilsner and two-row malts (our base malts) have similar extraction rates.

The German rye has Tettnanger hops for their spicy character. Early and flavor additions are meant to accentuate the spiciness of the rye malts. The American version is hopped throughout the boil with Cascades and even in the secondary fermenter for the style's spicy and citrusy character.

The rye malts tend to leave more mouthfeel in the beer and the caramel and crystal malts have more nonfermentables, which leave these beers with some sweetness in the finish.

For example, the German rye has little aroma but a spicy flavor with a crisp and quick finish. The American rye has hop aroma, then hop bitterness, followed by rye spiciness, then finishes long with hop flavors. They are two of the same kinds of beers with two distinct outcomes.

It is important to realize that brewing is an experimental process. You should try a recipe you're familiar with and change one thing, such as hops, malt or mash temperature. Keep careful notes — they will help you determine the best beers you can make.

Yeast is the last ingredient and the most important. The yeast for the rye beers could be an American or German ale variety.

Brewer: Sean Larkin has been head brewer at Trinity Brewhouse, located in Providence, Rhode Island, since 1994.

Figuring out what style you want to make is the first step in formulating a beer recipe. You will use the style to choose the appropriate grain, hops and yeast for your beer.

In the case of my Oktoberfest, I use a combination of light Munich malt, dark Munich malt and some Vienna grains. The combination of German malts produces remarkable results — a rich malt flavor and deep color. Standard Pilsner malt can be used as the base, but the finished product may lack body.

The next step is to figure out how much grain to use. Too little, and the beer comes in under style specifications. Too much, and your Pilsner might pack the punch of a barleywine.

Most styles give you guidelines to follow, and you can use recipes as a guide. But how well you hit the gravity numbers depends on the efficiency of your equipment. Adjustments to your mash must be made in the batches to come, either by adding more grain if your original gravity was low or less grain if it came in high.

Keeping accurate records of your brew gravity will help you to understand recipe formulation. My suggestion on grains is always to put in more than you think you need. A good general rule is to bump your base malt by one-half pound to a full pound the first time you make a recipe. With each subsequent recipe, you can adjust based on your previous results. There is no way to really gauge efficiency until you have made the same beer back to back on your system. If you come in low on gravity, use malt extract to bump it up.

In my system, I know I get roughly one degree Plato per bag at 10 bags per 16 barrels. This gives me a beer that starts anywhere between 9.5 and 10.5 degrees Plato. As I go up from ten bags, I start needing two bags per barrel to get the same effect. As you see, it is a rough formula that is very specific to the efficiency of my system.

I do not calculate color when I formulate recipes. I do, however, try to include no more than 20 percent coloring malts, such as caramel or black patent, in a batch. This has to do with flavor; these malts can overpower a brew, creating off or astringent flavors. Moderation is best.

Try using this 5-gallon Oktoberfest recipe to fine-tune your system. I use only German malts in this beer.

3.25 lbs. (1.47 kg) light Munich malt
3.25 lbs. (1.47 kg) dark Munich malt
3.25 lbs. (1.47 kg) Vienna malt
1 oz. (28 g) Tettnanger hops (4.5% AA) (60 minutes)
0.25 oz. (7 g) Tettnanger hops (4.5% AA) (30 minutes)
0.25 oz. (7 g) Tettnanger hops (4.5% AA) (1 minute)
White Labs WLP820 (Oktoberfest/Märzen)

With a high mash efficiency (72%), this recipe will yield an OG around 1.049 and 20.8 IBUs. The alcohol by volume will be about 4.9%. ■

Bring Out Yer Dead!

Overnight mashing efficiency and deleting DMS

I have been homebrewing for about 10 years and have had a lot of fun and success. However, for the last two years or so, getting good, reliable yeast has been a problem. I live about two hours away from the nearest homebrew store and used to use smack-packs. Then along came pitchable liquid yeast.

Pitchable tubes are great, but all too often I end up paying $7 for dead yeast. I keep the yeast cool until I get home, then put it in the fridge. This is true for White Labs and Wyeast. This became aggravating enough to send me to the Internet for supplies. I order extra ice packs and it gets here within one to two days of ordering. Again, all too often I find myself with dead yeast.

I have learned to keep dry yeast on hand as a backup, but dry yeast only comes in a limited number of styles. I also repitch the liquid yeast that has survived, but it only keeps so long. (My experience says no more than two to four weeks.) I do make yeast starters so there aren't any surprises on brew day. Should I consider revisiting smack-packs? Is this a common problem or have I been cursed by the fungal gods?

Joe Roach
Ingram, Texas

I get many, many questions sent in that I cannot answer in this column because of space limitations. The volume of questions I receive has given me a pretty clear picture of problems that are common at home and those that are not so normal. The problem of buying pitchable yeast that does not perform well in fermentation is not a problem I hear very often. In fact, I can't remember hearing from a homebrewer who has been as unlucky as you when it comes to yeast health.

Before I get too deep into this answer, however, I must point out one thing. When a propagation step is performed using a very high pitching rate — for example, if you pitch a tube of yeast into a pint of wort to make a starter — you may not observe a normal-looking fermentation because it happens so quickly. You may not, for example, see a lot of bubble evolution or kraeusen formation.

Assessing yeast health and viability is harder than it sounds without some sort of test method and equipment. Yeast experts use yeast stains coupled with examination under a microscope, plating techniques and a wide array of biochemical assays to evaluate yeast health. Although this is not the direction I will take in this answer, I do wonder how you are judging the status of your yeast. Lack of fermentation in a properly cooled wort is certainly a pretty clear sign things are not going right!

Let's assume, though, that you are getting dead yeast. There are a few items in your question that relate to key points with regards to yeast health and viability. The first point you raise is storage temperature of the liquid yeast (this applies to both "pitchable" yeast and to smack-packs). It's great that you keep the yeast cold between the store and your house. That same concern is valid from the time the yeast is shipped from its original source until the time you purchase the yeast. This factor, of course, is beyond your control.

In commercial breweries where yeast is stored in stirred tanks prior to re-use, the goal is to keep the yeast cooler than 38 °F (4 °C), preferably right at 32 °F (0 °C). The reason for this storage temperature is that liquid yeast remains much more viable during storage when the temperature is kept very cold, but not so cold as to cause freezing — ice crystals are extremely damaging to yeast cells and quickly kill the little critters.

The counterpart to temperature's effect on yeast health is time. As storage temperature rises, the practical storage time decreases. This is very hard to quantify without data and many things affect this time and temperature relationship, including alcohol, agitation and yeast age before storing (how many generations and so on). To me it sounds like you are buying yeast that has been abused during storage, possibly from a combination of too much time at too high of a temperature. I know that is an obvious conclusion! But, there are no other mystical reasons for a loss of yeast viability.

The other point you raise in your question is the subject of using a starter. The simplest form of starter for the homebrewer is the yeast smack-pack. If you whack the pack and don't see signs of life within a couple of days, you know you have problems. The smack-pack was not developed as a yeast viability test, but it works for me!

The other thing the smack-pack can indicate (in a crude manner) is yeast vitality or vigor. If the pack turns rock-hard in a day, the yeast acted quickly and shows signs of good vigor. If, on the other hand, it takes a few days for the smack-pack to pathetically expand into what feels like a balloon four days after a party, the yeast wasn't exactly performing like a rock star at his prime — more like Ozzy bum-

bling around the house. This yeast is probably not the type you want to rely on for a good fermentation.

The other type of starter to use is one conducted in a small fermenter of sorts. One-gallon apple-juice jugs work well and they are cheaper than the flasks used by microbiologists. I like using between five and 10 percent of the planned brew volume for my starters. For example, I use roughly one to two quarts of starter wort per five-gallon batch of beer (or between one and two liters of starter for a standard 19-liter brew).

As you mention in your question, the starter eliminates surprises on brew day. If conducted properly, the starter will also increase the cell population and restore vigor and viability to an aging yeast slurry. The key ingredients for a good starter are food (wort), oxygen (preferably bubbled into the wort with some sort of aerator) and enough viable yeast to propagate. Many brewers, including myself, add some yeast nutrients to the mix to boost key nutrients, such as zinc. I really doubt you can buy yeast that is 100% dead if used within the dates recommended by the supplier ... unless your homebrew store is in Death Valley and it has been without electrical power for several days.

Should you return to smack-packs? If they work, go for it. However, they can be abused just like any other form of yeast. What I really do recommend is asking about how the yeast is shipped and stored. I have ordered pub-sized batches of yeast from both White Labs and Wyeast directly and the yeast has always arrived one day after shipping, packed in Styrofoam with its own little coolant pack. These companies do not ship directly to the homebrewer and rely on distributors. Whether a local store or an Internet business, the distributor should be able to explain its handling practices. If the answers don't satisfy you, buy from another distributor. View yeast as you would milk. The gas station down the road may be known for selling soon-to-be-old milk from the local dairy, but that doesn't mean that all stores in town do the same thing. Better luck with the fungal gods!

All Through the Night

I have been brewing for almost 30 years. To increase mash efficiency, I mash overnight. I do this with beers of low to average original gravities, but especially with high-gravity beers. I will start the mash at 155–160 °F (68–71 °C) around 11 p.m. and sparge in the morning around 9 a.m. By then, the temperature of the mash is around 145 °F (63 °C). I have found this method to be successful at conversion and the beers have been good. Is there any reason why I should not be doing this? I am often asked for brewing recommendations and I want to recommend this, but I need to know if I am wrong.

Trev Cox
Reading, Pennsylvania

I am a great fan of methods that make things easier and this method is certainly a time-saver when it comes to scheduling those precious weekend hours. To me, saving time is the best way to improve efficiency. Very long mashes also will improve the extraction of wort-soluble solids from malt and improve your mash efficiency, although mash efficiency is primarily a function of milling and wort separation techniques. I toured a small brewery in California that brewed a batch of stout, then mashed in the second batch and returned the next morning to finish the batch. There are no major problems with this method, but there are a few things to keep in mind to avoid potential problems.

Mashing is all about enzymes. The two key enzymes in mashing are alpha-amylase and beta-amylase. Beta-amylase produces maltose from starch and is most active between 140–149 °F (60–65 °C). The thing about beta-amylase is that it stops working when it runs into a branch in the starch molecule. That's where alpha-amylase comes to the rescue. Alpha-amylase randomly reduces big starch molecules into smaller pieces. Its temperature optimum is right around 158 °F (70 °C).

When enzymes run out of their substrate — starch, in the case of amylases — the reactions just stop. No big deal. Brewers typically stop mashing when the mash is complete because they want to efficiently utilize their brewing equipment. In your case, the mash is over at midnight and you are more concerned about utilizing your bed than your mash-tun — so you let the mash wait for you to awaken.

The key to your method is keeping your temperature high. If you used this very long mashing method with a low mash temperature, say around 140–145 °F (63–65 °C), the result would be very fermentable wort because this temperature range is ideal for beta-amylase activity and also is high enough to get some alpha-amylase activity. When these two enzymes work together, the result is an increase in wort fermentability.

Dry beers and light beers typically begin with this sort of wort. If you want to brew something like Michelob Ultra, a very long mash in this temperature range is the ticket! Just make sure that you achieve complete conversion by using the iodine test before sparging. If you get a black iodine test result, you should heat the mash up to 158 °F (70 °C) for about 20 minutes for complete conversion. Most homebrewers don't want to brew super-dry beers and should keep the temperature above 150 °F (66 °C) for the mash.

Keeping the temperature high is also critical for pest control! Wort bacteria don't mess around and will quickly begin growing if the wort temperature falls into the 120 °F (49 °C) range. Malt is chock-full of bacteria that cause souring of wort, such as *Lactobacillus* and other bacteria that can lead to some really rank off-flavors. In fact,

the most common application to overnight mashing is for sour mashes where the temperature is intentionally allowed to drop into the realm of these "bugs" that so effectively turn mash sour. Perhaps the best method to guarantee that the mash stays in the 150 °F (60 °C) range is to put the mash into an oven set at its lowest temperature. I strongly suggest you verify that the lowest temperature is not too hot for the mash before chucking your mash into your oven for a 10-hour bake! However, it sounds like you have a very well-insulated mash tun if the mash only drops 10 °F (5 °C) over 10 hours.

As long as the mash temperature is adjusted to address concerns about overly-fermentable wort and bacterial spoilage, your method is a real daylight time saver!

Dastardly DMS

I have a problem and I need your help! I have been brewing all-grain for a couple of years and have won some ribbons in local competitions. However, every time I brew a light Kölsch or Pilsner I get a massive dose of DMS in my beer. The DMS does not show up until the beer carbonates and everything else about these brews goes well. As far as I know, the only thing I do differently is omit the gypsum from the mash to leave the water as soft as possible. Could this affect my mash pH, with the lack of any dark malts or gypsum in the mash to help correct it? How much gypsum is enough? My water is of medium hardness and I filter for chlorine. I know that Klages two-row malt is prone to DMS. Would a different base malt for the light beers be better?

Mark Stoakes
Woodbridge, California

The great thing about DMS problems in beer is that they are easy to identify and easy to rectify. DMS, or dimethyl sulfide, is derived from a compound found in malted barley called S-methylmethionine (SMM). When SMM is heated, it is converted to DMS. DMS has that wonderfully aromatic property that reminds one of canned corn . . . mmmm, canned corn.

Malted barley is heated in two key steps during malting and brewing. Malt is first heated during malt kilning and then it is heated again during mashing and wort boiling. SMM is converted to DMS during these hot processes and much of the DMS can be removed with vapor if the duration of heating is sufficiently long.

Very pale malts are exposed to as little heat for as little time as possible during kilning to prevent darkening. The goal with these very pale malts is to dry the grain, but not to toast or roast it. Consequently, pale malts may contain a lot of SMM since they have not had sufficient time at high temperatures to convert the SMM to DMS and drive the DMS from the malt.

Darker malts — like pale ale malts, crystal malts, Munich malts and roasted malts — contain much less SMM and much of the DMS formed from SMM has been driven off the grain during kilning.

Klages is a barley variety. Very pale Klages malts will have more DMS than darker malts made from Klages. It's the malt color that is the real factor with DMS, not the barley variety.

The problem with pale malts can show up in the brewhouse when SMM is converted to DMS during mashing and boiling, yet deficient evaporation during boiling leaves enough DMS in the wort to be detected in the finished beer. Increasing boil vigor helps if this is the case.

Another frequent cause of DMS is prolonged exposure to high temperatures after boiling. These holds will permit SMM to convert to DMS, but since the wort is not boiling, the DMS is not driven from the wort. This is one of the reasons why brewers like to rapidly chill wort. Mash pH and water salts, while very important for other reasons, do not play a role in the DMS equation.

In your particular case, you are using a pale-colored malt to make lightly flavored beers. Lightly colored beers typically have more DMS than darker beers because of the light malts and also because DMS is not masked by the strong malty aromas typically found in darker beers. It is very common for two beers to have the same measured levels of DMS, but to have very different perceived levels — for example, a stout may have no detectable DMS aroma, while a Pilsner with the same measured level will have an obvious DMS smell.

So what is a brewer to do? Some do nothing different and buy into the notion that pale beers have a detectable DMS aroma. In fact, some brewers take the idea further and make the argument that DMS should be present in certain styles. Other brewers see this as a cop-out for not being able to reduce the levels — it's the old "if you can't beat 'em, join 'em" mentality. The brewers who do not like DMS in their beers because they think the aroma is offensive aggressively take measures to minimize DMS in their beer.

Methods of minimizing DMS

include more vigorous wort boiling, resulting in better conversion of SMM to DMS and greater evaporation of DMS. Some commercial brewers are using thin film-type evaporators in which a thin film of wort is pumped over a hot surface to further reduce the levels of DMS in the wort. Anheuser-Busch has for many years used a device they call a "wort stripper" to reduce the levels of DMS in its beers. Other brewers have turned to changing how the wort is handled after boiling.

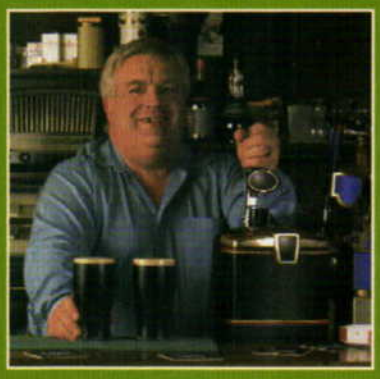
In a recent article published in the *Master Brewers Technical Quarterly* (Volume 39, Number 3, 2002), a group from Huppmann — a well-known German brewhouse supplier — presented a modification to wort cooling in which the wort is cooled to about 192 °F (89 °C) as it is transferred to the whirlpool. Their data shows a dramatic reduction in the increase of DMS due to the long stand in the whirlpool. (Commercial brewers hold hot wort in the whirlpool during cooling and the total time in the whirlpool is typically 60–75 minutes).

They reported the DMS after wort boiling to be about 18 parts per billion. The batch that was pre-cooled on the way to the whirlpool contained 47 parts per billion of DMS after a 30-minute hold in the whirlpool. The batch that was not pre-cooled, the experimental control, contained 87 parts per billion of DMS after the same 30 minutes in the whirlpool. This is a dramatic illustration of how SMM is converted to DMS when heated.

Some brewers deal with DMS problems by reducing its source. In other words, they replace malted barley with adjuncts, like rice, that do not contain SMM and do not contribute DMS to beer. This method is not for all brewers, but it is a viable technique.

No DMS answer would be complete without mentioning that certain wort spoilage bacteria can contribute DMS aromas to beer. *Obesumbacterium* in particular can cause real problems if brewhouse equipment is left sitting with wort. This problem is far more common in commercial systems where cleaning "dead legs" are more common and dirty equipment is often invisible. Wort coolers are notorious hiding places for wort and bacteria because of nooks and crannies that are often difficult to completely clean. I am quite sure this is not your problem, but I had to mention it. Good luck with those lighter brews! ■

Do you have a question for Mister Wizard? Write to him c/o Brew Your Own, 5053 Main Street, Suite A, Manchester Center, VT 05255 or send your e-mail to wiz@byo.com. If you submit your question by e-mail, please include your full name and hometown. In every issue, the Wizard will select a few questions for publication. Unfortunately, he can't respond to questions personally. Sorry!



MOUNTMELLICK BEERKITS

THE GENUINE ARTICLE

A BEER by any other name

The convoluted tale of the traditional festbier called MÄRZEN-OKTOBERFEST-VIENNA ... and details on brewing this lip-smacking Bavarian style at home.

by horst dornbusch

OKTOBERFEST by the numbers

OG	....1.050–1.063 but commonly above 1.055 (12.5–15.75 °P)
FG	.....1.013–1.016 (3.25–4 °P)
SRM	...usually 10–14
IBU	....23–27 (sometimes less)
ABV	...usually 5–6.2%

A BEER STYLE is usually named after its place of origin, its key characteristic, or both. Typical examples are the Irish red ale, the London porter or the Bamberg rauchbier. But there is one oddly named Bavarian beer that takes its moniker from two months of the calendar: March and October (spelled März and Oktober in German). In addition, this brew is labeled a "fest beer" (festbier in German). Some experts argue that the designation "Vienna" ought to be added to the name as well, thus making the beer's strange handle even longer. Hence the title of Volume Four of the Classic Beer Style Series, written by Laurie and the late George Fix: "Märzen-Oktoberfest-Vienna" (Brewers Publications, 1991). In spite of the "Vienna" appendix, this style is usually associated with Munich.

So what's in a name? Lots.

Why is this beer style surrounded by such verbal convolution? "Nomen est omen," the Roman comedy writer Titus Maccius Plautus (254–184 BC) is reputed to have penned in ancient times. The phrase means "a name is an indicator." This beer's cumbersome appellation tells the tale of its peculiar and meandering historical evolution.

About half a millennium ago, brewers in Bavaria had difficulty controlling the quality of their brews in the summer. They didn't have a clue why their beers often tasted awful during the hot season, while beers brewed roughly between early October and the end of March tended to taste clean and appetizing. Nowadays we understand that, in the foothills of the Alps, it got much too cold in the fall and winter for most airborne microbes to survive and spoil the brew. So Bavarian brewers resorted to a simple strategy to ensure a drinkable beer supply for the summer: They worked overtime in late winter to make plenty of higher-gravity and well-hopped "March" beer. This is how Märzen-Oktoberfest-Vienna came to the Märzen part of its name.

Unfortunately, we have only vague hints as to the composition of this original Märzen brew. It probably came in at a starting gravity of no less than OG 1.060 and a bitterness of perhaps as much as 40 IBUs. Most likely this beer was full-bodied. Its color was probably a darkish amber to deep brown, anywhere in the range of an English brown ale, an altbier or a dunkel.

After fermentation, the Märzen was stored in casks in cool cellars and mountain caves, some filled with ice from the winter. It was released gradually starting in late spring or early summer. The high alcohol content, the high acid and tannin levels from the hops, and the ideal storage conditions ensured that this beer kept well and actually improved as summer turned into fall. It probably became especially good near the end, when the hops mellowed out and the brew's malty character moved to the fore. By October, however, after the year's grain harvest, the last of the Märzen had to be drunk so that the precious casks could receive the season's fresh beer. Combine the pressure on those poor Bavarian brewers to empty the barrels with their propensity for having a jolly good time, and the concept of an Oktoberfest emerges automatically — as does the second part of the name.

Like most medieval beer styles, Märzen evolved with advances in the art of brewing. It underwent its first systematic, brew-technical change in 1841 at the hands of two friends, Gabriel Sedlmayr and Anton Dreher. These gentlemen were the owners of the Spaten Brewery of Munich and the Dreher Brewery of Vienna, respectively. Both brewers cooperated in lightening the color of the traditional Märzen grain bill (Dreher more so than Sedlmayr) by adding a new, slightly caramelized, but fairly pale malt to the grist — a malt that we now call Vienna (approximately 3–4 °Lovibond). At that time, Sedlmayr was using nothing but lager yeast for his Märzen, while Dreher was not. So Dreher switched to

PHOTOS COURTESY OF GERMAN NATIONAL TOURIST OFFICE

Oktoberfest was officially born on October 12, 1810, the day the Crown Prince of Bavaria got married and threw a big bash for the commoners. The modern-day festival lasts more than two weeks and is held in the same Munich meadow where it began.

Sedlmayr's yeast. In Munich, the new beer continued to be called a Märzen, but with the cosmopolitan tagline "gebraut nach Wiener Art" (brewed the Vienna way). But on Dreher's home turf, in Vienna, the new beer was given a new and separate style designation: Vienna lager. And this is how Märzen-Oktoberfest-Vienna beer acquired the remaining portion of its long name.

A Central-European lager becomes a modern beer style

The "Vienna way" of brewing was arguably more of a marketing ploy than a brew-technical term. It was true that the color of the two 1841 brews was significantly lighter than the standard beers of the day. But the brew was not yet as blond as the Pilsner lager, for instance, which was to be introduced a year later by the Burgher Brewery of Pilsen. In reality, both Dreher's and Sedlmayr's beers were still made the traditional Munich way, with an emphasis on multi-step decoction, the use of caramelized malts for body and some nutty sweetness, relatively long wort boils and low hopping rates to preserve the brew's predominantly malty character, and relatively long lagering periods for mellowness.

The Munich Märzen of "the Vienna way" was "re-Bavarianized" in 1871, when Spaten introduced at that year's Munich Oktoberfest a reformulated Märzen with plenty of Munich malt. This was the first time that the Märzen beer was marketed under the explicit brand name of Oktoberfestbier. In a way, the old Märzen-Oktoberfest-Vienna beer had come full circle.

Also, with the spread in the nineteenth century of scientific brewing methods — especially of controlled malting, yeast management, refrigeration and beer filtration — Bavarians could by then brew great-tasting beers of any style at any time of the year, not just during the cold season. So there was no longer a need to mass-produce Märzen-Oktoberfestbier in the spring. Instead the Munich brewers made this beer only when they wanted to — as a special style — often with an OG in the mid- to upper-1.050s. They also shaved some time off the long lagering periods that were standard for Märzen-Oktoberfest in the Middle Ages.

In a modern brewery, storing beer in refrigerated stainless-steel tanks for six months is considered an expensive luxury. Such extensive lagering is practiced only when it is a technical necessity. So brewers started to package their beers, including their spring offerings, as soon as they were considered "ready." Such less-aged Märzen-Oktoberfest beers are often marketed without the Oktoberfest suffix on the label. Judging by the practices of the big modern breweries in Munich, a Märzen beer may now be lagered no longer than six to eight weeks. A beer that still carries the hyphenated Märzen-Oktoberfest designation (or just the Oktoberfest name), on the other hand, is likely to have stayed in the tanks for about 12 to 16 weeks.

With changes in the Märzen-Oktoberfestbier also came an evolution of the notion of a "fest" beer. The Bavarians have never been content with just one beerfest per year. There are plenty of historical and religious holidays for which Bavarian brewers have been making special, and usually rather strong, beers. Thus emerged a separate festbier style. A modern Bavarian festbier may be a lager or an ale, and it is often as dark as a dunkel and as hefty as a doppelbock. It is generally designated a starkbier (strong beer), a category reserved for brews with an OG between 1.064 and 1.112. So the typical modern Oktoberfestbier is no longer a true festbier!

A three-part style definition

From this historical discourse it ought not to be surprising that the style definition of the Märzen-Oktoberfest-Vienna is somewhat fuzzy and a bit controversial. Perhaps the easiest solution for the contemporary homebrewer is to distill the following distinctions from the brew's three-part name and from its changing character over time.

1. Let's use the term Vienna lager only for a medium-bodied brew made "the Vienna way," with plenty of Vienna malt and aged no longer than two months. Its OG should not exceed 1.050 and its alcohol by volume should be 4.5%, give or take 0.4%. Because of its Vienna malt content, its SRM value should be on the golden side of the amber scale, within a range of 5 to 10. As such, and with apologies to the knowledgeable George and Laurie Fix, we might want to consider the Vienna lager a thoroughly separate style from the Märzen-Oktoberfestbier.

2. Then let's reserve the term Märzen only for a full-bodied lager made with plenty of Munich, instead of Vienna, malt. Like the Vienna lager, it should be aged up to two months, but its OG should be above the top Vienna limit of 1.050 and below the bottom of the starkbier limit of 1.064. The Märzen's alcohol by volume should be no lower than 5%, and preferably closer to 6%. Its SRM value should be a deep amber, within a range of 10 to 14.

3. Finally, let's give the term Oktoberfestbier (or Märzen-Oktoberfestbier) simply to a true Märzen that is aged at least two but no longer than six months. By these definitions, all Oktoberfest beers start out as Märzens (thus the hyphenated name is justified), but not all Märzens become Oktoberfest beers; and none of them are Vienna lagers.

These distinctions may raise hackles, but they are simple, sensible, practical and historically defensible. With these rough brewing guidelines, the Märzen-Oktoberfestbier becomes truly a beer for all seasons. You just have to vary the length of the lagering period. If you wish to adhere to tradition, you can brew the beer around the first day of spring. Then you can start drinking it as a Märzen in June. If you allow all or part of it to lager for another two months, as many modern breweries do, come August or September, you can enjoy it as an Oktoberfestbier. Finally, you can even give the beer its medieval six months' maturation time and then have your own little Oktoberfest on Columbus Day. And for good measure, because this beer keeps well, you can polish off any Oktoberfestbier that survives your fall imbibing as a satisfying winter warmer.

As any brewer knows, the higher your beer's original gravity (OG) and thus alcohol level, the longer you can usually keep it, provided you adhered to proper sanitation rules and you stored the brew in a cool, dark place. The recipe for our Princess Theresa's Oktoberfestbier (see recipes on page 27) has been formulated for an OG of 1.060 and an ABV of approximately 5.8%. This should give you at least one year to consume your batch.

Ingredients and brewing

My recipe for this beer has been tested repeatedly in five-gallon (19-liter) batches. In addition, I have brewed the all-grain version of this recipe several times in a 30-barrel system under my own commercial label of Dornbusch Oktoberfest.

All-grain brewers should note that the specified grain amounts are for a system with an extract efficiency of approximately 66%. If you know the efficiency of your system, you can adjust the grain proportionally to yield five gallons at the target gravity. Otherwise, either your volume or gravity yield will vary. You can customize recipes by scaling quantities (except the brewing liquor) up or down by a few percentage points to brew heftier or lighter versions. You can achieve the same effect by either extending the boil time beyond 90 minutes for more evaporation, or by liquoring down your wort to any gravity you prefer within the style's OG range.

Grains and malt extract

In the nineteenth century, many central European lagers, both amber and blond, were made from two-row

FEST FACTS

Oktoberfest started out as an informal affair, probably sometime in the fifteenth century. The brew was the Bavarians' traditional summer beer, and the fest was their excuse to polish off any leftover summer beer in the fall.

The date of Oktoberfest's great transformation from happy-go-lucky get-together to official celebration was October 12, 1810. On that day, the Bavarian Crown Prince Ludwig married Princess Theresa of Saxony-Hildburghausen. The noble couple organized a wedding party for the common folk on some grazing land outside the Munich city gates — and 40,000 happy Bavarians showed up for the fun. The meadow was then named of Theresienwiese (Theresa's meadow) in honor of the Princess. To this day, the same meadow is still the site of the annual Munich Oktoberfest.

Strangely, the most popular attraction of the festival in 1810 was horse racing, not beer ... because there wasn't any! By 1814, however, the German poet Achim von Arnim reported that the festivities featured an ample array of beer shacks where people could buy suds in half-liter steins. Eventually the festivities were extended to several days.

Today, the Oktoberfest lasts more than two weeks, during which Theresa's once-pastoral meadow is covered by a dozen huge beer tents. In these canvas monsters, with oompah bands blaring, congregate six million noisy revelers from all over the globe. They are there, it seems, for only one purpose: To down more than six million liters (roughly 1.75 million gallons) of beer. This consumption accounts for about 30% of the entire annual beer production of all the Munich breweries combined. To put this into a homebrew perspective, we are talking about 350,000 five-gallon carboys! These visitors also munch a staggering 400,000 sausages.

The Munich Oktoberfest has become by far the biggest party in the world. But the full-bodied Oktoberfestbier, which used to dominate the fest, is no longer its signature brew. The hefty, deep-amber Oktoberfestbier, though still served as "festbier," has long since been replaced for mass consumption in the beer tents by a more quaffable brew, the lighter Bavarian pale lager, the helles. —*H.D.*

summer barley varieties, such as Hanna and Kniefl, that were grown in Moravia (which is now, next to Bohemia, part of the Czech Republic). These varieties have long since been replaced by selectively-bred, higher-yield barley crops. Nowadays, their characteristics are most closely reflected in Pilsner-style malts. Using pale Pils malt as a foundation grain as well as specialty color malts based Pils-type grains is essential for an authentic Märzen-Oktoberfestbier. The malt that best fits the bill is Weyermann from Bamberg in northern Bavaria. These grains have enough of a protein level for a good head (about 10.5%), but not too much protein to cause a stuck mash, considering the substantial grain loading of this OG-1.060 brew. Also, these grains provide the strong maltiness that will become mellow and rounded after the long aging period. Lesser grains, especially lesser color malts, can impart a harsh and raw, instead of smooth and complex, maltiness that would turn the brew into an inferior representation of the style.

For the same reasons, extract brewers should stick with top-quality German-style canned malts. For these malts I have two favorites, Bierkeller (in 1.5-kilogram cans) and Weyermann (in 4-kilogram plastic jerry cans). I tend to follow a simple rule of thumb: The more local the beer style, the more local should be its ingredients, if you want to make an authentic brew. The more universal the style (as is the case with pale ale or stout, for instance), the broader is your spectrum of acceptable ingredients. Märzen-Oktoberfestbier, in my view, falls into the category of a local style, which calls for a local malt-extract selection as well.

Water and the boil

The water of the region from which Märzen-Oktoberfestbier comes varies slightly, from medium hard (about 250 ppm carbonate hardness in Munich) to about 100 ppm carbonate hardness in the Bavarian Forest near the Czech border.

A long boil is usually recommended by German brewers of this style, because melanoidins and pigments are formed in the kettle through the so-called Maillard reaction. Many brewers believe that this reaction between amino acids and carbohydrates, which occurs during a prolonged rolling boil, contributes to wort browning. Recently, however, there has been some controversy among brew scientists as to whether or not the color contribution from this reaction to the wort is a myth or reality. But because brewers have been making great Märzen-Oktoberfestbiers with a long boil for a long time, I bow to tradition. A 90-minute boil is sufficient to make a great Oktoberfestbier, but I still prefer a two-hour boil, even if the browning effect turns out to have been just a tale.

Picking the right hops

The most authentic hop varieties for this beer style are those that accentuate "nobility" of aroma, that is, hops that are relatively low in cohumulone (an alpha acid), but relatively high in humulene (a delicate aroma oil). There are many hop varieties that would work, but in my opinion some are more suitable for Märzen-Oktoberfest than others. Even though some authors recommend Saaz for this beer, I find the aromatic reverberations that Saaz leaves behind on the palate to be incompatible with the deep, smooth maltiness that should predominate in this beer's aftertaste. For bittering I have chosen Hallertauer and for flavor and aroma I have chosen Tettnanger. These are always safe bets for Bavarian-style, malty beers. You can use any of the Hallertauer derivatives, such as Magnum or Mittelfrüh, or the North American triploid Mt. Hood. The Tettnanger varieties tend to add just a touch of spiciness to the brew. But freshness of the hops is key, especially for the Tettnanger, which can taste just a bit grassy or even cheesy if it gets old.

"Nobility" in hops is largely defined by the relative proportion of humulene as part of the total amount of aroma substances. For the complex finish of a Märzen-Oktoberfestbier, you want to balance the strong, deep maltiness with delicate aromatics ... and humulene is the right tool for the task. To give you a point of reference, in most hop varieties humulene makes up less than 20 percent of the aroma substances, and a humulene proportion of 55 percent is considered exceptional in the nobility pecking order. Tettnanger, for instance, tends to have a low alpha-acid rating (often between 3 and 5 percent, which is why it is rarely used as a bittering hop), but about 25 percent of its aroma substances come from humulene. Actual values vary from one growing year to the next. Based on this "blue-blooded" perspective, here are a few guidelines for playing with the noble-hop load of a fine, malt-accented Märzen-Oktoberfestbier:

If you want to use only one hop variety, go with Hallertauer Magnum for bittering, flavor and aroma. Magnum tends to have an alpha-acid rating of about 12 to 14 percent (which gives you a great bittering bang for your hop buck) and a substantial humulene content of around 35 percent of all aroma substances.

If you want to use two different hop varieties but do not care for Tettnanger, you can stick with Magnum for bittering and use Hallertauer Mittelfrüh for flavor and aroma. Mittlefrüh is a good choice for aroma, because more than 50 percent of the aroma substances of this hops are humulene. This Magnum/Mittelfrüh combination can be a mellow sensation, especially if you want to lager the beer for several months.

Perle might be a good compromise hops for bittering, flavor and aroma, because it tends to have about 5 to 8 percent alpha acids, while its humulene content makes up about 35 percent of all aroma substances.

Bavarian lager yeast

An Oktoberfestbier can be made with any good Bavarian-type lager yeast, including Wyeast 2206 (Bavarian Lager), Wyeast 2308 (Munich Lager), White Labs WLP838 (Southern German Lager), or White Labs WLP920 (Old Bavarian Lager). Oktoberfestbier is only moderately effervescent, so do not overdo the priming. Half a cup of dry malt extract (DME) or corn sugar should be plenty for five gallons (19 liters). ■

EINS, ZWEI, DREI ... A trio of tasty Oktoberfest recipes

Princess Theresa's Oktoberfestbier

(5 gallons/19 liters, all grain)
OG = 1.060 FG = 1.014
SRM = approx. 13 IBU = 25
ABV = approx. 5.8%

Ingredients

10.67 lbs. (4.8 kg) pale two-row (2° L)
1.3 lbs. (0.58 kg) dark Munich (20° L)
0.50 lb. (0.23 kg) crystal (60° L)
5.6 AAU Hallertauer or Mt. Hood hops (bittering) (1.3 oz./36.4 g of 4.3% alpha acid)
0.6 oz. (16.8 g) Tettnanger hops (flavor)
0.3 oz. (8.4 g) Tettnanger hops (aroma)
Wyeast 2206 (Bavarian Lager), Wyeast 2308 (Munich Lager), White Labs WLP838 (Southern German Lager), or White Labs WLP920 (Old Bavarian Lager) yeast
1/2 cup DME or corn sugar

For a paler version of this beer, you can substitute the 1 lb. (0.45 kg) of Munich malt with 0.5 lb. (0.23 kg) each of Munich and Vienna malt. Another way of "playing" with the brew's color is to use Munich malts of different color ratings. Munich malts are available in colors between roughly 5 and 20 degrees Lovibond.

Step by Step

This beer traditionally has been brewed by the multi-step decoction method, but most experts agree that, given the quality of modern grains, infusion mashing can produce more than adequate results.

These instructions, therefore, are for a multi-step infusion mash, which starts, as is common in Germany, with dough-in at a temperature of approximately 122 °F (50 °C). Let the mash rest for about half an hour before infusing it with hot water until the temperature reaches 148 °F (64 °C). Keep the mash at that temperature for a second, 15-minute, rest. Infuse again to raise the temperature to 156 °F (69 °C) for a third rest, also of 15 minutes. Then start sparging, slowly, with almost-boiling water. Check the mash temperature frequently during the sparge. Make sure that it does not increase beyond 170 °F (77 °C). Lower the sparge water temperature, if need be. Expect the sparge to last an hour and a half or even longer. Check the run-off gravity frequently near the end of the sparge, and end the sparge when the gravity reaches 1.012. This avoids leaching out astringent compounds from the grain husks, which would ruin the rounded, malty character of the beer style. Then check your kettle gravity. If you need to make adjustments to your wort gravity in the kettle, do so by adding water or lengthening the boil time at the end.

Boil the Märzen-Oktoberfestbier for at least an hour and a half. Add the bittering hops one hour before shutdown (usually about 30 minutes into the boil). Add the flavor hops about 5 minutes before, and the aroma hops about 5 minutes after, shutdown. Stir the wort very gently (to avoid aeration) in a circular motion with a spatula to create a whirlpool effect. Wait about half an hour, then heat-exchange the wort as close to the fermentation temperature of 48 °F (9 °C) as your setup allows. Aerate the cool wort, pitch the yeast, and place your fermentation vessel into a refrigerator set to the fermentation temperature. Let the brew ferment to the finish, which can take as much as three weeks!

Then rack the brew and let it "warm" up to roughly 59–64 °F (15–18 °C) for a diacetyl rest of about two days. Then pull down the brew's temperature gradually by 2–3 °F (1–1.5 °C) a day. Keep the beer as close as possible to the optimum lagering temperature, which is approximately 28 °F (-2 °C). Lager the brew for as long as you wish, but no less than 6 weeks and no more than 6 months, after which rack the beer a final time and prime it.

Princess Theresa's Oktoberfestbier

(5 gallons/19 liters, partial mash)
OG = 1.060 FG = 1.014
SRM = approx. 13 IBU = 25
ABV = approx. 5.8%

Ingredients

7.25 lbs. (3.3 kg) Bierkeller or Weyermann plain light (Pils) malt extract
1 lb. (0.45 kg) dark Munich malt (20° L)
0.50 lb. (0.23 kg) crystal malt (60° L)
5.6 AAU Hallertauer or Mt. Hood hops (bittering) (1.3 oz./36.4 g of 4.3% alpha acid)
0.6 oz. (16.8 g) Tettnanger hops (flavor)
0.3 oz. (8.4 g) (Tettnanger hops (aroma)
Wyeast 2206 (Bavarian Lager), Wyeast 2308 (Munich Lager), White Labs WLP838 (Southern German Lager), or White Labs WLP920 (Old Bavarian Lager) yeast
1/2 cup DME or corn sugar

Step by Step

Coarsely mill the two specialty malts and pour them into a muslin bag. Place the bag in at least two gallons of cold water and raise the temperature slowly, for at least half an hour, until it reaches 170–190 °F (77–88 °C). At this point bubbles should start to pearl up in the liquid, but the pot must not boil! Lift the bag out of the steeping liquid and rinse it with several cups of cold water. Do not squeeze the bag. Discard the spent specialty grain and fill your kettle to the usual volume. Bring the liquid to a boil, turn off the heat, and stir in the canned extract. Bring the wort back to a boil and add the bittering hops. Boil for one hour. Follow the all-grain instructions for adding the flavor and aroma hops as well as for heat-exchanging, fermenting, lagering and priming.

Princess Theresa's Oktoberfestbier

(5 gallons/19 liters, extract only)
OG = approx. 1.060
FG = 1.012–1.014 SRM = approx. 13
IBU = 25 ABV = 5.8–6%

Ingredients

7.25 lbs. (3.3 kg) Bierkeller or Weyermann plain amber malt extract
1.0 lbs. (0.45 kg) Bierkeller or Weyermann plain light (Pils) malt extract
5.6 AAU Hallertauer or Mt. Hood hops (bittering) (1.3 oz./36.4 g of 4.3% alpha acid)
0.6 oz. (16.8 g) Tettnanger hops (flavor)
0.3 oz. (8.4 g) Tettnanger hops (aroma)
Wyeast 2206 Bavarian Lager, Wyeast 2308 Munich Lager, White Labs WLP838 Southern German Lager, or White Labs WLP920 Old Bavarian Lager
1/2 cup DME or corn sugar

Step by Step

Mix the two malts with your hot brewing water in the kettle. Stir thoroughly to dissolve. Bring the wort back to a boil and add the bittering hops. Boil for one hour. Follow the all-grain instructions for flavor and aroma hops as well as for fermenting, lagering and priming your beer. *—H.D.*

HOP to STYLE

by Mark Garetz

WHEN YOU'RE TRYING TO BREW A BEER in a particular style, you obviously need a recipe. The recipe will primarily consist of grains or malt extract, hops and yeast. Proper selection of these ingredients will determine how close you come to hitting the style on the mark.

While grains and yeast are just as important, this article will focus on picking the right hops for your chosen beer style. We can't possibly cover each and every style, so we'll focus on a collection of broad — and popular — categories.

Note: *In this article I'll be mentioning some hop amounts. These are all in relation to a five-gallon (19-liter) batch of beer. Adjust accordingly if your batch size is different!*

Bittering Hops Versus Flavor and Aroma Hops

There are basically two times I recommend that you add hops to beer (others may disagree, but it's my article!). The first time to add hops is near the beginning of the boil. This allows the alpha acids in the hops to be converted into iso-alpha acids, which give beer its balancing bitterness. Alpha acids are not soluble in beer, so they cannot contribute any bitterness. Boiling converts these alpha acids into iso-alpa acids, which are soluble in beer and therefore lend bitterness to your batch.

The other time you should add hops is near the end of the boil (or sometimes after the boil). This allows the oils in the hops to impart flavor and aroma to the beer. The hop oils contain the aroma and taste components of the hops. The oils aren't bitter, but they're very volatile. That means they evaporate easily. When hops are added for bittering near the beginning of the boil, almost all of their oils (and therefore the aroma and flavor effect of the oils) get boiled away. Adding hops at the end of the boil allows a lot of the oils to remain in the beer, but the boil time is too short for any significant amount of the alpha acids to be isomerized. So the late additions contribute to aroma and flavor without adding any bitterness to the beer. We'll call the first addition the "bittering hops" and the later addition we'll refer to as the "finishing hops." Some beers have no finishing hops, but almost all beers have bittering hops.

Within each style section, I'll give you the recommendations for both types of additions: bittering and finishing.

American Pale Ale

The commercial prototype for this style is Sierra Nevada Pale Ale. This beer has an aggressive bitterness and a distinct hoppy character. The hoppy character comes from the choice of hops and the method in which they are used.

Bitterness of the American pale ale ranges from 25 to 35 IBUs. You can use whatever sort of hops you like for bittering, though American hops are the most common choice. I tend to use Galena, as I think it provides a clean bitterness that's pretty neutral in character. You could also use something that works well with the finishing hops, such as the finishing hop itself or Centennial or Columbus.

Sierra Nevada, for example, is finished with Cascade ...

How to pick the **RIGHT KIND** of **HOPS** for the **STYLE** of **BEER** you want to brew.

PHOTO BY CHARLES A. PARKER/IMAGES PLUS

Hops add **bitterness** to beer, and also contribute to its **aroma** and **flavor.**

1. Fresh hops immediately after the harvest.
2. Mount Hood: Mild, pleasant and clean, somewhat resiny.
3. Half-grown hops reaching up a trellis.
4. Harvesting hops in the field.
5. Hops hanging on the vine.
6. Liberty: Clean aroma, slightly spicy character.
7. Training hops around the trellis.
8. Perle: Floral, slightly spicy, a pick for pale ale.

lots of Cascade. Many West Coast pale ales use Cascade for the finishing hop. It has a pronounced citrusy aroma. Some brewers apply it in two steps. First they add some hops before the end of the boil (about 5 minutes), and then they filter the hot wort through a hopback that is loaded with more Cascade. (A hopback is merely a fancy strainer. It originally was used to catch boiled hops when the kettle was being drained. Then brewers discovered that if they added fresh hops to the hopback, it gave the beer a distinct hop aroma.) You can do the same at home (if you use whole hops; strainers don't work with pellets) or simulate the effect by adding some hops after turning off the boil and letting the hops steep in the wort for 20 minutes or so (this technique, on the other hand, works with whole, pellet or plug hops).

Some American pale ales are finished with hops other than or in addition to Cascade. Centennial is quite popular, as is Columbus. Columbus is quite strong and some people don't like it. Try mixing these with Cascade or use them on their own. Columbus and Centennial are popular in West Coast IPAs.

Pale ales brewed on the East Coast tend to be more mellow than their West Coast counterparts. The hops may lean more towards the English varieties; some East Coast pale ales even use lager hops. You might try using Willamette for finishing instead of Cascade. Willamette is a clone of Fuggle and will have an English character. Another option is Mt. Hood. Mt. Hood is a clone of Hallertauer Mittelfrüh, the classic lager hop.

A West Coast India Pale Ale is a stronger version of the American pale ale. Bitterness clocks in at 35 to 45 IBUs and the beer has a definite hop aroma. This is achieved through a technique known as "dry hopping." Dry hopping is the process of adding hops to the beer during fermentation and it gives a beer a fresh hop aroma. Hop choices are the same as the American pale ale, but you simply use more of them! Depending on the recipe and your personal tastes, you might use 50 to 100 percent more dry hops than bittering.

Red ale is yet another version of pale ale. Reds have a different grain bill (to get the red color and the caramel notes that go with it) but are hopped pretty much the same

as pale ale. Depending on the brewery, these beers can lean a little towards the India Pale Ale side when it comes to hopping and they often are dry hopped, as well.

For finishing hops in a red ale, you can go with anywhere from 0.5 to 1.5 ounces (14 to 42 g), added 5 minutes before the end of the boil. I think one ounce (28 g) is the minimum, but I really like hoppy beers. If you also want to steep some hops, I usually try to match the finish hops. So if I use one ounce (28 g) of finishing hops five minutes before the end of the boil, I'll use another ounce (28 g) of the same kind of hops right after turning off the heat and then let them steep for 20 minutes with the lid on the brew kettle. This can be done while you're cooling the hot wort, if you are using an immersion chiller. The same one-for-one rule applies to dry hopping as well.

Barleywines are like a super-duper IPA. Bitterness can run as high as 60 IBUs. Finish hopping can follow the same recommendations as for IPAs, or you can turn up the volume even more, going to 2 ounces (56 g) at the end of the boil and another 2 ounces (56 g) dry hopped in the fermenter. (This rule holds true for barleywines like the classic Sierra Nevada Bigfoot. Other famous barleywines, like Old Foghorn and Thomas Hardy, are less bitter and require less hops. As always, let your palate be your guide.)

English Pale Ale

English pale ales fall into the same bitterness range as their American counterparts — about 25 to 35 IBUs, but occasionally you'll see them go a bit lower, down to 20. The bittering hop is not too important, as long as it's clean and neutral. I like Galena, but other excellent choices would be Northern Brewer or Cluster. Cluster is an American hop, but it is also a traditional British hop. How can this be? In the early part of the 20th century, many of the Cluster hops grown in the United States were exported to the breweries of England.

Finish hopping is where English differs from American pale ale. Obviously you'll want to use an English aroma hop for this style. The two most popular are Fuggle and Goldings. It would be ideal if you could get the real deal — hops imported from England. Many homebrew suppliers carry imported Fuggle and East Kent Goldings. You might be lucky enough to live close to one that does, or you could order them online.

If you can't find imported versions, try using domestically grown Fuggle or perhaps Willamette. Willamette is a seedless clone of Fuggle, which means it has most of the same characteristics as Fuggle, but is modified to grow without seeds. (For a variety of reasons, many brewers like seedless hops.)

One thing to be aware of is that imported East Kent Goldings and Fuggle hops tend to be a lot lower in oil content than typical domestic hops. This is partly due to the way they are dried, but also due to the long transatlantic voyage they must take to get here. What this means is that you'll have to use a lot more of them than you would think.

For example, if you've been brewing a nice English Ale using 0.5 ounce (14 g) of Willamette in the finish and you get some imported Fuggle to try instead, you'd be tempted to use the same amount. But you are likely to be disappointed. The imported Fuggle likely has half the oil as the Willamette or even less. I'd start by using twice as much Fuggle and see where that gets you. Some suppliers will give you the oil content when you buy the hops, but you can also use your nose as a great guide. Sniff both (after they've come to room temperature) and see if you think they are the same or not. Then take your best guess.

This is probably a good place to mention that finish hopping can have a pronounced effect on the mouthfeel of the beer. It can give it a perceived body that isn't there from the malt. This is really important in a beer like an ordinary bitter. This is often called a "session beer" because it is light enough in alcohol that you can drink many of them during a session. But it has to have good body. One of the secrets of getting there is with finish hopping. About 0.5 ounce (14 g) of finish hops,

HOP DETECTIVE

Where to get data if you want to clone a brew.

When I want to clone a commercial beer, I start by going to the source: Ask the brewery! Sometimes the data will be on the bottle, sometimes in their literature and sometimes on the company's Website. Failing any of these, it won't hurt to call and ask. Being told you can't have the information is no worse than not having asked! Taking a tour is another good way to do firsthand research. Often brewers are hanging about and you can just ask them (don't be a pest, though).

If you can't get the information directly, try looking in one of the beer guidebooks. These are the books that list popular beers and contain facts about the beer and the brewery. Be mindful of the date — don't get a book that is too old, as recipes do change. You can also buy one of the various "clone brew" books on the market. If the authors have done their homework, you'll get some good information.

A really bad way to get data is to look at other people's recipes, especially those that are posted the Internet. Some are great and others are spectacularly bad. The problem is that you may not know which is which. If you did, you wouldn't have to ask!

A good long-term strategy is to sample a lot of different kinds of beer — beer for which you know the hop data. (And one of the best ways to do this is to brew a lot of beer on your own.) Eventually, you should start to pick up on what hop does what. In cooking, this is what separates the good cooks from the mediocre. It's no different in brewing. — *M.G.*

added to the kettle 5 minutes before the end of the boil, does the trick.

English Porters, Stouts and Brown Ales

Porters run about 25-30 IBUs and stouts are a little stronger at 30 to 40 IBUs. (Imperial stouts can get as high as 60 IBUs.) It matters little what you use for bittering. Galena (there I go again) or Cluster will do. No need to waste expensive aroma hops for bittering here, as the roasted malt flavors should overpower the subtleties of the bittering hops.

Brown ales are lighter and more malty, so be sure to use a clean bittering hop. Galena or Cluster will work, but you could also consider using an aroma hop for bittering here. Choose one of the traditional English varieties or their clones (East Kent Goldings, Fuggle or Willamette). For some insight as to why, see the next section on American lagers (trust me!).

These beers are not traditionally finish hopped, but I like to use 0.5 ounce (14 g) of an English or English-style aroma hop (East Kent Goldings, Fuggle or Willamette) 5 minutes before the end of the boil to increase the mouthfeel of the beer.

You can apply this hopping advice to the range of Scottish ales as well. You can start out at 25 IBUs for the "lighter" Scottish ales and go all the way up to 40 IBUs for the really heavy-duty ones.

American Lagers

American lagers are really hard to brew at home, assuming your goal is to produce a beer along the lines of the Bud and Miller "megabrews." Bitterness on these beers is very light — 10 to 12 IBUs, which hovers at or just above the threshold for sensing any bitterness in beer. Bittering hops need to be super-clean and neutral. This beer style will also have zero finishing hops. You can use a high-alpha bittering hop like Galena, but a better strategy is to use a low-alpha finishing hop as your bittering hop. For this style of American lager I would choose Liberty or Mt. Hood.

Why would we use a low-alpha hop in this beer? Even though hops are almost non-existent in this beer style, we want them there for the subtle flavor the oils provide. Almost all of the oils will be boiled off, but very tiny amounts will make it into the finished beer. By using a low-alpha hop for bittering we'll have to use more and that will mean more oils. Secondly, they'll be the right kind of oils.

Here's another tip if you are making this beer super-light: Use more hops. Try a mid-boil addition of 0.5 ounce (14 g) of Mt. Hood. So if your boil time is 60 minutes, add these at 30 minutes. Cut back on the bittering hops a little to compensate for the mid-boil addition. This will help to increase the apparent body of the beer without adding much hop aroma and flavor.

German Lagers and Ales

In this category we'll be discussing German lagers and ales. We'll not include Pilsners (a lager) or wheat beers (an ale), because we'll discuss those styles later. That leaves Vienna, Märzen-Oktoberfest, Dortmunder, export, dunkel and Bock in the lager category and Kölsch and altbier in the ale category.

You might find this hard to believe, but you can hop most German ales and lagers (with the exception of Pilsners and wheat beers) pretty much the same. At least I've always gotten away with it!

Most German ales and lagers tend to emphasize malt over hops. Therefore they aren't too bitter (in the 20 to 25 IBU range), and they aren't too heavy on the finish hops either. You can use a clean bittering hop such as Galena, but my choice for these beers is Perle. This is a very mellow bittering hop and it also happens to be traditionally German. You also can't go wrong using a traditional German aroma hop for bittering. (See the next paragraph for suggestions.)

You'll want to finish these beers with a very light addition of a traditional German lager hop. I use about 0.5 ounce (14 g) of Hallertauer Mittelfrüh (if you can get it) or Hallertau Tradition. Spalt or Spalter Select are also good choices, but are somewhat hard to find. If none of these are available to you, then go with either Liberty, Mt. Hood or Tettnanger. Add these about 10 minutes before the end of the boil.

European Pilsners

This category consists of two types of Pilsners — Czech and German. These Pilsners can run the gamut from very low bitterness at 15 IBUs to quite bitter at 30-35 IBUs. The average seems to be around 25 IBUs. You can use any clean bittering hop or you can use aroma hops (see suggestions below) for bittering.

You might be surprised to learn that Pilsner Urquell — the original Pilsner — is bittered with Cluster! And my favorite German Pils (Jever) uses a hop extract. Perle is always a good choice, too.

What separates German from Czech Pils is the way these beers are finish hopped. Czech Pilsners almost always use the traditional Czech hop Saaz. Czech Saaz is sometimes hard to obtain. If you can't get it, you can substitute Polish Lublin, if you can find that! I've tried domestic Saaz and it's just not the same.

To get a real good hop aroma in your Czech Pils, you'll want to use lots of Saaz. I use about 1 ounce (28 g) five minutes before the end of the boil and then will steep another ounce (28 g) for 20 minutes after turning off the heat with the lid on. Some will say you should dry hop a Czech Pilsner. I disagree. You can do it if you like, but this article is about hopping to style and Pilsners aren't dry hopped.

Now I'm going to tell you the secret of how to get that elusive German Pils flavor: Tettnanger. Lots and lots of Tettnanger. I like to use Tettnanger for bittering as well as finish hopping when I'm making a German Pils. I'll typically use 1 ounce (28 g) of Tettnanger 5 minutes before the end of the boil, and sometimes steep another 0.5 ounce (14 g) as described above. Once in a while I'll put in 0.75 ounce (21 g) at 10 minutes before the end of the boil and another three-quarters of an ounce (21 g) at five minutes and not steep anything.

handy HOMEBREW HOPS guide

name	alpha acid %	typical beer styles	possible substitutes	flavor description
Admiral (U.K.)*	13.5 to 16%	Ale	U.K. Target, U.K. Northdown, U.K. Challenger	Known for its bittering potential.
Ahtanum	4 to 6.3%	Lager, American ales	Cascade, Amarillo	Floral, citrus, sharp and piney.
Amarillo	8 to 9%	Ale, IPA	Cascade, Centennial	Citrusy, flowery.
Bramling Cross (U.K.)*	5 to 7%	ESB, bitter, pale ale	U.K. Kent Golding, U.K. Progress, Whitbread Golding Variety	Quite mild, fruity currant aroma.
Brewer's Gold	7 to 8.5%	English ale	Bullion	Bittering hop with neutral aroma character.
Brewer's Gold (German)	6 to 7%	Ale, heavier German-style lagers	Northdown, Northern Brewer, Galena, Bullion	Black currant, fruity, spicy.
Bullion	6.5 to 9%	IPA, ESB, stout	Columbus, Northern Brewer, German Brewer's Gold	A rich hop primarily used for bittering. Intense black currant aroma.
Cascade	4.5 to 7%	Pale ale, IPA, porter, barleywine	Centennial, Amarillo, possibly Columbus	Flowery, citrusy. Can have a grapefruit flavor.
Centennial	8 to 11.5%	All ale styles, has been used with wheat beer	Cascade, Columbus, Chinook	Medium with floral and citrus tones.
Challenger (U.K.)	6.5 to 8.5%	English-style ales, porter, stout, ESB, bitter	U.S. or German Perle, Northern Brewer	Mild to moderate, quite spicy.
Chinook	10 to 14%	Pale ale, IPA, stout, porter, lager	Nugget, Columbus, Northern Brewer, U.K. Target	Mild to medium-heavy, spicy, piney and grapefruity.
Cluster	5.5 to 8.5%	Ale and lager (good aroma for ale, good bittering for lager)	Galena	Medium and quite spicy.
Columbus	11 to 16%	IPA, pale ale, stout	Nugget, Chinook, U.K. Target, Northern Brewer	Pungent.
Crystal	2 to 4.5%	Lager, pilsner, ESB	Mt. Hood, Hersbrucker, French Strisslespalt, Liberty, Hallertauer	Mild, spicy and flowery.
First Gold (U.K.)	6.5 to 8.5%	Ale, ESB	U.K. Kent Golding, maybe Crystal	A little like Golding family; spicy.
Fuggle (U.S.)	4 to 5.5%	Any English-style beer or American ale	U.K. Fuggle, Willamette, Styrian Golding, U.S. Tettnanger	Mild, woody and fruity.
Fuggle (U.K.)	4 to 5.5%	All English-style ales, ESB, bitter, lager	U.S. Fuggle, Willamette, Styrian Golding	Mild, pleasant and hoppy.
Galena	10 to 14%	Ale, porter, stout, ESB, bitter	Nugget, Pride of Ringwood, Chinook	Citrusy.
Golding (U.S.)	4 to 6%	Pale ale, ESB, all English-style beer	U.K. Golding, Whitbread Golding Variety, U.K. Progress, and possibly the Fuggle family	Mild, extremely pleasant and gently hoppy.
Hallertauer (U.S.)	3.5 to 5.5%	Lager, pilsner, bock, wheat	Liberty, Ultra, Hallertauer Tradition	Very mild, pleasant and slightly flowery, some spicy.
Hallertauer Gold*	6 to 6.5%		Crystal, Mt. Hood	Known for aromatic properties similar to Hallertauer.
Hallertauer Mittelfrüh	3 to 5.5%	Lager, bock, wheat, maybe pilsner	Liberty, German Tradition, Ultra	Mild and pleasant.
Hallertauer Tradition (Ger.)	3.5 to 5.5%	Mild-flavored beers	Crystal, Liberty	Very fine, similar to German Hallertau Mittlefrüh.
Hersbrucker (German)	3 to 5.5%	Lager, pilsner, bock, wheat	Mt. Hood, French Strisslespalt	Mild to semi-strong, pleasant and hoppy.
Horizon	11 to 14%	Ale, lager	Magnum or a high-alpha hop	Floral and spicy.
Kent Golding (U.K.)	4 to 5.5%	All English-style ales, ESB, bitter	U.S. Golding, WGV, U.K. Progress	Gentle, fragrant, and pleasant.
Liberty	3 to 6%	Lager, pilsner, bock, wheat	Hallertauer Tradition, Hallertauer, Mt. Hood	Mild and clean aroma, slightly spicy character.
Magnum	13 to 15%	All beers, particularly lager, pilsner, stout	Northern Brewer	Good, bitter quality.
Mt. Hood	3 to 8%	Lager, pilsner, bock, wheat	Crystal, French Strisslespalt, Hersbrucker	Mild, pleasant and clean, somewhat pungent and resiny.
Northdown (U.K.)	7.5 to 9.5%	All ales, porter		Mild, pleasant, delicate aroma.
Northern Brewer (U.S.)	6 to 10%	ESB, bitter, English pale ale, porter, California (steam) beer	Nugget, Chinook	Medium-strong.

Wheat Beer

Wheat beer is pretty simple to hop. Shoot for 12 to 15 IBUs of bitterness. Almost any clean hop will do — Perle is a good choice but I tend to use Mt. Hood. When shooting for low bitterness in any style I like to use a low-alpha hop, since errors in weighing or measurement will have less impact.

This beer style has no finish hops.

Steam Beer

Steam Beer is a trademark of the Anchor Brewing Company. It has a signature hop flavor and character, and that hop is Northern Brewer. So when making a steam beer I use Northern Brewer throughout. It's a fairly bitter brew, weighing in at 40 IBUs or so. It's pretty hoppy, too. I finish it with 1 ounce (28 g) of Northern Brewer five minutes before the end of the boil. And I don't care what other recipes you'll find for this beer, it should not use any Cascade!

Creating New Styles

This article touched on a lot of styles. But where do beer styles come from? Someone has to invent them.

Try inventing your own style. Don't be afraid to experiment. The styles I've presented here are mostly "mono-hopped." By that I mean you only use one kind of hop for bittering, and one kind of hop for aroma. I've advocated few hop blends. This is a great way to learn about hops, because you can really get a taste for the contribution of an individual hop variety.

Once you've learned that, you can start to mix hops. I prefer to bitter with just one hop (and nine times out of ten I'll use Galena), but now and then I'll use two or three hops in the finish or for dry hopping. A favorite blend is Cascade, Centennial and Columbus in a 50-25-25 ratio. I like this for IPAs. Another personal favorite is a 50-50 blend of Cascade and Tettnanger. We once finished our "IPA-on-steroids" XSPA with this blend. It was big hit.

In this article I hope you've learned some of my philosophies of hopping. One thing should be clear — I like to keep it simple. You have my recommendations on what hops belong with what style and you've gotten an indication of what hop amounts to use. I've even given away some of my precious hopping secrets. Now go brew some beer, OK? ■

Mark Garetz lives in California and is the executive vice president of a marketing firm. In 1993 he founded HopTech as a supplier of high-grade hops, and a year later he expanded the company to include a full line of homebrewing equipment. In 1996, he founded the award-winning HopTown Brewing Company. He has since sold both businesses but they continue to thrive. Mark serves on our editorial-review board and is the author of "Using Hops" (HopTech, 1994).

handy HOMEBREW HOPS guide

name	alpha acid %	typical beer styles	possible substitutions	flavor description
Northern Brewer (German)	7 to 10%	ESB, bitter, English pale ale, porter	Chinook, U.S. Northern Brewer	Medium-strong with some wild American tones.
Northwest Golding	4 to 5%	Ale, porter, stout, ESB, bitter		Known for aromatic properties.
Nugget	11 to 14.5%	Light lager	Columbus, Chinook, U.K. Target, Galena	Herbal.
Perle (U.S.)	6 to 9.5%	Pale ale, porter, German styles	Northern Brewer, Cluster, Galena, Chinook	Floral, slightly spicy.
Perle (German)	6 to 8.5%	Pale ale, porter, lager	U.S. Perle, Northern Brewer	Moderately intense, good and hoppy.
Phoenix (U.K.)*	4.2 to 5.5%	All ales	U.K. Northdown, U.K. Kent Golding, U.K. Challenger	Similar to U.K. Challenger.
Pioneer (U.K.)*	8 to 10%	Ale, ESB	U.K. Kent Golding	A mild, typical English aroma.
Polish Lublin	3 to 4.5%	Pilsner	U.S. Saaz, Czech Saaz, U.S. Tettnanger	Mild and typical of noble aroma types, spicy, herbal.
Pride of Ringwood (Australia)	7 to 10%	Australian lager	Galena, Cluster	Quite pronounced, but not unpleasant.
Progress (U.K.)	5 to 7.5%	Ale, bitter, ESB, porter	U.K. Kent Golding, Fuggle	Moderately strong, good aroma.
Saaz (Czech)	3 to 4.5%	Pilsner	U.S. Saaz, Polish Lublin	Very mild with pleasant hoppy notes.
Saaz (U.S.)	3 to 5%	Pilsner, lager, wheat	Czech Saaz, Polish Lublin	Very mild, earthy and spicy.
Santiam	5 to 7.9%	Lager, American ale, pilsner	German Tettnanger, German Spalt, German Spalt Select	Floral, slightly spicy.
Satus*	12.5 to 14%		Galena	Known for its bittering and aromatic properties.
Simcoe	12 to 14%			A bittering and aromatic hop.
Spalt (German)	4 to 5.5%	Lager	U.S. Saaz, U.S. Tettnanger, German Spalt Select	Mild and pleasant, slightly spicy.
Spalt Select (German)	4 to 6%	Lager, and any beer in which noble aroma is appropriate	U.S. Saaz, U.S. Tettnanger, German Spalt	Very fine Spalter-type aroma.
Spalt Select (U.S.)*	3 to 5%	German lagers	Tettnanger, Saaz	Medium intensity and pleasant hoppy qualities. Medium-strong aroma with wild American tones.
Sterling	6 to 9%	Lager, ale, pilsner	Saaz, Polish Lublin	Herbal, spicy, pleasant aroma, hint of floral and citrus.
Strisslespalt (France)	3 to 5%	Pilsner, lager, wheat	Mt. Hood, Crystal, Hersbrucker	Medium intensity, pleasant, hoppy.
Styrian Golding (Slovenia)	4.5 to 6%	All English-style ales, ESB, bitter, lager	U.S. Fuggle, U.K. Fuggle, Willamette	Delicate, slightly spicy.
Target (U.K.)	9.5 to 12.5%	All ale and lager	Fuggle, Willamette	Pleasant English hop aroma, quite intense.
Tettnanger (U.S.)	3.4 to 5.2%	German ales and lagers, American lagers, wheat	German Spalt, Czech Saaz, Santiam	An aromatic hop, mild and slightly spicy.
Tettnanger (German)	3.5 to 5.5%	Lager, ale	German Spalt, German Spalt Select, U.S. Tettnanger, Saaz	Mild and pleasant, slightly spicy, herbal.
Tomahawk*	15 to 17%	Ale	Columbus	Primarily a bittering hop.
Tradition (German)	5 to 7%	Lager, pilsner	Hersbrucker, Hallertauer Mittelfrüh	Very fine and similar to Hallertauer Mittelfrüh.
Vanguard	4 to 5.67%		Saaz, Hallertauer Mittelfrüh	Aroma similar to continental European types.
Warrior	15 to 17%	Ale, stout	Nugget	A bittering and aromatic hop.
WGV (Whitbread Golding Variety) (U.K.)	5 to 7%	Ale	U.K. Kent Golding, U.K. Progress	Quite pleasant and hoppy, moderately intense.
Willamette	3.5 to 6%	Pale ale, ESB, bitter, English-style ale, porter, stout	U.S. Fuggle, U.S. Tettnanger, Styrian Golding	Mild and pleasant, slightly spicy, fruity, floral, a little earthy.
Yakima Cluster	6 to 8.5%			Used as a kettle hop for bittering.
Zeus*	13 to 17%		Columbus	Aromatic and pleasant.

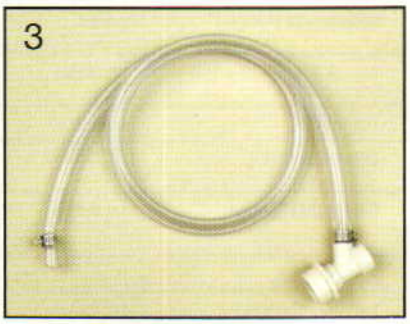
Hops chart updated and revised from BYO November 1999 (indicates limited production)*

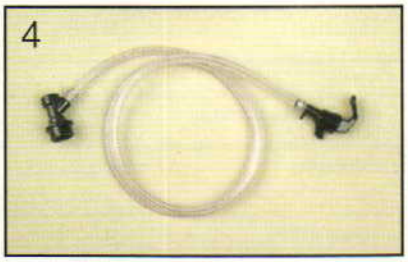
1. 5-gallon Cornelius soda kegs are the most common homebrew option.

2. This is a standard 5-pound aluminum gas tank that holds carbon dioxide.

3. This gas set-up has ball-lock gas-in quick-disconnect, line and 2 clamps.

4. A beer line with ball-lock quick-disconnect and cobra-head tap.





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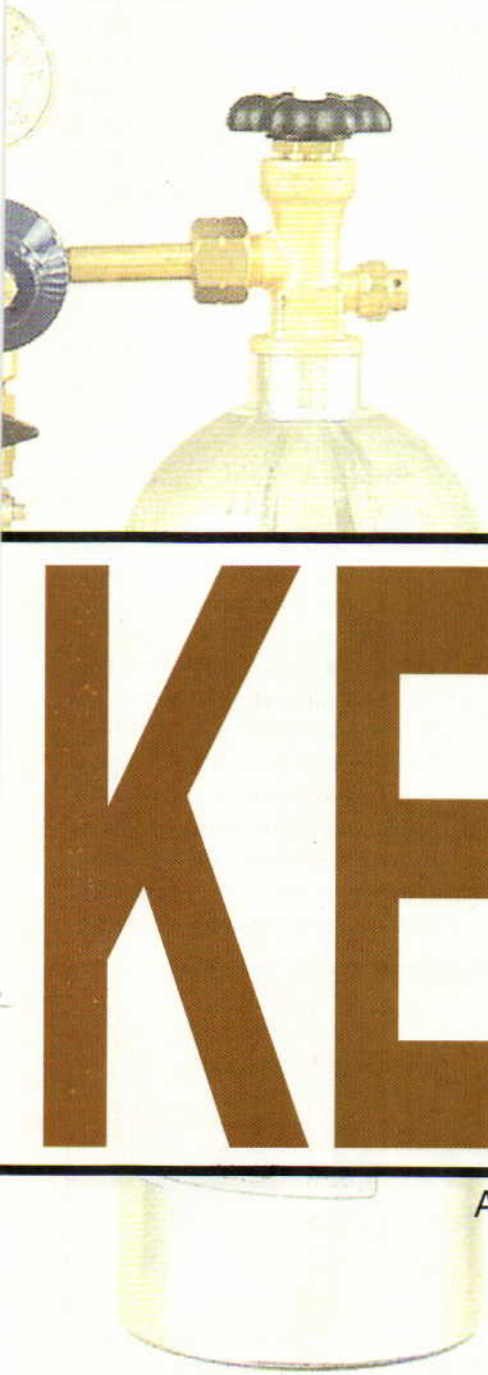


There's something special about draft beer. Maybe it's that you can pour as much or as little as you want. Maybe it's that having a draft system says, "I am serious about beer!" Whatever it is, most homebrewers eventually consider buying a draft beer system. In this article, we'll go over the reasons for getting a draft system, the equipment needed, how to set it up and how to use it.

story by **DON MILLION**

KEG YOUR BEER

A simple step-by-step guide to leaving the bottles behind

PROS and CONS

There are several advantages to kegging. The most obvious is the simplicity of cleaning and filling a keg. A five-gallon batch forces you to handle 50 or more 12-ounce bottles. With a keg you clean and fill one. The keg also takes up less room than 50 bottles and is easier to move.

You can also use your kegging system to force carbonate your beer; that is, carbonate without adding priming sugar to restart fermentation. Force carbonation results in less sediment and a quicker-clearing beer, as well as the option to carbonate and serve the beer within a few hours instead of waiting a week or more for the beer to carbonate on its own.

If you want to precisely control the level of carbonation in your beer, kegging is the only way to go. Force carbonating with a keg and CO_2 tank allows you to set the level of carbonation to any level you desire. You can also adjust it, if needed. With bottles you can only set the level of carbonation as precisely as you can measure the priming sugar and the volume of beer you're carbonating. Even then, you're at the mercy of how well the yeast can convert the sugar to CO_2.

Some people wonder if force-carbonated beer tastes the same as beer that is primed and conditioned. Most of the brewers I've talked to think they taste the same. One reason why some beer drinkers may believe they can taste a difference is that almost all beers benefit from aging. The week or two of conditioning that a primed beer goes through allows it to age as well as carbonate. Give a force-carbonated beer the same week or two and it will be almost indistinguishable from its primed cousin.

Another potential reason for kegging is that most filtration systems require a keg system. Likewise, having a kegging system will allow you to use a counter-pressure bottler.

There are some drawbacks to kegging your beer. For one thing, a kegging setup costs more than bottles. You need the keg, a CO_2 tank and regulator, fittings, hoses and some sort of dispenser. If you buy all used parts you could put together a system for $70 or so. Buy new and it can go well over $200. Most homebrewers will buy a reconditioned keg and CO_2 tank, but new fittings, hoses and regulator; they will end up spending $120–160.

When you keg your beer, you also have to figure out a way to cool the beer. While a bottle or two of beer can be put in the family fridge, a keg cannot. Most people who keg their beer have a dedicated cooler and that's the best way to go. The alternative is a jockey box, which I'll explain further on. For now, suffice it to say that cooling a keg is not as easy as cooling a few bottles.

A keg also has places inside where bacteria can hide, so cleaning one is more of a chore than cleaning a bottle. Of course, you only have to clean one. So, for a large number of homebrewers, the benefits of kegging outweigh the drawbacks. Personally, I would never go back to bottling my beer.

EQUIPMENT

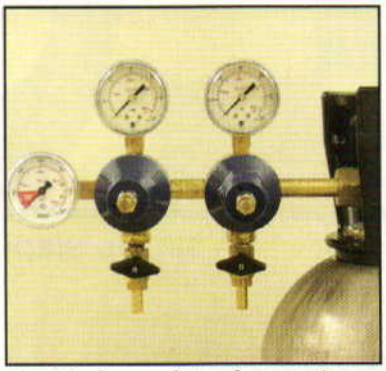
The first and most obvious piece of equipment that you need is a keg. Most homebrewers use five-gallon stainless steel kegs that are made for holding the syrup used in soda dispensers. These are commonly called "Corny" kegs, after one of their major manufacturers, the Cornelius Company. Corny kegs are sold by most homebrew stores, but may also be available from local soft-drink distributors. It's possible to use commercial beer kegs, but cleaning and filling them is much more difficult. In this article, we'll only consider soda kegs.

Depending on the type, five-gallon soda kegs are 8–9 inches (20–23 cm) in diameter and 25–26 inches (64–66 cm) tall. They usually have protective rubber bumpers around the top and bottom. In the top is an oval opening about 3 x 4 inches (7.6 x 10.2 cm). A lid with a pressure-relief valve fits the opening. On both sides of the opening are fittings containing poppet valves, one for "gas-in" and the other for "liquid-out." These take quick-disconnects to which you attach hoses. The fittings are often marked "in" and "out." If not, you can tell which is which by opening the lid and looking inside. The "out" fitting has a long tube (called a dip tube) reaching to the bottom of the keg. Attach your CO_2 tank to the "in" fitting and the line to your beer tap to the "out" fitting.

Corny kegs come in two varieties: ball-lock and pin-lock. The difference between them is the type of fittings they have and the kind of disconnects they use. Ball-locks are more common, but check with local homebrew shops to see what's available in your area. Since they use different connectors, you will have to have duplicate sets of

Basic homebrew draft system with Corny keg, CO2 tank and regulator.

Dual-gauge regulator for tank and beer pressure.



Dual-body regulator for creating two pressures from one tank.

Stainless-steel faucet minus tap handle.

mini KEGS what to buy for less than a batch

By Colin Kaminski

While kegs are nice, it's hard to grab a five-gallon keg and go to the beach. A more portable "package" is often desired. Additionally, being able to fit your beer in your refrigerator and still have room for pizza is useful. For homebrewers, there are several smaller packaging options.

The Party Pig ($40) is a 2.2-gallon (8.5 L) PET bottle with a dispensing tap. It does not use CO_2 cylinders. It has a "pressure pouch" that inflates by a chemical reaction and expels the beer. Some users have difficulty getting the pressure pouch to activate, but with practice, it's not hard. The cost of the bag is $4 and it has to be replaced each brew. Because there is no easy way to exchange a lid for the tap, you must have a dispensing tap for every bottle you have in storage. One must carbonate by bottle conditioning or fill from a keg.

Tap-A-Draft is the newest package to enter the homebrewing market. It uses a six-liter (1.6-gallon) PET bottle. It can also use three-liter (0.8-gallon) PET soda bottles. Some suppliers include the tap with bottles and extra lids, and some sell it all separately. To push out the beer, it uses disposable eight-gram CO_2 cartridges that cost 50 cents each. Two cartridges are needed to dispense one six-liter bottle. The pick-up tube is a small vinyl hose that also provides the restriction needed to pour without foam. The Tap-A-Draft is very well-engineered and affordable. It takes a little more than three six-liter bottles to hold one 5-gallon brew. One can carbonate either by priming or by forcing CO_2, which requires two extra cartridges. Since the valve is a "thread-on" you only need one valve for an unlimited number of bottles. You simply replace the bottle lid with the valve when you are ready to dispense. Bottles cost $7. The dispenser costs about $35. You will only need one valve for each flavor you want to pour, no matter how many bottles you have. With the Pig, there is no way to bottle a five-gallon batch without owning two complete kits.

The Mini-Keg system is comprised of small plastic-lined metal kegs. Many manufacturers make taps for the Mini-Keg. Its capacity is 5 liters (1.3 gallons) and it has been in use for some time by the breweries in Europe. Prices start at $65 for four kegs and a hand pump. The kegs are lined steel containers and have a short life. Once the liner is damaged the keg will rust and needs to be discarded. When they need to be replaced they cost $8. Longevity depends on care. The tapping systems use air or CO_2. CO_2 taps are available starting at $80 with four kegs. There is a replaceable rubber bung that costs $1. CO_2 cartridges are either the 8-gram (50 cents) or the 16-gram ($1.25). Only one valve is required for an unlimited number of kegs.

Beer Party 2 fits any screw-on-top bottle. This dispenser is similar to the Tap-A-Draft, except it is made of metal. It comes with adapters for any large-bottle thread. It's usually used with two-liter (0.5 gallon), three-liter (0.8 gallon) and six-liter (1.8 gallon) bottles. It is extremely difficult to find unless you bought one in Japan while they were made. This dispenser is of the highest quality. If you are lucky enough to find one, give it a try. Pricing is unavailable but would likely be in the range of $100 for the tap alone.

Keggy is a 5-liter (1.3 gallons) or 12.5-liter (3.3 gallons) package made in Germany. This is the coolest package I have ever seen! It is a stainless keg, refillable CO_2 bottle and dispenser in one unit. The cost is extremely high and it is rarely used in homebrewing. It would be better suited to a small brewery with lots of money.

10-liter (2.6 gallon) Sanke kegs are available as well. This vessel uses a standard tap for any Sanke keg, but it is small enough to fit in a refrigerator, as long as you are a bachelor. They run $60 used and $150 new and will last a lifetime. Tapping systems are around $150 unless you scrounge the parts.

All of these solutions are well-proven by homebrewers and, while they are more expensive than bottling, I trust you will find them an improvement for most applications.

The Tap-A-Draft dispenses beer from three-liter or six-liter PET bottles.

The Party Pig holds 2.2 gallons (8.5 L) and dispenses without CO_2.

A 10-liter (2.6 gallon) Sanke keg (right) next to its larger cousin.

quick-disconnects if you mix keg types. Get at least one "in" and one "out" quick-disconnect once you settle on a keg type. Also, get some food-grade lubricant to use sparingly on the lid gasket and disconnects.

Next you need a CO_2 tank. For this you have two options: buy or rent. Welding supply and fire extinguisher businesses are the usual places to get a CO_2 tank filled and many will rent you a tank. When you bring it back empty, they take your old one and give you another, filled one. Or you can buy a tank of your own. These are available either new or reconditioned, in steel or aluminum.

Find a place to fill the tank and see what its policies are. Some places won't handle aluminum tanks. Others will only exchange tanks — they won't fill your tank and give it back to you. This may determine whether you buy or rent and what kind of tank you get. I have a 5 lb. (2.3 kg) tank and it usually lasts through four to five batches of homebrew. The most common tank sizes are 5, 10 or 20 lbs. (2.3, 4.6 or 9.1 kg). Larger tanks obviously last longer, but they're bigger and heavier.

You will need a regulator for the CO_2 tank. You can buy either single-gauge or double-gauge regulators. Single-gauge regulators have one gauge showing the pressure being applied to the keg, with an adjustment knob to set that pressure. Double-gauge regulators have an additional gauge showing the pressure remaining in the tank. This tells you when the tank is almost empty, but it won't tell you, for instance, when you've used half of the tank.

The tank gauge only registers a drop in pressure towards the end of the fill because CO_2 is not sold as a gas. Your tank is filled with liquid CO_2 under about 800 psi (41,000 Torr) of pressure. As you use CO_2, the liquid boils off and turns into a gas as it comes out of the tank. As a result, the pressure in the tank stays close to 800 psi (41,000 Torr) until all of the liquid is gone. From then on the pressure drops as you use up the remaining gas.

Your regulator should come with a check valve to prevent beer from being forced back into the regulator's mechanism.

Next you need equipment for dispensing the beer. Here again you have two basic choices: a picnic tap or a faucet. A picnic tap (also called a cobra tap) attaches to the end of a hose and is held in your hand. You squeeze the handle to dispense the beer. A faucet is the kind of tap you see at your local pub. Mounted solidly in some way, you pull on the handle to open the faucet and dispense the beer. Picnic taps are cheaper and easier to set up, but I prefer the look and feel of a mounted faucet. Having a picnic tap as a backup is a good idea if you ever want to take a keg with you to a party.

You also need hoses to connect the CO_2 tank to the keg and the keg to the tap or faucet. Either 1/4-inch (0.64 cm) or 5/16-inch (0.79 cm) inside diameter hose can be used from the regulator to the gas-in disconnect. The tubing used for gas should be rated to withstand at least 50 psi (2590 Torr). Small hose clamps should be used to secure the hose to the fittings.

For the hose going from the beer-out disconnect to the tap, I recommend 3/16 inch (0.48 cm) inside-diameter, food-grade tubing. In this case the pressures will be low, so the psi rating doesn't matter.

Finally, you need a way to cool the beer. As mentioned before, the options are a refrigerator that fits the keg, or a jockey box. (See the September 2002 column, "The DraftErator," for instructions on how to build a dedicated keg cooler.) A jockey box is a cooler that contains a coil of copper or stainless steel tubing. The keg is connected so that the beer flows through the tubing before being dispensed. The cooler is filled with ice until it covers the tubing, so that the beer is quickly cooled as it flows through to the glass.

Similar alternatives include a cooling coil inside a refrigerator, or a "cold plate." A cold plate is a block of aluminum that has tubing running inside it. This is set in ice or a refrigerator and the beer is run through it the same as with a jockey box. (See the December 2002 Projects column, "Tap-A-Fridge," for an example of a refrigerated jockey box.)

If you use a refrigerator, you can dispense via a picnic tap that stays inside with the keg or you can run a faucet through the door or sidewall of the fridge. If you run a faucet through the fridge, be careful when drilling not to damage the cooling coils that are inside the walls.

My favorite arrangement is a chest freezer with a temperature controller. The controller maintains the chest at a temperature above freezing. You set the thermostat on the freezer as low as it will go and plug the freezer into the

Stainless faucet, knob and shank that will fit through most refrigerators.

The classic hand-held plastic "cobra" or picnic tap.

Handy faucet shank with built-in nipple.

Angler keeps tap handles from touching the wall.

controller. The controller turns the freezer on and off to maintain the temperature you desire. These are available at most homebrew shops for about $50.

My own setup is a chest freezer with a collar made of 2x6 lumber that fits between the top of the chest and the lid. The CO_2 is fed into the kegs via a hose running through the collar. A manifold on the inside routes gas to as many as three kegs. Beer faucets are mounted on the front of the collar for dispensing. All the holes are drilled in the collar, none in the freezer, so I can easily restore the freezer to its original condition.

Should the CO_2 tank be inside or outside the refrigerator? Either way works. The only problem with putting the tank inside is that some people get condensation within their regulator gauges as a result. For that reason I recommend outside, but only if it's convenient.

CLEANING and FILLING

New kegs should be disassembled and cleaned before use. Start by opening the lid and checking the large gasket around it. If it was last used for soda syrup, it will hold the smell and you'll have to replace it as well as the gaskets in the fittings.

The fittings screw off. With pin-lock kegs, you have to buy a special socket or make one yourself by notching a socket with a grinder. Once you remove the fittings you can pull out the tubes held underneath them.

If the keg isn't too dirty, soap and water will clean it. If that doesn't work, try B-Brite or PBW. Chlorine can break down the outer layer of stainless steel, allowing corrosion to get a foothold, so sanitize your kegs with something like iodophor or Star-San.

The kegs don't have to be disassembled every time you clean them. Most of the time I just swish mine with hot soapy water, then run some through the beer-out fitting. I follow that with a hot water rinse and some iodophor solution, running a bit of each through the beer-out fitting. I only disassemble them every fourth or fifth time I use them.

When you're ready to fill your keg, start by putting CO_2 into it. This will prevent oxidation of your beer during transfer. Release the pressure, take the lid off and rack your beer into the keg under the "blanket" of CO_2. Now "purge" the keg. This is the process of removing air from the headspace (the space inside the keg above the liquid) and replacing it with CO_2. You can do this by pressurizing the keg with CO_2 and letting it sit for a couple of minutes. The CO_2 is heavier than air and will settle to the bottom. You can let the air out through the relief valve on top of the keg or by pressing on the gas-in poppet valve. Repeat this step two or three times to get out all of the air.

I've been asked if kegged beer can be stored as long as bottled beer. The answer is yes, as long as you are careful. For beers that are going to be stored for long periods, disassemble the keg, carefully clean and sanitize each piece, and purge thoroughly after filling.

CARBONATING

The ability to precisely control carbonation is a big advantage of kegging. It requires, however, an understanding of how carbonation is measured and set. The carbonation level of beer is measured in "volumes" of CO_2. This is calculated by dividing the volume of CO_2 dissolved in the beer by the volume of beer in which it is dissolved. So, if you had one liter of CO_2 at ambient pressure and you dissolved all of it into one liter of beer, the beer would contain one volume of CO_2. Two liters of CO_2 dissolved into one liter of beer would make two volumes of CO_2.

Figure 1 *(at right, above)* shows some typical carbonation levels for different types of beer.

Controlling your beer's carbonation level introduces the concept of "equilibrium pressure." When you fill your keg with beer, then put CO_2 under pressure on top of it, it will begin to absorb the CO_2. The colder the beer, the more CO_2 it will absorb. Also, the more pressure you apply, the more CO_2 it will absorb. The equilibrium pressure is the pressure at which the rate of gas diffusing into the beer equals the rate of gas diffusing out of your beer (into the headspace). At equilibrium pressure, your beer will absorb a specific volume of CO_2.

Figure 1

Beer Type	Volumes of CO_2
Real Ale	1.5-2.0
British Stouts, Pale Ales	1.7-2.3
American Microbrews	2.5-3.0
American Megabrews	2.5-2.6
European Lagers	2.2-2.7
German Wheat Beers	3.0+

One way to visualize this is to think of a plastic soda bottle. Before you open it, it is highly pressurized and if you squeeze it, it feels very hard. Open it up and you release the pressure. Pour a glass and you create headspace in the bottle. Put the cap back on, give the plastic bottle a squeeze and it will be quite soft.

Wait a few minutes, though, and it will get harder. That's because the CO_2 in the soda is coming out of solution, filling the headspace and creating more pressure in the bottle. The CO_2 will continue coming out of solution, slowly increasing the pressure in the headspace and reducing the volume of CO_2 in the soda, until the pressure of the CO_2 in the liquid equals the pressure of the CO_2 in the headspace; this is the equilibrium pressure.

Figure 2 *(see page 42)* shows the equilibrium pressure for different temperatures and volumes of gas in beer. Find the serving temperature on the right and the volumes of CO_2 you desire on the top; where they meet in the table shows the equilibrium pressure. So, for instance, if your beer is cooled to 45 °F (7.2 °C), and you want

Figure 2

Volumes of CO_2							
Temp. (F)	1.5	1.7	1.9	2.1	2.3	2.5	2.7
40	1.9	3.9	5.8	8.0	10.0	12.3	14.5
45	3.4	5.6	7.9	10.2	12.5	14.9	17.2
50	5.0	7.4	10.0	12.5	15.0	17.6	20.0
55	6.6	9.1	12.1	14.9	17.6	20.3	23.0

Figure 3

= (0.001 * B1 * B1) + (0.155 * B1 * B2) + (4.24 * B2) - (0.08 * B2 * B2) - (0.012 * B1) - 14.7

Given: B1 = serving temperature
B2 = desired volumes of CO_2

it to contain 2.1 volumes of CO_2, you would pressurize it to 10.2 psi (530 Torr) — the equilibrium pressure for that combination — and let it sit with the tank connected to the keg until as much CO_2 as possible had dissolved into the beer; this process will take a week or so.

The equilibrium pressure can also be determined mathematically. **Figure 3** *(above)* shows a formula that can be put into a spreadsheet. Fill in the temperature and volumes of CO_2 and it will calculate the equilibrium pressure.

Kegs give you the option of serving your beer much quicker, though. Cool the beer first, turn the pressure up to 20 psi (1040 Torr) or higher and shake the keg to make the CO_2 dissolve quickly. When the CO_2 stops hissing out of the tank, let the keg settle for an hour or so and drink! The drawbacks to this method are that you lose the benefits of aging and you won't know how many volumes of CO_2 are initially dissolved in your beer.

The final method for carbonating beer in kegs is to prime and condition. Priming in kegs is essentially the same as priming bottles; you just treat the keg like one big bottle. The difference is that you use proportionally less priming sugar; 1/3-1/2 cup for a five-gallon (19 L) batch is all you need; any more and you'll get excessive foaming. The drawback to this method is that you end up with yeast sediment in the bottom of the keg. This sediment will mostly be drawn out with the first glass or two that you pour. After you start pouring, connect your CO_2 tank to maintain the level of carbonation and push out the rest of the beer.

Of course, regardless of how you carbonate your beer in the first place, you can adjust the carbonation any time. Too fizzy? Reduce the pressure at the regulator, relieve the pressure in the keg and give it a few days. Not fizzy enough? Set the pressure higher and wait. Keep adjusting until your beer has precisely the carbonation level that you want.

Dispensing is what it's all about. Pulling on the tap handle of your keg and pouring a precisely carbonated beer, with just the right amount of head, is why you bought all that equipment in the first place.

Now you need to decide how to dispense your beer. A picnic tap and jockey box is probably the simplest way. Most brewers want a fridge to keep their beer in, though, and with a fridge — or freezer with temperature controller — you might as well mount a faucet.

The objective is to dispense your beer with enough foam to give it a nice head, but not too much foam. The dip tube in the keg, the fittings, the hose and the tap — everything between the beer and your glass — will restrict the flow of beer out of the keg. Most of the restriction comes from the hose that runs between the keg and the tap. Happily, this is the easiest thing to control. When pouring, the amount of restriction needs to match the pressure in the keg. Too little restriction and the beer will flow too quickly and foam heavily. Too much restriction and the beer will barely trickle from the tap, as well as foaming more than it would with just the right amount.

Some brewers adjust the pressure from their CO_2 tank down for dispensing, then back up to the equilibrium pressure for storage. An easier way is to "balance" the system; that is, run the right length and size of hose between the keg and the tap so that the restriction matches the equilibrium pressure. Then you don't have to make adjustments while serving.

A 3/16-inch (0.48 cm) inside diameter hose provides about 3 psi (160 Torr) of restriction for every foot (30 cm) in length. A 1/4-inch (0.64 cm) inside diameter hose provides about 1 psi (50 Torr) of restriction per foot (30 cm). So, if you have 3 feet (91 cm) of 3/16-inch (0.48 cm) hose between your keg and your tap, it will provide 9 psi (470 Torr) of restriction. This is just right if you have the regulator on your CO_2 tank set to 9 or 10 psi (470 or 520 Torr).

If you use a jockey box, you'll need more pressure on the keg to push the beer through all that tubing and you'll want to use larger tubing. In that case, experiment with the CO_2 pressure to see what works. I would start with 15 psi (780 Torr) and work up or down (probably up) from there.

As an example, my "house" beer is an American pale ale that I serve at 42 °F (5.5 °C) and carbonate to about 2.2 volumes of CO_2. The equilibrium pressure for that combination is 10 psi (520 Torr), so that's where I set my CO_2 regulator. Knowing this, I put a little over three feet (91 cm) of 3/16-inch (0.48 cm) hose between my kegs and my beer faucets. This way I carbonate and serve my beers at the same pressure and rarely have to change it. If you have a long run between your kegs and your faucet, use larger diameter hose.

In any case, start with a longer hose than you think you'll need. It's easier to shorten the hose to make adjustments than it is to replace the hose with a longer one.

The PAYOFF

Putting together a draft system takes time, effort and money. The first time you pull a perfect pint from your own tap, though, you'll know it's worth it. And speaking of pulling a perfect pint, I believe I hear one of my own kegs calling to me! ■

Don Million got started in homebrewing eight years ago. This is his second article for BYO.

Infusion Mashing

A cookbook introduction to all-grain brewing

by Chris Colby

PHOTOS BY CHRIS COLBY

All-grain brewing starts with malted grain instead of malt extract. This grain must be crushed prior to mashing. Crushing the grain breaks the hull and exposes the starchy kernel.

A combination mash tun and lauter tun like this is what many homebrewers use for all-grain brewing. This mash tun is fitted with a mash jacket for insulation.

I started all-grain brewing five years ago. I approached my first all-grain brew as I approach everything in my life — as geekily as possible. I read every available homebrew book and magazine article I could find. I worried about every possible detail and sweated every option. I drew up a checklist of things to do and a schedule by which to do them. Then, finally, I tried it. If I could go back in time and give myself one piece of advice, it would be to try a cookbook version of all-grain brewing first, then learn about the details as needed.

In all-grain brewing, you make your wort (unfermented beer) from roughly 10 pounds (4.5 kg) of malted grains instead of two cans of malt extract — assuming you're making five gallons (19 L) of roughly average-strength beer. The wort is extracted from the grain through a process called mashing.

Although entire books could be (and have been) written on the details of mashing, it is — at its core — very simple. Stripped of all the brewing jargon, mashing is just soaking malted grain in hot water and then draining the resulting liquid away from the grain husks. Although there is a wealth of technical information about mashing, you don't need to know it all to try all-grain brewing. You can just jump in and let your problems — if you encounter any — be a guide to what you need to learn. Remember, the English were making bitter and the Germans were making bock long before any of these details were known by anybody. (On the other hand, if you are interested, you can start with Steve Parkes' "Homebrew Science" article in the September 2001 issue of *BYO*.)

The simplest mashing procedure is called a single infusion mash. In a single infusion mash, crushed grain is mixed with hot water and the mixture is allowed to stand awhile before the liquid is drained away from the grain bed. Although this is the easiest form of mashing, it doesn't mean it's inferior to other types of mashing. Many beer styles — including pale ale, porter and stout — are traditionally made from single infusion mashes and many base grains are malted specifically for use in single infusion mashes. Your favorite ale from your local brewpub is likely made from this type of mash. In this article I'll explain how to do a single infusion mash. I'll focus on the techniques and mostly skip the theory.

Advantages and Disadvantages

There are several advantages to brewing beer from grains. With all-grain brewing, you can make beer from any imaginable combination of malted base grains, specialty grains, unmalted grains and starchy adjuncts. Base grains include pale, Pilsner, Vienna and Munich malts. Specialty grains include chocolate malt, crystal malt and roasted barley. Corn and rice are common starchy adjuncts.

All-grain brewing also allows more control over the fermentability of your wort. This is especially important if you like your beers dry. Worts made from extract are almost always less fer-

all-grain brewing equipment for 5-gallon (19 L) batches

- mash tun/lauter tun (necessary)
- mash paddle (recommended)
- wort chiller (recommended)
- pH meter/strips (recommended)
- 7-gallon (26 L) or larger kettle (necessary)
- propane burner (recommended)
- iodine solution (optional)
- grain mill (optional)

Gruesome Foot Lawnmower Beer
(5 gallons/19 L all-grain)
OG: 1.045 FG: 1.011
IBU: 24 SRM: 5

Ingredients
8.25 lb. (3.7 kg) 2-row pale malt
1 lb. (0.45 kg) flaked maize
6 AAU Cascades hops (bittering) (1.2 oz. (45 g) hops at 5% alpha acid)
0.5 oz. (14 g) Cascades hops (flavor)
0.25 oz. (7 g) Cascades leaf hops (dry hop)
1 tsp. Irish moss
Wyeast 1056 (American Ale) or White Labs WLP001 (California Ale) yeast (0.5 gallon/2 L starter)
1 cup corn sugar (for bottling)

Step by Step
Make yeast starter 3–4 days before brewing. On brewday, heat or add 5 gallons (19 L) of water at 170 °F (77 ° C) to your mash tun and let it sit for 5 minutes. Drain water from mash tun, leaving enough water to cover false bottom or manifold. Add crushed 2-row pale malt and flaked maize to mash tun. Stir 3 gallons (11.3 L) of strike water at 160 °F (71 °C) into crushed 2-row malt and flaked maize to mash in at 150 °F (66 °C). Mash for 1 hour. Stir twice during mash. After one hour, add boiling water to raise mash temperature to 168 °F (76 °C) and hold for 5 minutes. Recirculate wort (i.e. draw off wort at rate of 64 oz. (1.9 L) every 5 minutes and add wort to top of grain bed) for 20 minutes. After recirculation, begin collecting wort at the rate of 32 oz. (0.9 L) every 5 minutes. When the water level drops to the top of the grain bed, begin adding sparge water at 168 °F (76 °C) at same rate as wort is being collected. (You'll need about 4.75 gallons (18 L) of sparge water total.) Collect 4.75 gallons (18 L) of wort from mash. Add 1.25 gallons (4.7 L) of water to collected wort, making 6 gallons (23 L) of wort total. Boil this wort for one hour, adding bittering hops immediately after boiling begins. Add flavor hops and Irish moss with 15 minutes left in boil. Cool wort. Siphon wort to fermenter and aerate. Pitch the sediment from yeast starter. Ferment for 5–7 days at 68 °F (20 °C), then rack to secondary fermenter and add dry hops. Seven days later, bottle with 1 cup of corn sugar. Let bottle condition for 10 days then enjoy.

mentable than all-grain worts (or at least those designed to be highly fermentable). In addition, all-grain brewing allows for better control over beer color, especially when making light-colored beers. Finally, it's cheaper (after the initial investment in new equipment). Ten pounds (4.5 kg) of malted grain to make a typical batch costs about five to six bucks, while two cans of extract might cost over $20.

The recipe at left illustrates some of the options you can explore and the control you can exert with all-grain brewing. The recipe makes a lightly-colored and flavored beer with a spicy hop kick. The recipe uses a small amount of adjunct (flaked maize) and lower mashing temperatures to decrease the body a bit and make a clean, dry beer. In terms of style, it's similar to a Kölsch or a cream ale (although it couldn't pass as either). I just call it a lawnmower beer and make a big batch of it every summer, which in Texas seems to start in February and last through November. (Of course, you can make big, dark, malty beers with all-grain brewing, too.)

One disadvantage of all-grain brewing is that you need some new equipment. See the equipment sidebar for a list of required and recommended equipment. With all-grain brewing, you will also have to spend more time on brew day. Mashing typically lasts for an hour and separating the wort (lautering) takes another 90 minutes. It also takes extra time to heat the water and crush the grain. Extract brewing is faster and easier, but either way, you wind up with great beer.

Crushing the Grain

Before you can begin mashing, you must crush your grain or get it crushed for you. Crushing the grain breaks the hull and exposes the interior of the grain kernel. This allows the mash water to dissolve the starch in the center of the kernel and the enzymes in the malt to float free in solution and degrade the starch into simpler sugars. A proper crush of your grain is one of the four most important variables in all-grain brewing.

Grain is crushed in a device called a grain mill. If properly crushed, the barley hull will break into two or three pieces and the starch inside will exist as a few "chunks." Individual grains will not hang together. If the malt is not crushed adequately, the hulls may be cracked but the whole kernel hangs together. In overcrushed malt, the hull is fragmented into multiple pieces and some or all of the starchy interior is reduced to a fine powder.

Most homebrew shops have a grain mill and will crush your grain for you, sometimes for a small charge. Some malting companies also sell crushed grain. One benefit of buying crushed grain is that this variable has been taken care of for you. Crushed malt from a malting company is likely to have been properly crushed. Likewise, most homebrew shops do a good job of crushing. It's best to use crushed grain as soon as possible after crushing, within three months or so, assuming it's kept in a cool, dry place.

Many all-grain brewers crush their own malt. To do this, you need a grain mill. An advantage to crushing your own malt is that you can wait until brew day to crush. Crushed grain goes stale faster than intact grain, so — if feasible — it's best to leave your grain whole until brewing day.

Water Treatment

Water is the most abundant ingredient in beer. Without good water, you cannot make good beer. In addition, the types and amounts of minerals dissolved in the water will influence the success of your mash.

Water treatment is one of the most potentially complicated parts of all-grain brewing. Many homebrewers go to great lengths to treat their water. For example, some may try to make their water more closely resemble the water from famous brewing centers. The "Burton salts" you may have seen in your homebrew shop contain roughly the same proportion of minerals found in the water of Burton-on-Trent, the British town long famous for its pale ales. (For more information, see Don Million's and Steve Parkes' articles on water in the January-February 2002 issue of *BYO*.)

You can, however, take a relaxed approach to water treatment and perform successful mashes. Just about any water that is safe for drinking and tastes good can be used for mashing if you deal with two important variables: levels of chlorination and levels of calcium ions.

Most municipal water plants treat their water with some type of chlorine. The flavor of chlorine detracts from that of beer, while chlorine — or chlorinated substances — can interfere with some of the chemical reactions in mashing. If you can taste chlorine in your water, you should filter your water through a carbon filter. Boiling eliminates chlorine but not newer chlorinated compounds, called chloramines, that many city water departments are now using.

Optimally, your water should have between 50 and 100 ppm calcium when brewing most beers. However, many world-class beers are made from waters that have much more or less calcium. The waters of Pilsen, Czechoslovakia have between 5–10 ppm calcium. The water in Burton-on-Trent contains 268–295 ppm calcium.

Knowing this, I think it is reasonable to urge brewers who don't want to fiddle with the details of water chemistry to just go ahead and use their local water and see what happens. It's unlikely your water is softer than that of Pilsen or harder than Burton-on-Trent (although my local water supply has that distinction). Odds are, everything will go fine. I certainly wouldn't let water chemistry worries dissuade you from trying all-grain brewing.

If you do want to ensure your calcium levels are close to optimal, try the following. First find out the level of calcium in your water. To find out your calcium levels, contact your local water department. Alternately, you can get water hardness tests at most homebrew shops. Performed correctly, these provide reasonably accurate estimates of water hardness.

If you have soft water (less than 25 ppm calcium), add calcium in the form of gypsum or calcium chloride. One gram of gypsum adds 61.5 ppm calcium to one gallon of water. If your water

is between 25 and 150 ppm calcium, just leave it alone. If your water contains over 150 ppm, dilute it with distilled water. You should not use water from your water softener if you have the type that exchanges sodium ions for calcium ions, as you will end up with too much sodium in your beer.

Mashing In

The first step of mashing is called the mash in. This is when the crushed grains are combined with hot water. In a single infusion mash, the temperature of the water and grains should be between 150 and 158 °F (66–70 °C) after they have been mixed. Temperature is the second key variable to a successful mash.

The temperature of the mash influences the fermentability of the wort. Mashes held at the lower end of the temperature range yield more fermentable worts than mashes held at the higher end of this range. So, if you'd like to make a dry beer, mash at 150–153 °F (66–67 °C). If you like a sweeter beer, mash at 155–158 °F (68–70 °C). Your choice of ingredients also effects fermentability, with specialty grains contributing less fermentable sugars than base malts.

Because the grains are cold compared to the hot water, the water used for mashing (also called strike water) must be hotter than the mash temperature. If your grain is at room temperature, try heating your strike water to 10 °F (5 °C) greater than your desired mash temperature. For example, if you want to mash in at 152 °F (67 °C), heat your strike water to 162 °F (72 °C).

There are two ways to mix the water and grains. The first is to add all the crushed grains to your mash tun, then slowly add the strike water until you are mashed in. Be sure to stir well with a large spoon or a mash paddle as you mix the water into the grains. If you don't, you will leave dry pockets of crushed grain in the mash. The starch in these pockets won't convert to sugar.

The second method of mashing in is to mix small amounts of grain and water together and add this "mush" to your mash tun. Take two pounds or so of crushed grain in a small pot and add hot water until it's roughly the consistency of oatmeal. Then dump it in your mash tun and repeat until you've used up all your grain. Once all the grain is in, add water until there is about an inch (2.5 cm) of water standing above the grains.

Either of these methods works, although the second is easier if you do not have a spoon or mash paddle large enough to easily stir your entire mash. In either case, you should add enough water to cover your manifold or false bottom before you add any grain to your mash tun.

Overall, you will need about 1.25 quarts water per pound of grain (2.6 L per kg) to mash in. For example, for 10 pounds (4.5 kg) of grain, you would need 12.5 quarts (12 L) of water to mash in. At this water-to-grain ratio,

the grains will be completely wet and the water level in your mash tun will be an inch (2.5 cm) or so above the level of the grain bed.

In order to hit your desired mash temperature, you should work quickly when mashing in to avoid losing lots of heat to the environment. There's no need to rush, but work purposefully. If you pre-heat your mash tun with hot water before mashing in, you will minimize heat loss due to heat transfer to your mash tun.

Before mashing in, I fill my mash tun with hot water (170 °F/77 °C) and let it sit for five minutes. (I use this water later for sparging.) I also put my mash paddle and the beer pitcher I use for a hot-water ladle in that water so nothing that touches the strike water or mash will take heat from it. (This might be a bit of overkill on my part, but I like the mash in stage to go smoothly.)

Always have some extra hot and cold water on hand when mashing in. For 5-gallon (19 L) batches, having a couple gallons of boiling water handy will allow you to boost your mash temperature if you fall short at mash in. Likewise, room temperature water can be used to lower your mash temperature if you overshoot. When adjusting mash temperatures, go easy on the hot or cold water additions. Add a couple pints of water and stir thoroughly each time you do. Then check the temperature at a couple different places in the mash. It's not the end of the world if it takes a couple minutes to adjust your mash temperatures.

Mash pH

The pH of your mash is the third important variable. The pH of a mash should be between 5.2 and 5.6. With any luck, you won't have to do anything to adjust it. After mashing in, draw off a small sample of wort and check the pH. The simplest way to do this is with pH papers, which are available at most homebrew stores. If the pH is over 5.6, stir one teaspoon of gypsum into the mash. If the pH is below 5.2, stir in one teaspoon calcium carbonate into the mash. Retest pH and add one more teaspoon if needed.

The Starch Conversion Rest

Once you've mashed in, and adjusted the temperature if necessary, let the mash stand for stand 45–90 minutes. If you are using a picnic cooler, close the lid during the mash to conserve heat. If you are using a pot or kettle-type mash tun, put a lid on it and insulate it with towels. (Some mash tuns have specially-fitted "mash jackets" for insulation.)

If your mash tun is well-insulated, the temperature should only drop by a degree or two during the rest. If your temperature drops more than this, you can boost it by stirring in some boiling water. Alternately, if your mash tun is heatable, you can simply add heat. Be sure to stir when heating and watch that you don't overshoot. You should

turn off the heat when you are within 2–3 °F (1 °C) of your target and let the heat in the metal near the heat source radiate into the mash.

In many commercial breweries, the mash is stirred continually by rotating paddles. Constant stirring is not necessary for homebrewers, but stirring your mash a few times during the starch conversion rest can improve your efficiency. However, watch out for heat loss when opening up your mash tun and stirring. Keep some hot water on hand in case you lose too much heat when you open up the mash tun for stirring.

During the starch conversion rest, the grain will absorb water, the starch in the grains will dissolve and enzymes from the malt will degrade the long starch molecules into simpler sugar molecules that the yeast can use during fermentation.

One way to test if the mash is complete is to perform an iodine test. To do this, take a couple drops of wort and place it on a white plate. Take care to exclude any solids from the wort sample. Then, add a drop of iodine solution to the wort. If the iodine changes color to blue, purple or black, then starch is still present. Almost any solution with iodine in it, including iodophor, can be used for this test. To see what a positive reaction looks like, dissolve a pinch of corn starch in water and add a drop of iodine. (To see what a negative reaction looks like, add a drop of iodine to a drop of water.) If you get a positive result after mashing, which is unlikely, check your mash temperature and extend your mashing time. Keep performing iodine tests until the test results are negative.

After the starch conversion rest is complete, you have two options. The first is to proceed directly to separating the wort from the spent grains (lautering). The second option is to perform a mash out.

When you mash out, you add boiling water to the mash to raise the temperature to 168 °F (76 °C) and let it rest for five minutes at this temperature. Mashing out makes lautering easier and may increase your extract efficiency slightly. Also, mashing out destroys the enzymes in the mash. If you mashed for lower fermentability (for a sweeter beer), mashing out ensures that fermentability won't increase if the temperature of the grain bed drops to the lower 150s (around 65 °C) — the mashing range for higher fermentability — during lautering.

Once the mash is complete, you need to drain your wort from the grain bed. Proper wort separation is the last of the four important variables. There are a few options to consider and I'll deal with them thoroughly in the next installment of Techniques. (If you want to jump right in and try an all-grain batch, just follow the instructions for the recipe on page 44.) ■

Chris Colby would brew more dark, malty beers if he lived farther north.

Tiny Bubbles

Carbonation methods and beer clarification

Homebrew Science

by Steve Parkes

They say that first impressions count. Your initial judgment of a beer is highly correlated with its carbonation and clarity. When you open a bottle of beer, your first impression (aside from the packaging and possible brand association) is the satisfying "phhhht" sound of carbon dioxide gas escaping. If you are served a beer at a pub, or from the Corny keg of a fellow homebrewer, the first thing you can assess is the color, clarity and head of the beer. Many different variables — including ingredient choice, fining and filtration options — influence a beer's appearance. In this article, I'll discuss two of them — carbonation and clarification.

Background

Traditionally, brewers matured lager beers for many months at low temperatures. This was designed to achieve three key goals. First of all, the flavor would develop with time as off-flavors — such as diacetyl, hydrogen sulfide, dimethyl sulfide and acetaldehyde — were removed and mature beer flavors, such as some higher alcohols and esters, were formed. (The majority of these flavors were formed during the primary fermentation and just "topped up" during maturation. This was discussed in the previous article in this series, "Flavor Maturation," in January-February *BYO*.)

During this time, beer would also naturally carbonate as residual fermentable extract left behind in the "green" beer fermented to produce carbon dioxide gas. This gas became trapped in solution in the beer as the maturation vessel was closed to prevent gas escaping. The degree to which carbon dioxide (CO_2) dissolved in the beer is determined by the temperature and the pressure of the tank.

Another issue in maturation is the clarity of the beer. It was discovered that beer that was kept for long periods at low temperatures developed a brilliant clarity as both yeast and non-biological hazes settled out of the beer to the bottom of the vessel.

For traditional ale brewers, these goals are the same. However, since the yeast is not as active at lower temperatures, the beers tended to be less carbonated and were more prone to hazes. In a modern brewery — including the one you have in your own home — the goals of maturation can be shortened. Beer can be clarified by fining or filtering, and CO_2 can be added after the fact using bottled gas.

Carbonation

The level of CO_2 dissolved in beer after normal fermentation is between 1.2 and 1.7 volumes, depending on the temperature. One volume refers to the amount of gas forced into solution. For example, one volume of CO_2 means that one pint of gas has dissolved in one pint of beer. This is the amount of gas, produced from normal fermentation of sugar to alcohol and carbon dioxide, that beer at fermentation temperature will hold in solution without a top pressure being applied. It is usual to raise this level to between 2.4 and 2.8 volumes for packaged beer. This can be achieved two ways, by trapping the natural carbonation produced by finishing the fermentation under pressure or by forcing CO_2 into the beer later, during the processing phase.

The law governing the amount of gas that will go into solution is Henry's Law, which states that the concentration of a slightly soluble gas in a liquid is directly proportional to the partial pressure of the gas. (If a container holds more than one type of gas, each exerts its own pressure — its partial pressure — on the container.)

In our case, the gas is CO_2, the liquid is beer and the partial pressure is equal to the total pressure, either in the headspace of the bottle or the maturation container. The higher the pressure under which the beer is kept, the more CO_2 will stay in solution.

Carbon dioxide solubility is also influenced by the temperature. A colder beer will allow more CO_2 to stay in solution, hence a cold lager will hold more natural carbonation than a cask-conditioned British ale at cellar temperature. Thus, carbonation in beer is a balancing act between temperature and pressure. In general, the lower the temperature and the higher the pressure, the more CO_2 gas will stay in solution.

Natural Carbonation

Professional brewers may transfer their beer from the fermenter to the storage tank (keg, Cornelius, can or bottle) with 1.0–1.5 °Plato of fermentable extract remaining. The fermentation that occurs produces sufficient CO_2 to carbonate the beer to 2.8 volumes without raising the tank pressure above 15 psi (780 Torr). This will only work at around 40 °F (4.4 °C) and only lager yeast will ferment at that

temperature. If this technique is used on ales, ale fermentation temperatures of 50–60 °F (10–16 °C) will require that the pressure in the tank will need to be around 30 psi (1600 Torr). The beer will not pour well at that pressure, so the beer will need to be refrigerated for serving. This technique is much easier to control in a keg where excess pressure, if developed, can be vented. Bottling is trickier because either the CO_2 level is correct or it isn't (and you won't know until you pop the top).

Forced Carbonation

Carbonation can be forced into the beer by manipulating the temperature and pressure. There are two main techniques for achieving this, in-line and in-tank carbonation.

In-line carbonation: This method does not apply to homebrewers and is used in all large breweries, either as a primary carbonation or as a final fine-tuning to reach the standard specification for carbonation just prior to packaging. CO_2 can be injected into beer as it passes through a pipe on the way from one container to another. The gas is injected through a sintered stainless steel diffuser which creates very fine (10–100 µm diameter) bubbles that readily dissolve in unsaturated beer. The carbonation is rarely done before filtration due to the risk of CO_2 bubbles disturbing the filtration.

In-tank carbonation: A top pressure of CO_2 is applied to the tank, which is picked up and gently rocked back and forth. Any beer exposed to the high pressure of CO_2 in the tank headspace will carbonate to the required level immediately. Once all of the beer in the container has passed by the headspace, even carbonation is achieved throughout the can. With a Cornelius keg this is even more rapid if the keg is placed on its side to increase the surface area. This method will disturb any settled yeast.

Clarification

With time, the suspended solid particles in beer will sediment to the bottom of the vessel. The rate at which they settle is determined by several parameters, including the particle's size and density, the viscosity and density of the liquid, and gravity. The law governing the rate of sedimentation is Stokes Law and it is stated as:

Stokes Law

$$V = \frac{D^2(d_p - d_m)g}{18\mu}$$

In the equation, V is the terminal settling velocity of the particle (in cm sec^{-1}), D is the diameter of the particle (in cm), d_p is the density of the particle (in g cm^{-3}), d_m the density of the liquid (in g cm^{-3}), g is the acceleration of the particle due to gravity (in cm sec^{-2}) and µ is the viscosity of the liquid (in dyne sec cm^{-2}).

It can be seen that the best way to speed up the rate of settling of particles

is to increase their diameter. Yeast with strong flocculation characteristics tend to stick together more easily and increase their particle size dramatically. The best way to improve the time taken for the beer to clarify is to reduce the distance they have to travel. Large brewers do this with horizontal aging tanks. In some cases, larger brewers use centrifuges that decrease the settling distance and dramatically increase the gravity component (the "g" in the equation) of Stokes Law with centrifugal force.

Isinglass

Isinglass is extracted from the swim bladder of the sturgeon, and some other tropical or subtropical fish. It is prepared by soaking in a mixture of acids for many weeks. The colorless, viscous liquid produced by this treatment is rich in collagen, with a net positive electrical charge. The structure is like that of a large net that falls through the beer, attracting and binding the negatively charged yeast cells, along with some proteins, lipids and antifoaming agents. The particles form large flocs that rapidly sink to the bottom of the tank or vessel. It is most often used in the United Kingdom, but many microbreweries and brewpubs in the USA use it rather than filtering the beer. Used in conjunction with a silica-based auxiliary fining agent, isinglass can significantly reduce the yeast in suspension in beer. Isinglass does not work too well with high yeast counts (i.e. over 4 million cells/mL) and it works best if the temperature is allowed to rise a little. Since it is a protein extracted from fish, it is denatured at relatively cool temperatures and should never be allowed to rise above 68 °F (20 °C), even in storage, although different species of fish provide collagen with different temperature stabilities. This is related to their particular protein structure. Preparations of isinglass are available that are already activated by acid and are then dessicated for storage. These preparations still require careful rehydration, however, so the manufacturer's instructions should be followed accurately.

Kraeusening

Many brewers choose to accelerate the maturation process by kraeusening. This involves adding back 10–20% of actively fermenting wort to finished beer in the aging tank. The kraeusen beer is 12–24 hours old and still contains fermentable sugar and a large number of actively growing, healthy yeast. This fermentation will produce the required carbonation in the beer and the active yeast will more quickly mop up the diacetyl and acetaldehyde, and purge off the volatiles. Using this process does require that the same beer is being produced repeatedly, and the beer still has to be chill-proofed and clarified. Homebrewers reproduce this process in a way every time they add back priming sugar and leave behind a small amount of yeast for bot-

tle conditioning. Bottle conditioning differs from this technique in that the yeast count is much lower and the yeast is at the end of a fermentation. So, it has a much lesser ability to "mop up" the mess than the freshly aerated "active" yeast added with kraeusening.

Colloidal Haze

You may have noticed that when you take your brilliantly clear beer from the cupboard under the stairs where it was maturing and put it in the fridge, it turns cloudy. This is due to certain compounds present in beer that form a solid precipitate when chilled. This haze is known as "chill haze" and it is formed when compounds extracted from malt and hops, known as polyphenols or tannins, combine chemically with proteins. Traditional lagering methods involved forming them and then allowing them to settle out. Modern brewers treat beer with adsorbant chemicals, such as silica gel or PVPP, which remove either the protein or the polyphenol or both. Many homebrewers simply live with the haze.

Ale Maturation

Since the term "lager" means "to store," there is a tendency among some brewers to think of lager beers as the only style that requires maturation. Ales too require a period of maturation while the yeast work their magic. Since the yeast is more active at higher temperatures, this means that the biochemical reactions leading to flavor improvement occur more quickly. A British-style cask-conditioned beer is a classic example of a beer matured and then served in the same container.

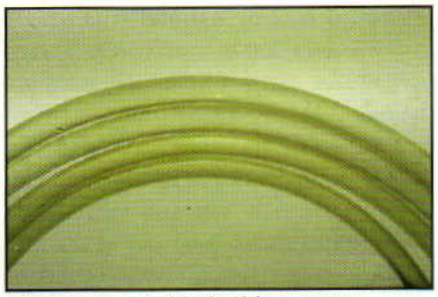
The beer is transferred from the primary fermenter after a period of reduced temperature maturation at 50 °F (10 °C) to a stainless-steel barrel with some residual extract (or added sugar in the form of primings), some yeast, and perhaps some additional hops. The ale then carbonates to a slightly higher level, and the flavor develops. Finings are then added to clarify the beer of yeast and it is served at warmer temperatures so chill haze shouldn't be seen. This all takes place in about a week. For homebrewing ale brewers, when primary fermentation is carried out in carboys, the beer is usually transferred to closed Cornelius kegs, or bottles for aging. The beer will then be chilled to a more appropriate temperature for consumption. Beer fresh out of primary fermentation would contain far too much yeast for appropriate maturation, so the beer should be reduced in temperature in the primary for a couple of days to slow yeast metabolism and drop the bulk of the yeast to the bottom of the vessel. Leaving the beer sitting for too long on the bulk of the yeast at high temperatures will undoubtedly lead to off-flavors due to yeast autolysis. ■

Steve Parkes writes the "Homebrew Science" column in every issue of BYO.

Scumbuster!

A slick CIP pump for cleaning beer lines

story and photos by Thom Cannell



Hoses can quickly build up nasty residues that can harbor wild yeasts and bacteria and taint beer flavor.

Every brewer, regardless of the size of his brewery, uses hoses to move liquid throughout the brew house. Hoses (or pipes) transport water to the kettle and wort to the counterflow chiller, fermenter and bottling bucket. If you keg your beer, one hose carries every bit of beer as it flows from keg to glass.

While homebrewers scrupulously clean kettles, chillers, fermenters, paddles, whisks, spoons, airlocks, stoppers, bottling buckets and stainless-steel kegs — what about the hoses? How do you ensure your hoses are clean and sanitary? Are you certain the hose you used last week to transport sweet wort doesn't contain flourishing colonies of wild yeast or hideous amounts of bacteria? Are you meticulous in cleaning and sanitizing your hoses and tap lines every other week? I know of no homebrewer who does, including myself. No homebrewer, that is, until recently.

I became absorbed in this question after a very nice American wheat beer of mine took on attributes of a style I've never brewed — the tangy-sour Berliner Weisse. The sour flavor was the result of an infection, undoubtedly the result of some contaminant growing in the beer line during the weeks it was on tap. And you could actually see nasty deposits in the clear poly tubing. Yeeechhh. I needed a way to forever put dirty beer lines behind me, so I came up with this.

The CIP Beer Line Cleaner

This issue's project is an inexpensive, pump-based, clean-in-place (CIP) approach to cleaning and sanitizing every hose and tube in your brew house. For less than $25 you can build a complete system for cleaning tap lines and transport tubing. With a bit of adaptation, you can even clean rigid tubing like racking canes and counterflow wort chillers.

Maintaining clean hoses, inside and out, depends on soaking and pumping cleaning solution through them. Professional brewers traditionally rely on caustic solutions — lye or sodium hydroxide (NaOH) — and relatively high heat (160–170 °C). Caustics, however, are dangerous and require personal protection, including rubber apron, gloves and eye protection. For this reason, most homebrewers do not mess with caustics.

Fortunately for homebrewers, there are modern solutions for cleaning beer lines. These include Five Star's PBW (Powdered Brewery Wash) a sodium percarbonate cleaner mixed with wetting agents, surfactants and chelators, which attract metallic ions. Other percarbonate-based cleaners like One-Step and B-Brite don't contain these other chemical agents. Another chemical designed for this application is National Chemical's BLC (Beer Line Cleaner). The remaining common cleaner is unscented household bleach. (See "Beer Minus Bacteria" by Steve

LINE CLEANER

Parts

One pump: Little Giant drill-powered pump ($5) or transport pump (approximately $120)
One 6' (2 m) washing-machine water-supply hose ($5)
3" (75 mm) copper or stainless steel pipe, 3/8" interior diameter
1 Oetiker clamp (or screw clamp) ($0.50)

QD CLEANER

Tools required:

hacksaw or tubing cutter
propane torch or heavy duty soldering iron
solder (silver solder preferred) and flux
drill motor and bits
screwdriver

Parts required:

One pump: Little Giant drill-powered pump ($5) or transport pump (approximately $120)
One (per project) hose with female garden hose-end connectors 48" (1200 mm) (approx. $6 ea.)
3" (75 mm) copper or stainless steel tubing (price varies) 3/8" interior diameter (ID) (sized to fit compression fitting or hose ID) ($0.50)
One ball-lock or pin-lock fitting ($5)
One brass compression fitting sized to screw into the keg connector (3/8" x 1/4") ($1.25)
2 Oetiker clamp ($0.50 each) (or screw clamp)
Teflon tape

Our cleaner for quick-disconnect (QD) tubes will take a bit of drilling and soldering to make the proper adapter.

A drilled brass fitting is screwed into a keg-out fitting. The QDs will attach to the keg-out fitting.

Bader in December 2002 *BYO* for general tips on cleaning and sanitizing beer equipment.)

Sanitizers like iodophor (generic) and StarSan (Five Star) are just that — sanitizers, not cleaners. Sanitizers are meant to destroy harmful wild yeasts and bacteria, not to remove soil. Before a sanitizer can work, equipment must be thoroughly cleaned.

Your first question may be, "Why use a pump?" If you're cleaning tap lines between a keg and spigot, you have to push stale beer out of the line and cleaning solution into it. (Think of a keg full of cleaner instead of beer.) And for open tubes, while soaking works, pumping pressure should expand the tube to expose cracks and let the cleaner penetrate. Also, soaking has no mechanical action to dislodge proteins and oxalates or quickly expose new layers of contamination to the cleaning action. Once clean, biweekly cleaning with this CIP device should keep your keg system's lines and taps or spigots free of contamination.

Brewery tubing can also be cleaned with long tubing brushes available at many homebrew stores. These brushes work well, but — as with any manual cleaning of brewing equipment — they require the application of some elbow grease. Our CIP solution will take the drudgery out of this task.

The Project

We've created open tubing and tapline cleaning "kits" based on a choice of pumps. At the conclusion are step-by-step instructions for using readily available cleaners.

Open Hose Cleaning

If you're using a drill-powered pump — the same inexpensive Little Giant pump we used for our fermenter and keg-sized CIP system ("Fermenter Washer," October 2002) — you'll need two 3' (1 m) lengths of hose with female garden hose-end connectors at one end. Cutting a washing-machine water supply hose in two is inexpensive; these hoses have two female fittings. Some homebrew shops also sell this type of hose. (You could also construct hoses from brass barbed-end fittings with

female garden hose-end connectors and appropriately-sized Tygon hose.)

For those who own transfer pumps (magnetic or vane-type), you'll want to utilize the proper intake and output connectors (likely female garden hose-end as above) or quick disconnects, which are a bit pricey but so easy.

The "business end" of either line and tubing cleaning system is the same and incredibly simple. Cut a piece of copper or stainless pipe to a length of at least 3" (75 mm) long. Insert half the length of the copper pipe into the pump's discharge hose; it may help to heat the discharge hose in hot water (160 °F / 70 °C). Clamp the tube to the pipe, preferrably with Oetiker clamps.

To use, drop the pickup/intake end of your pump hose into a bucket of cleaner or sanitizer. Connect your dirty hose to the copper tube by inserting it 1/2" (13 mm) onto the tube and start the pump. Run cleaning solution into the line, pushing out any beer, then circulate the solution through the line for 10–30 minutes at room temperature or higher. Flush with clean water and sanitize. Sanitizing solutions require two to five minutes of contact time, depending on type. Cut your newly-cleaned hose 1/2" (13 mm) from the pipe end and discard this unclean bit.

To clean a counterflow chiller's interior, racking canes, or keg "spears," use a bit of tube to join the pipe to the other rigid tube. Then pump the dirt away!

Cleaning Keg Quick Disconnects

Step-by-step: Adapting our CIP cleaner for quick disconnects is a bit trickier, requiring both drilling and soldering. If you don't keg beers, you don't need it. Start at your local home do-it-yourself store with a keg-out fitting in hand. Select a brass compression fitting that will screw into it.

Insert your copper pipe into compression fitting as in the photo. It was necessary to drill the interior of the compression fitting to the pipe's out-

With a copper tube welded to the adapted keg-out fitting, you're ready to clean your quick-disconnect lines.

Your tap line is the last thing your beer will touch before it's in your glass. Now you can clean it easily.

Clamp brewery tubing to the copper tube and then pump cleaning solution through it with our simple CIP device.

Circulating cleaning solution through this tap powers away the hose residue.

side diameter (OD). Clean the pipe and solder it to the compression fitting. Use silver solder for copper or stainless steel or plumbing quality no-lead solder (copper only). Be sure to use the appropriate flux. Wash and scrub the assembly to remove any remaining flux. Attach an output hose from your pump to the copper pipe with an Oetiker clamp. It will make life easy if you make one complete pump-to-hose-to-gadget for kegs, and another for cleaning lines.

Use: To use, drop the pickup/intake end of your pump into a bucket of cleaner or sanitizer. Connect your keg cobra-head fitting to the ball-lock or pin-lock fitting and start the pump.

Run cleaning solution into the line and fitting, pushing out any beer. Pump the solution for 10–30 minutes minimum at room temperature or higher. I'm using it to clean the Tap-A-Fridge project from December's *BYO*; you can clean in place any dedicated tap system that uses "Corny" keg connectors! Once cleaned, flush with water, then repeat with sanitizing solution which requires only two to four minutes wet contact depending on type.

Open Tubes

Cleaning procedure is the same for open tube or an assembled keg tap or cobra head. Push the cleaning solution in, displacing any beer in the line, and let soak for 10–30 minutes. Warming the solution to 120–140 °F (40–60 °C) will speed the process. (Heat is energy and will help dissolve deposits more quickly.) Follow all manufacturer's instructions for concentrations of cleaners or sanitizers. ■

Thom attributes this project to a pub crawl from one end of Douglas, Isle of Man, to the other with his Manx cousin Peter Christie. "For great ale, it's all about the lines, man — you have to clean them every week!" A battle cry he's never forgotten.

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The Gift of Beer

Better than fruitcake or another tie

by Sam Piper
Laguna Hills, California

PHOTO BY SAMUEL L. PIPER

"There once was a man from Clocktoberfest . . . ?" Sam's friend Ray reads the limerick on his personal beer label.

DO YOU GIVE YOUR HOMEmade beer as gifts? I hope so — some of the best gifts I've ever given have been beers that I've made. It's as close to a perfect gift as you can get, especially if you make someone a special batch. If the person likes beer, he'll be quite touched that you thought enough of him to make a beer in his honor. (And if he doesn't like beer, why would you want to give him a present, anyway?)

With a little thought behind it, you can get pretty creative in the process! So here are a few ideas and tips.

If you're fairly new as a brewer and have just one beer that you've repeatedly made well, make that. If you're a more accomplished brewer, perhaps you could make something your pal likes but cannot easily get on his own. Meads, Imperial stout, barleywine, chili beer, Belgian beers and fruit beers — not to mention my Romulan Ale — can all be hard to find commercially. Same with seasonal beers, like bock or wassail, during the off-season.

My dad happens to love Moylan's Imperial Stout, so I've tried to match that beer a few times. Dad says I came close on my last attempt. My brother-in-law, Jeff Hershey, likes my porter, so I've made that for him. And my friend, Terry Hale, the guy who taught me how to brew — well, Terry is an aficionado of barleywine. So, when he turned 50 I made him a case of "Old BBG," a lightly spiced barleywine that I've developed.

Labels are a sore spot for me. I've observed over the years that the best homebrew either comes from a keg with a batch tag or from a plain brown bottle with a batch number on the cap. There are exceptions to this rule, of course. John Higdon, my cousin's husband and a fantastic homebrewer, names his beers and has a gorgeous label for his Bay Moon Brewery.

When the beer is a gift, however, I say if you've got time, go whole hog. Name the beer after the recipient or something he or she likes and make a label. I did go all-out once on a custom label I made for Ray Ballard, a really good brewer and close friend.

I felt bad when I failed to remember Ray's 50th birthday until it was too late to brew something exotic. So I made a Scottish ale (we're both fans of the style), enough for 50 bottles. Then I wrote a different limerick for each label and bottle. One of them went:

It's fun to make beer in a vat!
It doesn't get better than that!
Than watching your brew
Bubble and stew
Into beer you can bottle and cap!

This brings me to Allen Spayeth. Allen turned 40 a couple of months back. Allen likes beer, and likes my beer, but is not a brewer. I'd thought about making a couple of cases of my fest beer for him. He seemed to like that a lot at a recent party, but then I got distracted and forgot about the gift. When I finally got around to brewing, it was two days before his birthday — a rather short cycle for a lager. That's when I got a really fun idea — I'd give Allen a beer that was fermenting in a glass carboy and let him watch it!

On the night before Allen's party, I made a pale ale, but I didn't pitch the yeast right away. I chose a pale ale because I couldn't control the fermentation temperature and that's a fairly forgiving beer. I waited until two hours before the party, put a bubble lock in the carboy, and gift-wrapped a case of sterile, empty bottles with a note inside telling him to look out on his porch, where I had left the fermenter.

When the party got around to opening presents, somewhere in the middle of all the Viagra and Metamusil gag gifts, Allen opened mine. At first he thought it was another gag gift — a case of empties for a washed-up 40-year-old geezer. But then he read the instructions enclosed in the gift, went to the front porch, and returned to the party carrying 4.5 gallons of fermenting pale ale.

This turned out to be a special gift, for Allen and his family had a lot of fun watching, hearing and smelling the beer ferment, which was something they had never before experienced. He kept the carboy in a cool corner of his family room, where they could all enjoy it. Allen got a big kick out of this gift.

The best part of the whole experience was the afternoon two weeks later when I came over to bottle and cap the batch. I believe the best gift anyone can give is the gift of time, and the afternoon we capped was a special time. Allen, his wife Beth and I had fun as we talked about making beer, bottled Allen's batch, and put away a couple of beers in the process.

One last suggestion: Include the recipe. People like to know what they're drinking! ■

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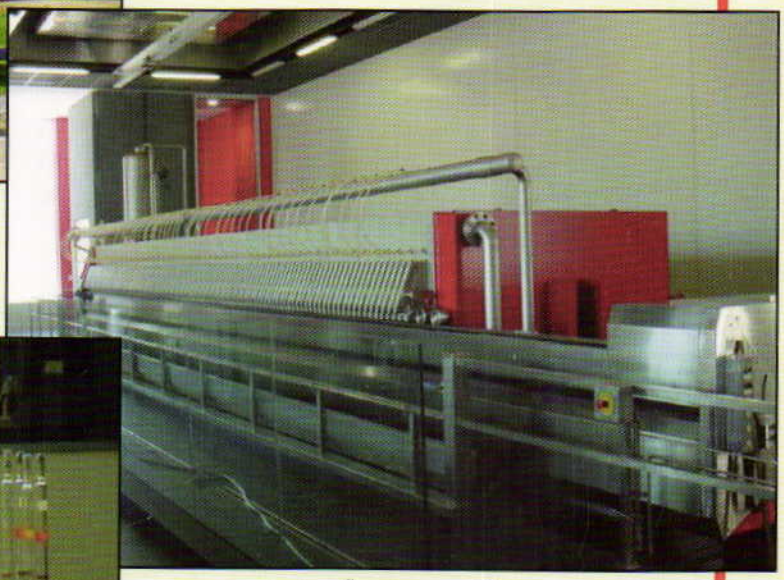

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