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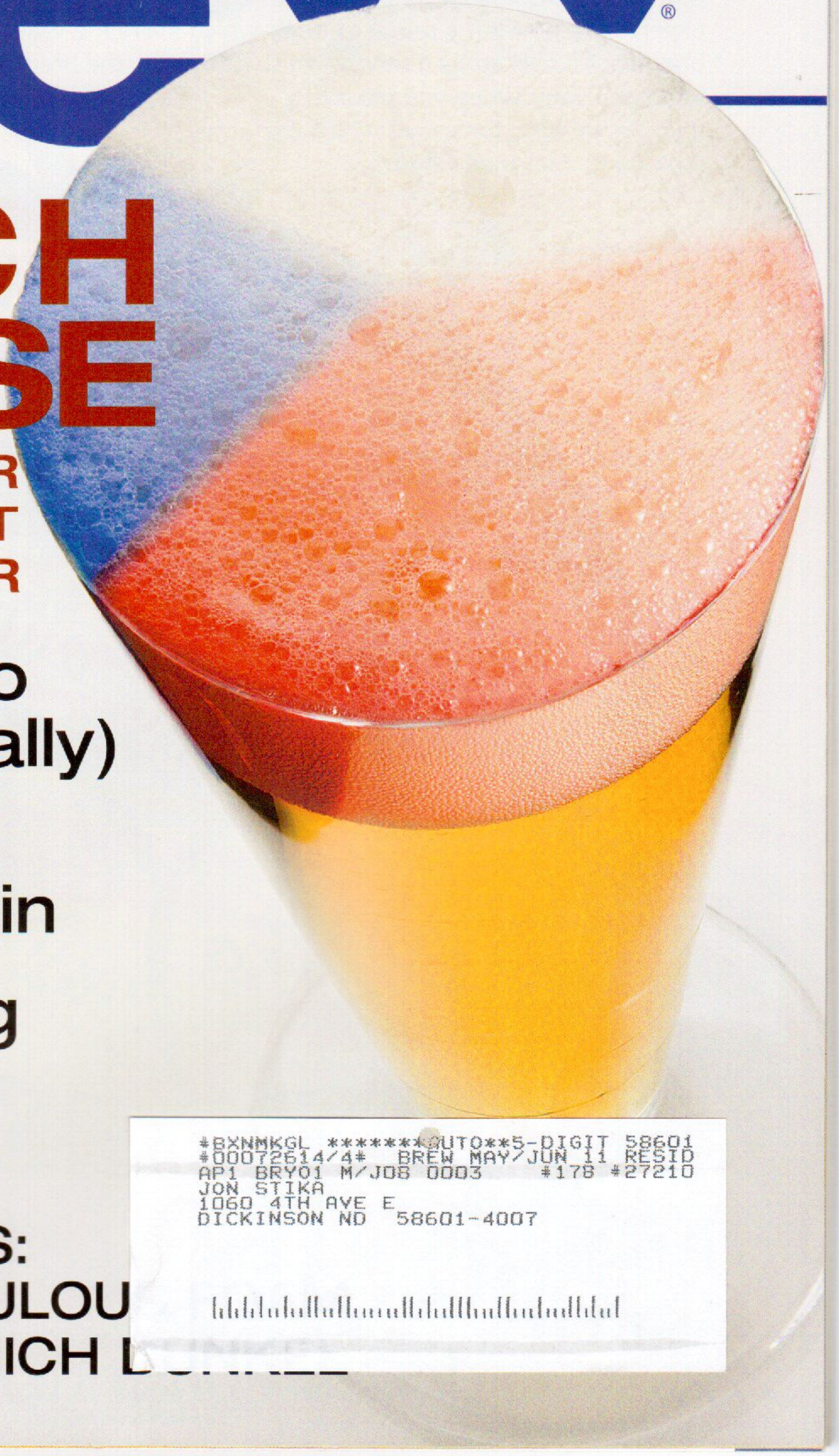
Brew

THE HOW-TO HOMEBREW BEER MAGAZINE

MAY-JUNE 2008, VOL.14, NO.3



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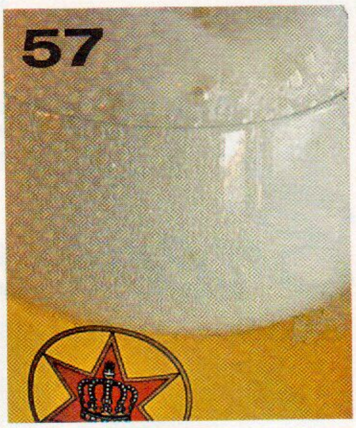
Volume 14 Number 3



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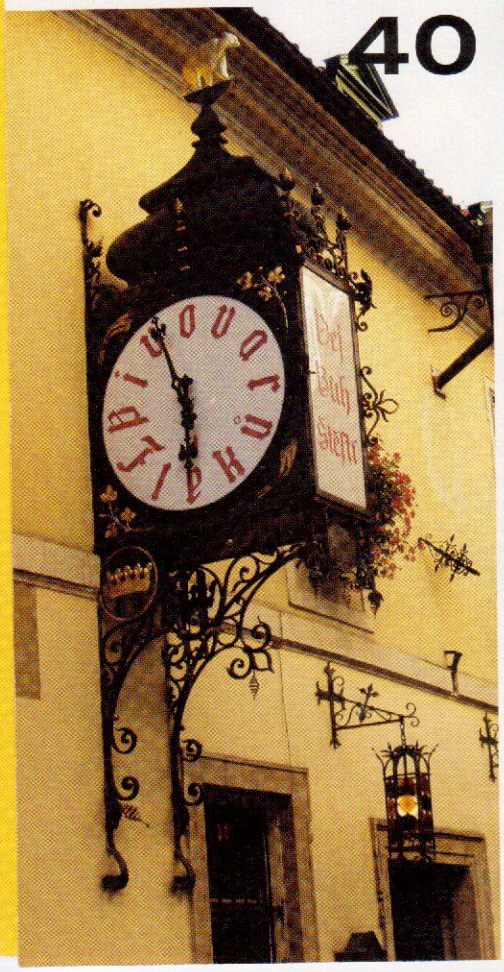

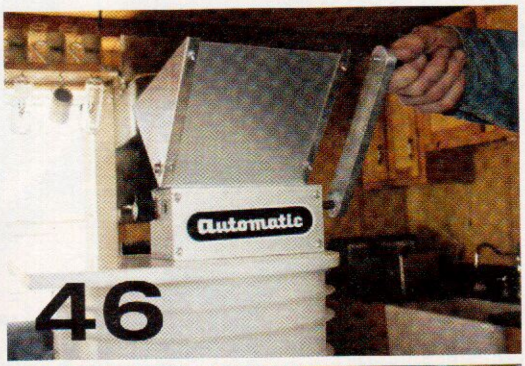

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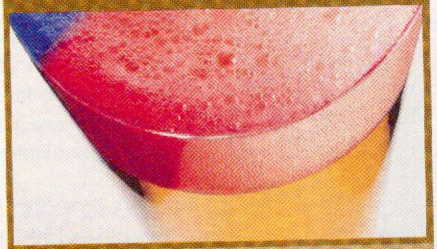

BYO RECIPE STANDARDIZATION

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

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

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

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

Brew Your Own

THE HOW-TO HOMEBREW BEER MAGAZINE

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Cover Photo: **Charles A. Parker**

Planting in Planters

Thank you for the various articles on hops in the March-April issue. I have a question about hop growing that wasn't covered in the article, about the roots and planting. What type of pot would be best for second and third year hop plants? Tall and skinny, short and fat? Do the rhizomes branch out a lot or not? How much cubic feet would they need? Thanks.

Curtis Beene
Muskegon, Michigan

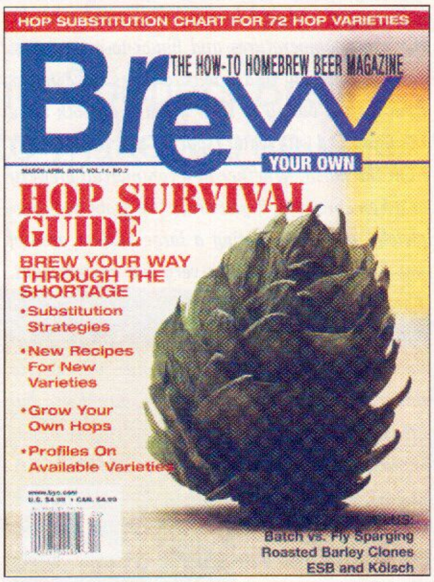
You can grow hops in a pot, but it needs to be a big one. Hop rhizomes spread out laterally, and also downward somewhat. For most of the round plant pots found at nurseries and home improvement stores, the height of the pot is at least roughly the same as the diameter and these dimensions will work well-enough. Plant the rhizome in potting soil or garden soil with a little composted manure thrown in. Avoid soils with too much clay.

A 20-inch (51-cm) diameter planter should be big enough to hold a hop plant for a couple of years. After that, transplant the rhizome into the ground or take it out of the pot, break it up into smaller pieces and replant the smaller rhizomes into multiple 20-inch (or larger) planters.

The gardening section of your local library or bookstore likely has books on container gardening. Although these books will not discuss hops, the general knowledge you can gain from them will be helpful if you plan on growing hops in containers. Two frequent problems faced by container gardeners are plants that get dehydrated and plants that end up malnourished.

Potted plants tend to dry out quickly and you need to keep an eye on the moisture levels in the soil. Likewise, it is easy for a container-grown plant to take up all the nutrients in a pot, then quickly begin to show signs of malnutrition. You want to prevent this from happening by periodically applying some slow-release fertilizer. Buy a bag of composted manure (or other good-quality compost) and add a few pounds of the compost to the pot every few months. Keep some liquid plant food (such as Miracle-Gro) on hand in case a problem does arise. Hop leaves should be nice and green; if the new emerging leaves look yellow or purple, add some of the liquid plant food. These contain nutrients that the plant can take up readily. After a few days, add some compost to the pot to keep a steady flow of nutrients available to the growing plant.

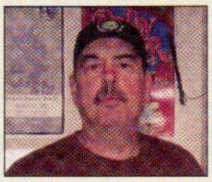
Growing hops in a container requires more attention during the growing season, but it can easily be done. And, a container can be picked up and moved to a new location if the previous year's location was found not to be suitable.



Batch Sparge Brewha

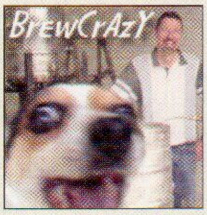
Steve Holle's article, "A Comparison of Batch Sparging and Continuous Sparging," in the March-April 2008 issue, generated some discussion on several online forums.

Some batch spargers disagreed with the conclusions of the article. These brewers asked a variety of questions, including: Why didn't I notice a change in my beers when I switched sparging methods? Why have homebrew judges never commented on this in my beers? Several noted that batch sparged beers have won medals at homebrew competitions, some presumably against continuously-sparged beers. And, finally some complained that the topic hasn't been investigated experimentally at the homebrew level (or at the commercial level, as batch sparging is practically unheard of at the commercial level.) The question, "Why don't homebrewers or judges notice a difference?" is a fair one. However, we think it has a very simple answer — how could they? Unless you brewed the same beer twice, changing only your sparging routine, then tasted the beers side by side, it's unlikely you would notice the difference. If you brewed an IPA one day and a Russian Imperial Stout a few weeks later, it would be highly unlikely that you could pinpoint any change brought about by differences in your sparging procedures. Among batch sparge supporters, nobody had claimed to have ever done a side-by-side comparison. Homebrew judges would be in an even worse position to comment as they do not know if a beer was batch sparged or fly sparged (or made with a partial mash or with malt extract and steeped grains



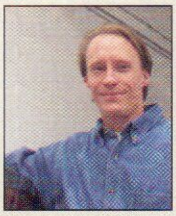
Marc Martin has brewed over 250 batches, taught over 50 people to homebrew, won over 100 ribbons and medals in competition, took a UC Davis Brewing Science course, judged at countless competitions and served as an officer in the Austin ZEALOTS during his 20 years of homebrewing. He is now the "Primary Fermenter" for the Plato Republic homebrew club in southwest Washington.

Each issue, Marc tracks down recipes for your favorite commercial beers as The Replicator. Check Speedway Brewing Company's Speedy Kiwi 5.6 ESB on page 11.



John McKissack may be better known as Johnny Max from the brewing podcast Brew CrAzy. (Look for it at www.brewcrazy.com). McKissack co-hosts the show with Captain Ron, his dog. His first podcast episode aired in July 2006, and he has posted two shows per month since then. He podcasts Brew CrAzy and brews his beer in Vidor, Texas.

In this issue, John explains how to aerate your wort using olive oil. Read it on page 34. He also wrote "21% Alcohol All-Grain Beer" in December 2006 (http://www.byo.com/feature/1556.html).



Bob Hansen used to brew at the Water Street Brewery in Milwaukee, which used extracts in their brewhouse. In 2001, he joined Briess Malting in Chilton, Wisconsin and is now the Manager of their Technical Services division. He has given many presentations at a variety of brewing conferences.

In this issue, on page 26, Bob explains the origin and process of making extract in "The Life and Times of Malt Extract."

or . . .). If the sparging details of all entered beers were made known to homebrew judges and the aggregate results of several competitions were examined, perhaps a difference would begin to emerge. Award-winning beers have been brewed with virtually every homebrewing technique known, so this fact doesn't really shed any light on the possible difference in wort quality between batch and continuous sparging.

The point that experiments have not been done at the homebrew level is true, but trivializes the amount of research that has gone into the causes and effects of oxidation by brewing scientists. The research cited in the article was done in commercial breweries, and it admittedly pointed to the general effects of oxidation on wort compounds, not specifically the oxidation of wort compounds in homebrew mash tuns. However, if you assume that the laws of chemistry work the same in homebreweries as they do in commercial breweries, it's hard to avoid drawing the conclusion that exposing hot wort to oxygen is going to produce the same outcome that it has in every other case that has been studied.

Commercial breweries and homebreweries do differ — primarily in scale and related issues, but frequently also in some other aspects. However, both commercial and homebreweries mash at the the same temperatures and liquor-to-grist ratios. Both commercial and homebreweries have husks from malted barley in their grain bed. Both rinse the grain bed with water (sparge) to recover extract from the mash. Whether in a commercial brewery or a homebrewery, if you drain the grain bed completely, you are exposing a large surface area of wet husks to oxygen in a very hot environment. The rate at which oxygen that can dissolve into the liquid surrounding the grains on the relevant timescale and the rate that tannins are oxidized under these conditions are open questions, but brewing experiments in commercial breweries have shown that these conditions elsewhere lead to darker worts and reduced stability in the resulting beer.

While it's true that concerns at the commercial level do not automatically translate to the homebrew level, the change in scale does not mean that all commercial practices or observations are automatically rendered irrelevant either.

The author of the story (and the reviewers of the article) thought that the combination of heat, wort and the large surface area exposed to oxygen would be something that modern brewers (and brewhouse designers) would definitely avoid. On the other hand, it's also a fact that there are a lot of old brewhouses in operation around the world, and these breweries are still able to produce and sell beer, which gets consumed.

Given the amount of discussion this article generated, it is likely that Brew Your Own will try to gather and present some experimental data on this issue at some future date.

Questions, concerns, comments?

Contact us!

Brew Your Own — The How-To Homebrew Beer Magazine

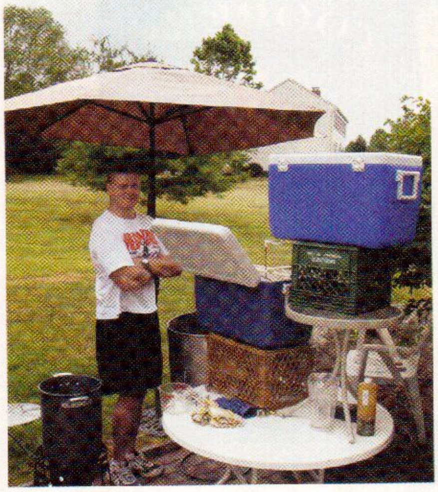
5515 Main Street
Manchester Center, VT 05255
edit@byo.com

homebrew NATION

reader RECIPE

Dave Grosch • Flemington, NJ

Dave took home the Best of Show for his BJCP 1-A Light Lager, Lite American Lager recipe at the latest War of the Worts, held February 23 in North Wales, Pennsylvania.



Pours Lite
(5 gallons/19 L, all-grain)
OG = 1.048
FG = 1.004
ABV = 5.5% 65% efficiency
IBU = 20

Ingredients
10 lb. (4.53 kg) Continental Pilsner malt
4.13 AAU Hallertau hops
(1.29 oz./36.6 g) 3.2% AA (60 mins)
White Labs WLP 029 (German Ale/Kolsch) yeast

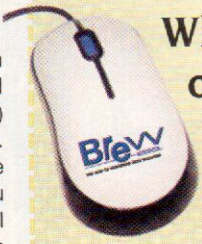
Step by Step
The day before brewday, prepare a 1 qt. (~1 L) yeast starter or pitch 2 vials of yeast. Mash with 3 gallons (11.35 L) of soft water (low mineral content) to achieve a temperature of 148 °F (64.5 °C). Rest for 60 minutes. At 60 minutes add 1 gallon (~4L) 170 °F (77 °C) water for temperature maintenance and to thin the mash. Rest an additional 30 minutes or until converted. During the last rest, heat 4 gallons (15 L) of water to 170 °F (77 °C) for sparging. Recirulate and sparge. Collect 6.25 gallons (24 L) of wort. Boil for 90 minutes with one hop addition at 60 minutes remaining. Chill wort (preferably in the kettle) to 62 °F (17 °C) and siphon the clear wort to the fermenter. Aerate and pitch your starter. Ferment at 64 °F (18 °C) until the yeast drops and the beer is clear. Usually about 14-21 days. Keg or bottle as normal. Allow whatever time you deem necessary for proper conditioning. I let this beer lager about three months before entering it into competition.

Pours Lite
(5 gallons/19 L, extract)
OG = 1.048 FG = 1.004
ABV = 5.5%

Ingredients
6.5 lbs. (2.95 kg) Pilsner liquid malt extract
4.13 AAU Hallertau hops
(1.29 oz./36.6 g) 3.2% AA (60 mins)
White Labs WLP 029 (German Ale/Kolsch) yeast

Step by Step
Mix your extract with 6 gallons (~23 L) of distilled or R/O water and bring to a boil. Add the hops and boil for 60 minutes. Chill wort (preferably in the kettle) to 62 °F (17 °C) and siphon the clear wort to the fermenter. Aerate and pitch your starter. Ferment at 64°F (18 °C) until the yeast drops and the beer is clear. Usually about 14–21 days. Keg or bottle as normal. Allow whatever time you deem necessary for proper conditioning and enjoy!

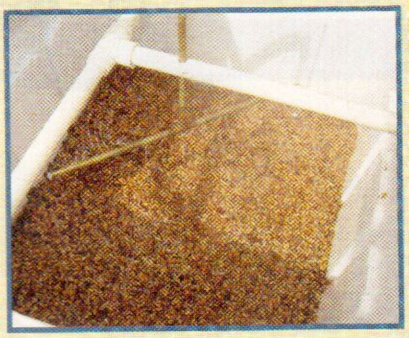
byo.com BREW POLL



Which type of sparging do you prefer?

Batch: 69%

Fly: 31%



Check out the latest poll question and vote today at byo.com

hop PROFILE Sorachi Ace

Japanese bittering hop variety developed by Dr. Yoshitada Mori at Sapporo Breweries Co. in Tokyo whose pedigree is Brewer's Gold x Saaz. It matures midseason to a dark green color and yields very high alpha acids — usually around 13% or as much as 16% in Japan. It has many European aroma characteristics and is often described as lemony. Nodding Head Brewery in Philadelphia, Pennsylvania released a limited edition double IPA made with only Sorachi Ace as part of its recent "Single Double" series of beers. Lodi Brewing Company has also experimented with it during the recent hop shortage.

club **PROFILE**

Society of Akron Area Zymurgists

Akron, Ohio

ahhhh! Saaz. That wonderful, aromatic noble hop from the Czech Republic. Most every homebrewer covets the qualities of this fine hop. But in addition to the hop variety, SAAZ takes on a different meaning in the Akron, Ohio area.

The Society of Akron Area Zymurgists, or SAAZ, is a local homebrew club that loves its beer. Founded in 1995, SAAZ was chartered to develop and promote the hobby of homebrewing and the general love and appreciation of quality craft beer. From a humble beginning of 24 members (7 of whom are still on board), we are going strong today with more than 80 members. Between 40 and 50 members actively take part in attending monthly meetings and club events.

SOCIETY OF AKRON AREA SAAZ ZYMURGISTS
www.hbd.org/saaz

Photo by John Pastor

SAAZ is sponsored by the fine folks at the Grape and Granary in Akron, Ohio and we hold our monthly meetings (held the second Tuesday of each month, except July and August) at their facility to discuss the business (and pleasure) of beer.

But we're more than just monthly meetings. Throughout the year, we plan and organize several social events providing various avenues for our members and their families to interact, enjoy good company, food, and of course, homebrew. A sampling of previous events include pub crawls to Cleveland, Pittsburgh and Columbus, conducting apple pressings for fresh cider, an oak barrel project, an annual Blues and Brews festival, good food and beer tasting events, brewing experiments, participation in the American Homebrewers Association's (AHA) Big Brew every May, and monthly homebrew contests. At the end of the year, we honor the top point-getter as the highly coveted H-BOY . . . SAAZ Homebrewer of the Year.

Many of our members have fared extremely well at the AHA's National Homebrew Competition and several members have even turned professional and are now brewing for a living. What a concept! We attribute this to the wealth of knowledge available from our diverse membership.

If you are ever in the northeast Ohio area, be sure to come check us out. Or find us on the Web at: http://hbd.org/saaz/.

WE WANT YOU

Do you have a system or a home-made gadget that will make our readers drool? How about a killer recipe or tip? Want to profile your club? Email a description and photos to **edit@byo.com** and experience fame among 100,000+ homebrewers!

If we publish your article, recipe, photos, club news or tip in Homebrew Nation, you'll get a cool ½ Liter German Stein (courtesy of White Labs) and a *BYO* Euro sticker.

homebrew systems that make you DROOL

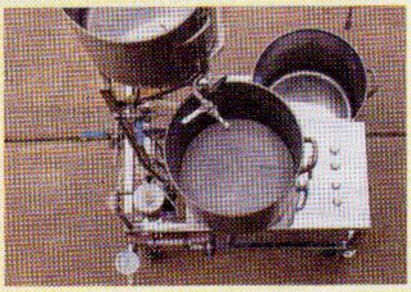
Randy Smith • Cumming, Georgia

The brew system pictured here is, hopefully, the last one I'll have to build for myself. One "glaring" mistake was to polish the stainless out too much. Otherwise, it's an easy cleanup. I've been an all-grain guy for over 15 years and have used 3-vessel systems for most of that time.

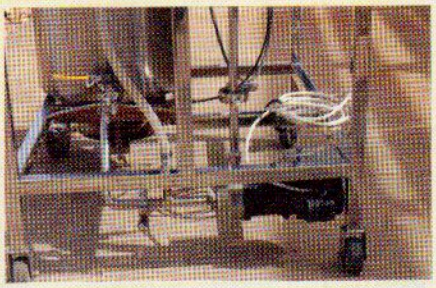
This system uses a 1-¼" stainless square tubing frame, three Vollrath's stainless steel, aluminum-clad, 15-gallon vessels, a very large March pump and a Shirron plate chiller. All of the fittings are custom-made (I'm a machinist) and polished. Most of the connections are sanitary for easy removal and cleanup. The larger, 3B burners are ignited by Quikliters, from Channel Products. The funny looking thing standing behind the mash tun is one of my smaller hopbacks. Wort is pumped through vertically before reaching the chiller.

The non-traditional configuration of the vessels, while making a deeper footprint, allows me to spin the HLT and drop make-up water into the boil kettle. The weird looking fitting at the end of the HLT valve is a custom-made ⅜" flared elbow that allows a direct connection to the stainless steel twirly sparge wand and provides a hard point for mounting the stainless RIM ring doodad.

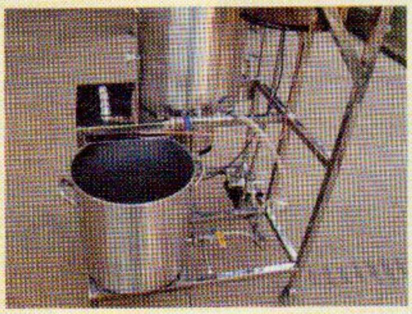
Randy (a member of the Chicken City Ale Raisers) has been brewing on a 3-tier system for nearly 15 years.



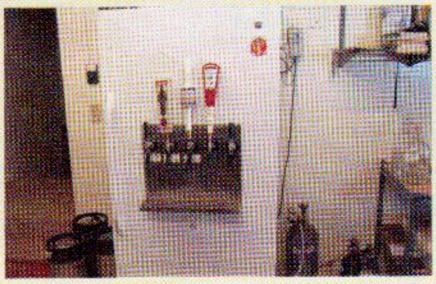
All the fittings on the system were custom-made, including this ⅜" flared elbow over the hot liquor tank valve.



The system's frame is made from 1-¼" stainless square tubing and the burners are ignited by Quikliters.



From the way the system is set up, Randy can turn the hot liquor tank to add make-up water to the kettle.



To keep all his homebrew cold — and easy to access — Randy also built this 5-tap system.

Randy's 3-tier system uses three stainless steel, aluminum-clad, 15-gallon vessels and a Shirron plate chiller.

From this angle you can see the small hopback, which wort is pumped through before reaching the plate chiller.

SPEEDWAY BREWING COMPANY

Dear Replicator,

The communications company job I have doesn't allow me much travel but when I do travel I try to find the best local craft beers. Recently I had to attend a seminar in Olympia, Washington. After the first night I thought I had sampled all of the local offerings. I asked the hotel manager if there was any good barbeque in the area and he directed me to a place called Speedway. You can imagine my surprise to discover it was a brewpub. The owner must be a car racer as the whole place is full of racing memorabilia. I must say, the barbeque was very good but the beers were even better. I especially liked the ESB, which is very similar to the traditional English styles. I have been homebrewing for two years and have tried to brew ESBs several times but can't seem to get it right. Could you possibly talk to the brewer at Speedway Brewing Company and get him to share his recipe?

Frank Dodson
Boise, Idaho

Frank, I have to thank you for this request. It should be obvious from my articles that I love good beer but after living in Texas for five years I also have a craving for good barbeque. I had heard about a new, small brewpub in the Olympia area called Speedway but I hadn't seen much information about it. Since Olympia is only about 100 miles from my home it was a great excuse for a road trip.

I discovered this is really a one-of-a-kind brewpub. Your first clue is the door handles made from V-8 engine piston rods. Upon entering you notice you are in a veritable museum of auto racing with an aroma of barbeque and boiling wort.

Bret Dodd, the owner and brewer was eager to discuss his unique establishment. As we talked over a pint of his great beer I discovered that he has a very colorful background. While not a professional auto racer he had spent many years filming auto races for television. This work allowed him to travel all over the world, especially the British Isles. This is where he discovered beers with real flavor.

With microbrews not readily available in 1987, Bret began homebrewing out of necessity. About three years ago he decided it was time to settle down and open a business. He spent two years perfecting his beer recipes by making 10-gallon (38-L) batches on his home three-tier system.

Since he is also a big fan of good barbeque, Bret figured a barbeque brewpub would make a good business model. His father had worked at the now defunct Olympia Brewery and a good friend, Paul Knight, had been the last head brewer there. A used ten-barrel brew house was purchased and, with the help of those two, Speedway Brewing opened in November of 2006. This is really a family operation as Bret brews, his sister works the restaurant, and his dad assists with all of the brewhouse equipment.

In keeping with the racing theme, all of Speedway's beers have auto related names. The Flying Scot Scottish ale is named after Jackie Stewart, a famous driver. 426 Hemi-Weizen is derived from a high horsepower Chrysler engine and the Speedy Kiwi 5.6 ESB refers to two of New Zealand's best drivers.

In discussing the Speedy Kiwi ESB, Bret says that this is one of the brewery's more popular beers. He has worked hard to emulate the same flavor profile that he enjoyed in similar beers in England.

The base malt of Speedy Kiwi provides the backbone with the Victory and caramel malts building a nutty sweet finish. An earthy, resiny bitterness is developed through the use of the traditional East Kent Goldings. Bret recommends fermenting this a little warmer than normal to fully develop the fruity esters. This is a very true-to-style ESB, much like Fullers or Samuel Smiths.

While you may not be able to duplicate Speedway's excellent barbeque ribs, at least now you can "Brew Your Own" Speedy Kiwi 5.6 ESB.

For further information about the Speedway Brewing Company and any of their other fine beers visit the Web site www.speedwaybrewing.com or call the brewery at 360-493-1616.

Speedway Brewing Company Speedy Kiwi 5.6 ESB

(5 gallons/ 19 L, extract with grains)

OG = 1.055 FG = 1.012
IBU = 38 SRM =12 ABV = 4.3 %

Ingredients

6.6 lbs. (3 kg) Briess light, unhopped, malt extract
1.5 lbs. (0.68 kg) Victory malt
6 oz. (0.17 kg) wheat malt
5 oz. (0.14 kg) crystal malt (60 °L)
2 oz. (57 g) carapils malt
6.3 AAU East Kent Goldings pellet hops (60 min.) (1.5 oz./ 43 g of 4.2% alpha acids)
2.1 AAU east Kent Golding pellet hops (30 min.) (0.5 oz./ 14 g of 4.2% alpha acids)
5.5 AAU Amarillo pellet hops (0 min.) (0.75 oz./ 21 g of 7.3% alpha acid)
½ tsp. yeast nutrient (last 15 minutes of the boil)
White Labs WLP 025 (Southwold Ale) or Wyeast 1968 (London ESBAle) yeast
¾ cup (150g) of corn sugar for priming

Step by Step

Steep the crushed grain in 2 gallons (7.6 L) of water at 155 °F (68 °C) for 30 minutes. Remove grains from the wort and rinse with 2 quarts (1.8L) of hot water. Add the liquid and dry malt extracts and bring to a boil. While boiling, add the hops and yeast nutrient as per the schedule. Add the wort to 2 gallons (7.6 L) of cold water in a sanitized fermenter and top off with cold water up to 5 gallons (19 L).

Cool the wort to 75 °F (24 °C). Pitch your yeast and aerate. Allow the beer to cool to 70 °F (20 °C) and hold until fermentation is complete. Transfer to a carboy, avoiding any splashing. Let the beer condition for one week and then bottle or keg. Carbonate and age for 2 weeks.

All-grain option:

This is a single step infusion mash. Replace the malt syrup with 8.5 lbs. (4 kg) ESB malt and 1.5 lbs. (0.68 kg) 2-row pale malt. Mix the crushed grain with 3.5 gallons (13 L) of 172 °F (78 °C) water to stabilize at 155 °F (68 °C) for 60 minutes. Sparge slowly with 175 °F (79 °C) water. Collect approximately 6 gallons (23 L) of wort runoff to boil for 60 minutes. Reduce the 60 minute hop addition to 1.25 oz. (35 g) to allow for the higher utilization factor of a full wort boil. The remainder of this recipe and procedures are the same as the extract with grain recipe.

Note: ESB malt is produced by Gambrinus. If it is not available substitute Maris Otter pale malt.

homebrew NATION BYO

Homebrew CALENDAR

May 16–17
Buffalo, New York
Western NY Homebrew Competition
The 12th annual competition and Brewer's Night Out banquet. Deadline for entries is May 3. All BJCP categories will be judged. Best of show will be awarded to both beer and cider/perry/mead. $6.00 per entry for the first five entries. More information at www.niagarabrewers.org/awog/.

May 17
Gainesville, Florida
2008 Hogtown Brew-off
The annual AHA/BJCP sanctioned competition based on the 2008 BJCP Style Guidelines. Points accumulated at this event will be counted toward The Florida Brewer and Brew Club of the year. Entries accepted from April 28th to May 9th. More information at www.hogtownbrewers.org.

May 23
Toronto, Ontario
Great Canadian Homebrew Conference Deadline
The deadline for entries to the GCHC homebrew competition. 2004 BJCP rules apply, Canadian currency only. For more information about entries, rules and judging, email homebrewer@sympatico.ca.

June 7
West Chester, Pennsylvania
2008 BUZZ Off
A qualifying event for the Masters Championship of Amateur Brewing (MCAB). Deadline is May 23 for mailed entries, 24 for dropoffs. More information at http://hbd.org/buzz/.

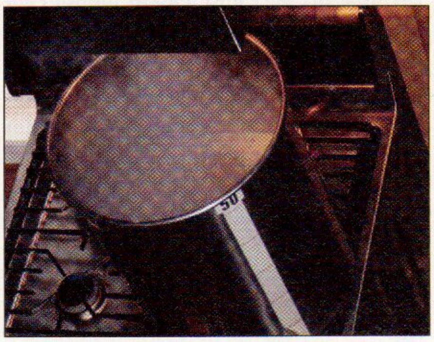
June 20–21
Boston, Massachusetts
American Craft Beer Fest
The first annual East Coast event, in partnership with BeerAdvocate magazine and Harpoon Brewery. Featuring three sessions featuring 75 breweries and at least 300 craft beers. For more event information, contact mail@beeradvocate.com.

BEGINNER'S block

Stovetop Boiling

by Betsy Parks

When many homebrewers start making beer, their first batches of wort are concentrated extract brews, boiled on a stovetop with less liquid than the full batch in a recipe. A smaller batch of wort is great for new brewers because it doesn't require purchasing a dedicated brewpot, and you



can do it on any kitchen stove. But while it may seem as easy as turning on a burner, there are some important facts to know about stovetop boils.

Have what you need

Any chef will tell you that before they begin making any dish, they have to have their ingredients ready, which is known as *mis en place*. This is just as true for making wort. Boiling wort can take anywhere from thirty minutes to an hour, which can seem like a lot of time, but it does not afford the time to search around and take your eyes off of the brewpot. Have all the tools (brewpot, stainless steel spoon, thermometer, measuring cup) you will need ready, as well as your extract, yeast and hops on hand.

Begin the boil

Start making your wort by adding the cold water you plan to boil to your brewpot, which is typically around 2 gallons (7.6 L) or whatever your recipe or kit calls for. Place your pot on the stove and turn on the heat. Once the water starts to boil, either take the pot away from the stove or turn off the flame to add your extract and stir well to incorporate it. Liquid malt extract has a tendency to sink to the bottom of the pot and scorch, while dried malt extract has been known to linger near the top of the pot and cause it to boil over. Boil-overs are also the reason why you need to keep an eye on your pot while it is on the heat.

For concentrated worts, be aware of what is happening to your brew while it is boiling. All boils are similar, but small batches have particular concerns. For example, the more concentrated the wort, the darker it will become during the boil. If you're brewing a beer that is typically lighter in color, try to boil as much of the recipe's full volume as you can.

Because of their small size, concentrated boils can also become much more concentrated more rapidly than larger batches because of evaporation, which will also darken the wort. To prevent rapid evaporation, lower the heat.

To avoid some of the problems associated with concentrated boils, try using either the Texas two step or the late extract method. The Texas two step means simply boiling two separate batches of wort to make up the full volume. Boil one half-batch (2.5 gal./9.4 L) of wort and chill it, the other half later. For the late extract method, instead of adding all your extract at once and stirring, boil your wort with half the extract. Late in the boil (20 minutes or so left, just to sanitize), add the remainder of the volume of extract and bring it back to a boil for the remainder.

Add the additions

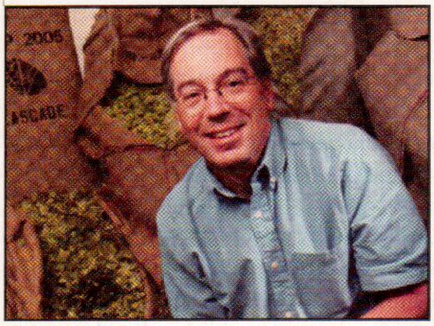
Once you've brought your wort back to a boil, you can add your hops and any additions. Boil for as long as the recipe calls for and no longer. Concentrated worts are known for lower hop utilization, so you will need to compensate for the loss. To learn more about hop utilization and how to compensate for losses, read more online at: http://byo.com/mrwizard/1688.html.

Evaluating Hops

Look and smell your way to better brew

by Betsy Parks

Think the big guys have fancy methods of finding the best hops? Well, that may be true, but these three pros say that anyone can pick a good quality hop — you just need a good nose and to know what to look for.

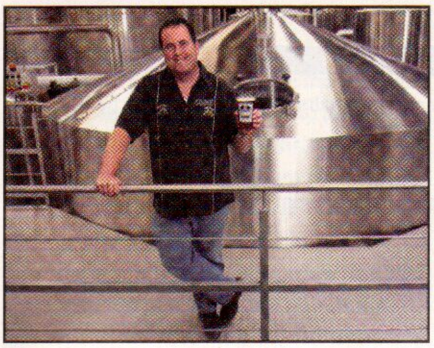


LARRY SIDOR, Brewmaster at Deschutes Brewery, Bend, Oregon. Before coming to work for Deschutes in 2004, Larry worked for hop company S.S. Steiner, Inc. in Yakima, Washington, Pabst Brewing Company in Tumwater, Washington and Olympia Brewing Company, also in Tumwater. He studied brewing at the Siebel Institute of Technology in Chicago, Illinois and is a member and past president of the Master Brewers Association of the Americas.

Cascade is probably our number one hop and then Nugget. US Tettnang is a favorite as well as Northern Brewer, East Kent Goldings and Centennial.

First and foremost we have 100% whole hop usage. We go to the field and select the hops in the middle to end of September in Yakima, Washington. What we're looking for is things that are related to the hops that we prefer, such as aroma and alpha. Once we've seen the hops, we establish an aroma number between zero and ten, with ten being the highest quality, and a physical number for that hop based on its physical qualities, like the color, how shattered the cones are and how friable the cones are. As for aroma, look for typical aromas like citrus, herbal, piney, spicy, garlic, onion, grassy, tobacco, cheesy, earthy. Some are good, others, like some of the last ones mentioned, are defects.

Evaluating hops is mainly sensory. Look closely at how they are packaged — that's the single biggest thing. Hops should be packed in a foil oxygen-barrier package — no plastic — and stored dark and cold. The ideal temperature for storing is around 26 °F (3 °C). If you open up a package of hops and they smell like cheese, they should go back — you deserve better than that. For pelletized hops, the pellets shouldn't be too dense and the color shouldn't be brown. The pellets should be dull green, not shiny, indicating it was pelletized at a cool temperature. If they are brown and shiny, it means there was too much heat during pelletization, and that will give a burned flavor.



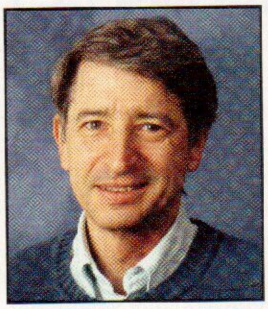
MITCH STEELE, Production Manager and Head Brewer at Stone Brewing Company, Escondido, California. Before coming to Stone, Mitch worked as the Assistant Brewmaster for Anheuser-Busch's Merrimack, New Hampshire facility. He has also brewed professionally at San Andreas Brewing Co. in Hollister, California and has acted as the New England District President for the Master Brewers Association of the Americas.

We use a lot of Centennial, Ahtanum, and Magnum hops and smaller amounts of Simcoe, Amarillo, Mt. Hood, Warrior, Columbus and some others.

We get all our hops in pellet form, and as such they are vacuum packed and sealed on arrival. Hop pellets store better than whole hops compressed in bales, and I have more confidence that they are of good quality when they arrive at the brewery. One way we can tell if there's a problem is by looking at the resulting beer — does it have the hop aroma, flavor, and bitterness we expect? In addition, on brew day, if the hop pellets look or smell different (a different shade of green, more or less stickiness, etc.) we usually start asking questions.

We have an opportunity at times to go to Washington State just after harvest and select hops straight from the bales. In this situation, you look for many of the same things: do the hops look nice and green, is there an absence of windburn or mold (discoloration of the cones), are the lupulin glands nice and bright yellow colored? Then you do what's called a "rub" where you take some hops and rub them in between your hands to shatter the lupulin glands. Then you smell the hops and evaluate the flavor and select the lots with the most desirable aroma characteristics.

For a homebrewer, I would recommend using pellets, just because they store better. But if you want to use whole hops, look for good looking, uniformly colored hops that are in good condition. Hop plugs are a nice way to use whole hops, because they are so strongly compressed they don't tend to oxidize as much or break apart. If they are brown or don't have intact lupulin glands between the leaves of the cone, they have probably seen better days. Make sure you smell the hops, and look for a nice aroma.



DR. VAL PEACOCK, Research Scientist, Anheuser-Busch, Inc. Dr. Peacock's primary responsibilities at Anheuser-Busch include evaluating and examining incoming hops, working with hop breeders to develop new aroma varieties and assuring the quality of hops for the brewery from field to bottle.

Peacock began his career at Anheuser-Busch in 1989 as manager of hop technology, a role he continues to serve at the company. He graduated with a B.S. in Chemistry from Iowa State University in 1973 and received a Ph.D. in Organic Chemistry from the University of Wisconsin in 1978.

With our premium brands, mostly what we use for hops is aroma varieties like Hallertauer Mittelfrüh, of which ⅔ comes from Germany and ⅓ from the US, some Saaz hops which come from our own farm in Idaho and we also use quite a bit of Willamette grown in Washington and Oregon. Those three make up about about 90% of our hops, but we also use a small amount of Strisselspalt from the Alsace region of France.

We have a lot of acreage contracted for growing hops and we own the hops right there on the farm. We always stay in contact with the farmers and visit the fields to make sure the quality is there for us — to make sure there is no disease or insects.

At Anheuser-Busch, hops are delivered in cloth bales as whole hops in a cold storage warehouse and a sample is taken randomly from a bale. We'll look at the samples from the lot individually to see if the hops are damaged by diseases or insects and if they have been properly handled by the farmer. The farmer picks the hops and dries them from 80% to 10% moisture and you can ruin hops quite quickly by drying. On the other hand, if you don't dry them enough there is combustibility — like wet hay — that is a hazard. And if that doesn't happen, you may spoil them from mold forming, so drying is a key quality problem.

The hops should be green, telling you that they are free of diseases and picked early enough. If they were picked too late they will turn brown and the cones will break up when you bale them. On the other hand, if the farmer picked the hops too early, they'll be very green and pretty, but won't have much aroma to them — that might not be what you want.

We are capable of further testing here, but we buy hops based on someone touching, smelling and feeling the hops — basically that is going to tell you everything you need to know about hops. Don't just look at them, smell them. If you're buying hops and they are green and the cones are intact, take them and rub them in your hands hard, stick your nose in them and it will tell you a lot about the hops. If you're smelling something in there that is unpleasant, it's probably not something you want.

Glass Color Clarity

Dealing with braun hefe and reusing hops

by Ashton Lewis

Color correction

In the December 2007 issue of BYO, you gave an answer about light skunking a beer. You stated that it was UV light that was damaging the beer. I don't see how this is possible. It must be visible light if any light is destroying a beer at all. For example, our eyes cannot see UV light, hence the name "visible light." So, why then would the visible color of a bottle determine its ability to transmit or reflect UV light. In fact, glass itself actually absorbs most UV light that reaches it no matter what the visible color of the glass; this depends on the quality of the glass, for example the amount of silica and quartz in the glass. A brown bottle is brown because it absorbs visible "brown" light. A green bottle is green because it absorbs "green" light and so forth. So then if UV light does in fact "skunk" a beer, then the color of the glass would have no effect.

Jake Ocque
Buffalo, New York

Thanks for the great comment with respect to my answer about hops and skunkiness, Jake. I have spent several hours reading and have gained a new appreciation for glass and the intricacies of light filtration. You are indeed right that visible light causes beer to go skunky. I am also correct that UV light causes beer to go skunky. Ultraviolet light ranges from 10–400 nanometers (nm) in wavelength and visible light occupies the portion of the electromagnetic spectrum ranging from 400–700 nm. There are numerous references in the brewing literature stating that light ranging from 350–520 nm results in skunky beer. That covers the upper portion of the UV light range and visible light from violet to green, including blue.

I do want to clarify one point about color because the explanation of why objects have a given color is backwards. A green beer bottle, for example, does not absorb green light, it absorbs all visible wavelengths except green. This is an important distinction; since green bottles do not absorb green light (520–550 nm) this wavelength passes through the glass and catalyzes the reaction that results in the dreaded skunk nose! Clear and blue glass bottles produce the same result.

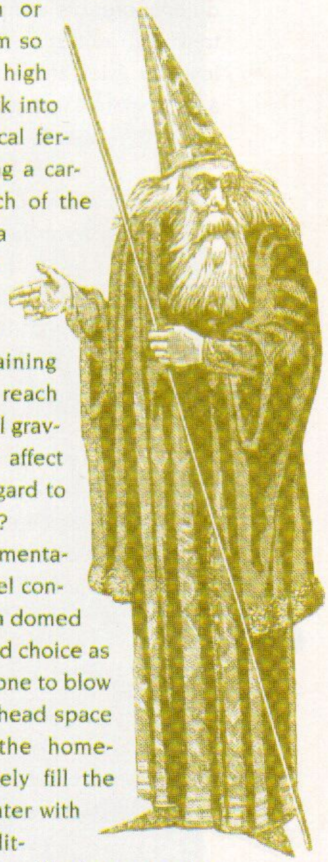
You are also correct that the color of an object relates to visible light and color provides no information about the absorption of ultraviolet light (and other non-visible wavelengths). High-purity, clear glass containing nearly 100% silica transmits all visible light and also transmits ultraviolet light. In contrast, the ordinary clear glass beer bottle is made from a mixture of silicon oxide, sodium bicarbonate, calcium oxide and magnesium oxide. This type of glass allows about 90% of wavelengths greater than 350 nm to pass through and blocks about 90% of wavelengths shorter than 300 nm. While most of the UV spectrum is absorbed by clear glass, they transmit all wavelengths involved in causing skunky beer.

The color brown is a mixture of red, orange and yellow wavelengths. These colors range from about 580–700 nm. This means that brown beer bottles absorb the shorter wavelengths that damage beer. Brown glass is pigmented with iron oxides, among other metal oxides, and these various forms of iron absorb UV light over a wide spectrum of wavelengths. In a nutshell, brown glass absorbs the visible and UV wavelengths of light responsible for skunkiness. Brown glass is also used to store other light-sensitive products, such as medications and film developing reagents (for those youngsters out there in homebrew land, film is what was used before digital cameras).

In the process of doing my homework, I came across some interesting patents pertaining to this subject. One patent is for a clear glass containing vanadium pentoxide and the stated application for this patent is beer bottles. Vanadium pentoxide does not impart color to glass and does absorb UV light, but does have an affect on the susceptibility of beer to light damage. Another patent was for a colorless group of UV-absorbing, Maillard reaction products extracted from roasted malt. These compounds were demonstrated to greatly reduce the rate at which beer is skunked. Interestingly, Heineken filed this patent. It has always seemed to me that dark beer has immunity to light and this paper seems to support that observation. Since neither patent addresses visible light, and both relate to skunky beer, I assume that UV light is a more potent catalyst for the reaction than visible light. Hopefully this sheds a bit more light on this stinky topic!

To blow off or not to blow off, that is the question.

Is it better to blow off during primary fermentation or use a closed system so the debris from high kräusen settles back into the carboy or conical fermenter? Does filling a carboy within one inch of the top and inserting a blow off tube lead to the expulsion of yeast that may degrade the remaining yeasts' ability to reach the desired terminal gravity? Does blow off affect hop presence in regard to aroma or bitterness?



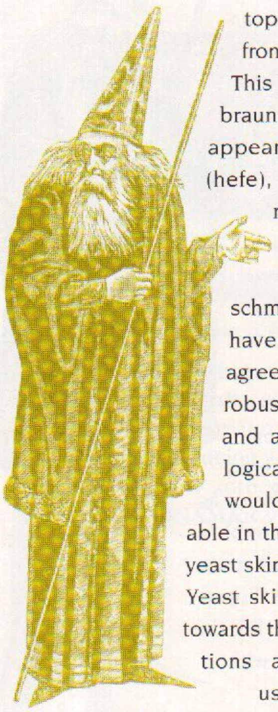
For a closed fermentation, a stainless steel conical fermenter with a domed lid seems like a good choice as it does not seem prone to blow off due to its large head space thereby allowing the homebrewer to completely fill the fermenter. A fermenter with a flat lid, with very little headspace, when filled to capacity, appears more likely to blow off since it has little or no headspace when filled.

Some of our primary fermentation carboys blow off very aggressively and terminal gravity is in the 20 to 30 range. If one of ours blows off less (with little or no debris leaving the carboy), it seems as if TG is lower — more in the 08 to 12 range. Would blow off cause the variability?

Most of my beers are mashed somewhere between 150 and 152 °F (65.5 and 67 °C) and initial gravities are rarely lower than 1.070. Target terminal gravity is 1.010 or less and little if any crystal malt or unfermentables which would result in a higher terminal gravity are used. My club and I use liquid yeast with a starter and visible fermentation starts in less than eight hours in all cases. We infuse oxygen in each carboy with our recipe kits from disposable oxygen tanks (20 second infusion).

Roger Swantek
Clinton Township, Michigan

This is a classic question about brewing technique. Allow me to give a little background on the technique of fermenter skimming used by some traditional brewers using open fermentation tanks. Traditional, manual skimming involves using an archaic tool resembling a giant spatula with holes. The yeast skimmer is used to remove the top brown layer of yeast from the fermenting beer. This layer, frequently called braun hefe because of its appearance, contains yeast (hefe), trub and some hop resins (the trub and hop resins are the braun part of this schmoo). Most people who have tasted braun hefe will agree that this stuff is pretty robust! It has a harsh bitter and astringent flavor that a logical brewer may think would be less than desirable in the finished beer, so the yeast skimmer was invented. Yeast skimmers are also handy towards the end of ale fermentations and are traditionally used to harvest these top cropping yeast strains from the top of the fermenter before the beer is racked to a closed vessel. Some ale yeast strains sink into the beer after fermentation and harvesting yeast with a yeast skimmer has the advantage of minimizing yeast carry-over from fermentation into the next vessel, be it a secondary fermenter or cask.



Using a yeast skimmer is somewhat labor intensive and there are methods of fermentation with built-in skimming features. Examples include Yorkshire stone squares and Burton Unions. Some of the largest US brewers have skimming systems that separate braun hefe from the fermenter. All of these methods that rely on fermenter design use the kräusen to move the braun hefe into a chamber or a separation tank where it can be removed.

So there is certainly a lot of anecdotal evidence supporting the notion that removing a portion of the kraüsen may be advantageous. At home there are a few ways to remove braun hefe. One method is to allow the fermenter to overflow or "blow off." This method is not very well controlled and the amount of blow-off varies by batch and is influenced by the fill level of the fermenter (batch size), pitching rate, yeast strain, fermentation temperature, aeration rate, wort gravity, etc. Since most homebrewers do not brew the same beer all of the time the blow off volume is likely to vary from batch to batch. Another problem I have with intentionally blowing kräusen from the fermenter is that there can be fairly high beer losses associated with this method and I am not overly thrilled with the idea of beer loss.

I think the primary goal here is to remove braun hefe. Beer loss and yeast removal is secondary to this goal. If you have a fermenter with enough headspace to prevent blow-off but with something in it to help remove braun hefe you can achieve your primary goal without losing beer or yeast. There was a style of fermenter that was quite popular in the US during the 50's, 60's and 70's called bread-loaf tanks. These tanks are still found in many breweries built during those decades. Bread-loaf fermenters are rectangular and often have a flat roof with a slight pitch where one end of the tank is slightly taller than the opposite end. Many bread-loaf tanks also have a chamber in the corner of the tall end. The chamber is open at the top and its purpose is to collect braun hefe that is pushed into the chamber as the kräusen rises and flows across the bottom side of the tank top during fermentation.

Another more contemporary design is found in cylindroconical fermenters, where a false roof with holes in it is used to retain braun hefe from kräusen that is pushed up onto this deck during fermentation. This system is really quite similar to how a Yorkshire square functions. The nice thing about this method is that braun hefe is retained on the roof and beer and yeast flow drain back into the fermentation and the loss of beer and yeast is virtually nil. Another similar system is to use a small tank to do the same thing. Kräusen blows off from the fermentation in a tank equipped with a strainer and yeast and beer return back to the fermenter. This system has some commonalities with Burton Unions. Both methods are used by large US brewers that are often mocked by beer enthusiasts.

Whether you have a fermenter with a flat top or a dished top you can prevent excessive blow-off by not overfilling the tank. I typically suggest 25% headspace or "free-board" in a fermenter for most yeast strains. Some strains are known to be very foamy and some commercial breweries have as much as 40% headspace in their tanks, although this is relatively uncommon. If you then devise a system to retain the braun hefe or separate from kräusen that blows off from the fermentation you can minimize beer and yeast losses.

You provided a lot of good information in your question to help me offer ideas I think will help. The extremely high finish gravities in some of your batches with aggressive blow-off is not a good thing. If asked "does excessive blow-off" affect final gravity I would answer "no." In light of the information in your question, this answer is clearly wrong. It seems that you are actually removing enough yeast to cause your fermentations to finish high and I am really surprised by that fact. If you would like to continue using the blow-off technique to skim your fermentations you need to get this factor under control so that your fermentations come to completion. Most commercially brewed beer around the globe these days does not use any method specifically devised to remove braun hefe. Most cylindroconical tanks are not overfilled and do not blow-off during fermentation. There is some adhesion of braun hefe to the top and sides of the tank that form the headspace above the beer level, but this happens in almost any fermenter with enough headspace to prevent blow-off. We have this type of fermenter at Springfield Brewing Company and we have brewed many delicately flavored beers over the years that have not, in my opinion, suffered by this fermentation method.

To repeat a common theme of mine, I encourage you to evaluate the flavor of your beers. If your beer tastes better when you remove braun hefe, then by all means figure out the best way of fine tuning this technique. However, if you really cannot tell much difference between batches with blow-off from batches without blow-off then you should really question worrying about it. And if the main difference is that batches with blow-off taste more like wort than beer then any benefit realized in your brewery seems totally negated by hanging fermentations.

Recycled hops

Is it possible to take hops previously used for dry hopping and bitter a beer with them? Is there any reason to think the alpha acids are either gone or broken down or otherwise unable to be isomerized in a fresh batch?

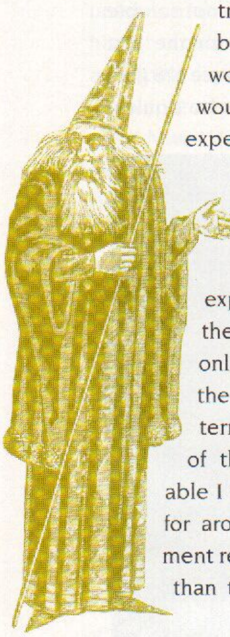
Brad Petit
Columbia, South Carolina

This reminds me of an idea created from necessity and desperation, like something one would hear in a tale about the Great Depression. And like many of the thrifty practices created in really bad times such as the Great Depression, I think this idea has some merit and could indeed work.

If I were to suggest a method of using hops for dry hopping, then to use them a second time in the boil to add bitterness there are a few things that come to mind. The first is that whole hops should probably be used because the pellet making process breaks the lupulin glands containing oils and alpha acids. My inclination is that whole lupulin glands found in whole, compressed hops could be successfully captured from beer after dry hopping and used again. Although hop oils are found in the lupulin glands it is clear from conventional dry hopping using whole hops that the oils move into the beer without having to crush the lupulin gland.

I think a hop bag made from a fine nylon mesh with a pore size of about 20 microns would work well to contain the hops used for dry hopping. This fine mesh would retain the lupulin glands, yet allow beer and hop oils to freely move across the barrier. After dry hopping is complete, the hop bag could be plucked from the batch and used in the brewhouse. My gut feeling is that the hop bag should be rinsed before tossing it into a batch because boiling yeast and beer with a new batch of wort sounds like something that would lend some unusual and potentially unpleasant flavors to the new batch.

The question of course is how much hops to use. If you added 1 ounce (28 g) of 10% alpha hops to the batch being dry hopped you probably should factor in some losses, even though according to all the text books alpha acids are not soluble in beer. If I were trying this for the first time I would consider the 1 ounce (28 g) of hops used for dry hopping to be equivalent to ½ to ¾ of an ounce (14 to 21 g) of 10% alpha hops the second time around. Since the hops will be wet you needn't weigh them before reuse. This means it's important to note the weight and alpha content of the hops you use to dry hop.



If I were to actually give this method a try I would start by splitting a batch of wort. Half the batch would be treated normally and would serve as a control in the experiment and the other half would be the experimental batch. It is important to hold all variables constant except for one. In this example the experimental variable would be the first hop addition. I would only add my recycled hops at the beginning of the boil for bitterness and to make evaluation of the data somewhat manageable I would add only one addition for aroma (or to make the experiment really clean, add no other hops than the first addition, but this is homebrewing and the product needs some aroma!). The control batch would be hopped the same except the first addition would be unused hops. Ideally the hops would be the same, for example Centennial cones with 8.5% alpha, except the test batch has recycled hops.

All other steps in brewing, fermentation and aging would be identical and the evaluation done blind to minimize bias. These experiments are difficult to objectively evaluate yourself since you know what the two experimental beers are, even if you taste them blind, and knowing the experiment can easily skew your palate. So you may want to recruit a couple of friends who are truly blind panelists. The basic sensory test to perform on something like this is a difference test. Google triangle test and/or duo-trio test to learn how to perform a statistically valid difference test. If the two beers cannot be distinguished from one another there are several conclusions that could be drawn.

If the samples are different, then you could perform some descriptive testing to give more information. For example, they may be very similar except for bitterness. Or one sample may be described as having a soy sauce, vegemite flavor note. Whatever the descriptions, descriptive testing tells you more about two beers than that they simply taste different.

Brew Your Own Technical Editor Ashton Lewis has been answering homebrew questions as his alter ego Mr. Wizard for the last 12 years. A selection of his Wizard columns have been collected in "The Homebrewer's Answer Book," available online at brewyourownstore.com.
Do you have a homebrewing question for Ashton? Send inquiries to *Brew Your Own*, 5515 Main Street, 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 personally. Sorry!

Munich Dunkel

A "back in the day" kind of beer

by Jamil Zainasheff

I love technology, but there are times when going "old school" is just better. I could write these columns using the latest computer software, but I like to write them with pencil and paper while enjoying a pint in some wonderful spot. There is something about writing a little slower and sipping a pint, doing it old school, which makes the article better, right? At least it makes the process of writing more enjoyable.

The funny thing is, there are some beer styles that feel old school, regardless of how they are produced. Munich dunkel is one of those beer styles. It isn't light, fizzy, and near colorless. It is dark with gemstone highlights and rich with bready malt flavors. When I drink a fine Munich dunkel, I get the feeling, right or wrong, that the brewery must have been producing this style of beer for many years, if not many centuries.

Munich dunkel is the maltiest style in the BJCP Dark Lager category. It is a beer full of toasted bread and other malt flavors and aromas from the heavy use of melanoidin-rich Munich malt. Most good examples are balanced nearly even, leaning a little to the sweet side, which hides the restrained hop bitterness. However, it is never overly sweet, heavy, or as intensely malty as bock-style beers. While schwarzbier will often have a slight roast note, Munich dunkel should never be roasty. Munich dunkel is also lighter in color than schwarzbier, ranging from deep copper to dark brown.

Hop character in this style, like the hop bitterness, is restrained. A touch of hop flavor or aroma is acceptable, but it should be no more than a subtle complement to the overall beer.

I've seen some excessively creative recipes for Munich dunkel, including everything from molasses and honey to roasted barley and wheat malt. Then there are other recipes that use half Munich malt, half Pilsner malt and a substantial amount of CaraMunich. The CaraMunich adds a caramel sweetness that some people may enjoy, but I find it completely out of place in this style. Even moderate amounts of CaraMunich result in a beer more like a bock than a Munich dunkel. The best Munich dunkel that I've had was made from a simple recipe. Munich dunkel is a beer rich in malty flavors, but it does not require a complex recipe.

The key to brewing Munich dunkel is using a very high percentage of Munich malt. Munich malt provides all of the rich malty flavors and aromas that the beer needs. Some of the best commercial examples are made entirely from Munich malt and a dash of Weyermann Carafa® Special for coloring. The question many all-grain brewers have is what color Munich malt? Maltsters produce varying colors of Munich malt, from a low of 6 °L to

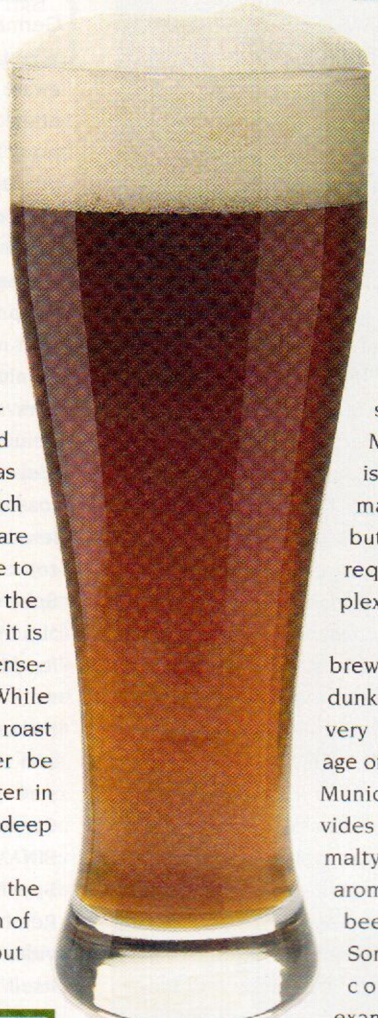


Photo by Charles A. Parker/Images Plus

MUNICH DUNKEL by the numbers

OG:	1.048–1.056 (11.9–13.8 °P)
FG:	1.010–1.016 (2.6–4 °P)
SRM:	14–28
IBU:	18–28
ABV:	4.5–5.6%

RECIPE

Old School Dunkel
(5 gallons/19 L, all-grain)

OG = 1.054 (13.4°P)
FG = 1.014 (3.6°P)
IBU = 23 SRM = 20 ABV = 5.3%

Ingredients

11.0 lb. (5 kg) Durst or Weyermann Munich Malt 8 °L
5.0 oz. (142 g) Weyermann Carafa® Special II (huskless) 430 °L
4 AAU Hallertauer pellet hops (1.0 oz./28 g at 4% alpha acids) (60 min.)
2 AAU Hallertauer pellet hops (0.50 oz./14 g at 4% alpha acids) (20 min.)
White Labs WLP833 (German Bock Lager), Wyeast 2308 (Munich Lager) or Fermentis Saflager S-23 yeast

Step by Step

Mill the grains and dough-in targeting a mash of around 1.5 quarts of water to 1 pound of grain (a liquor-to-grist ratio of about 3:1 by weight) and a temperature of 154 °F (68 °C). Hold the mash at 154 °F (68 °C) until enzymatic conversion is complete. Infuse the mash with near boiling water while stirring or with a recirculating mash system raise the temperature to mash out at 168 °F (76 °C). Sparge slowly with 170 °F (77 °C) water, collecting wort until the pre-boil kettle volume is around 5.9 gallons (22.3 L) and the gravity is 1.046 (11.44 °P).

Once the wort is boiling, add the bittering hops. The total wort boil time is 1 hour after adding the bittering hops. Add the flavor hops with 20 minutes left in the boil. Add Irish moss or other kettle finings with 15 minutes left in the boil. Chill the wort rapidly to 50 °F (10 °C), let the break material settle, rack to the fermenter, pitch the yeast and aerate.

RECIPE continued from page 19

Ferment around 50 °F (10 °C) until the yeast drops clear. With healthy yeast, fermentation should be complete in two weeks or less, but don't rush it. If desired, perform a diacetyl rest during the last ⅓ of fermentation. Rack to a keg and force carbonate or rack to a bottling bucket, add priming sugar and bottle. Target a carbonation level of 2 to 2.5 volumes. A month or more of cold conditioning at near freezing temperatures will mellow some of the flavors. Serve at 43 to 46 °F (6 to 8 °C).

Old School Dunkel

(5 gallons/19 L, extract plus grains)

OG = 1.053 (13.3 °P)
FG = 1.014 (3.5 °P)
IBU = 23 SRM = 19 ABV = 5.3%

Ingredients

7.5 lb. (3.4 kg) Weyermann 100% Munich liquid malt extract
5.0 oz. (142 g) Weyermann Carafa® Special II (huskless) 430 °L
4 AAU Hallertauer pellet hops (1.0 oz./28 g at 4% alpha acids) (60 min.)
2 AAU Hallertauer pellet hops (0.50 oz./14 g at 4% alpha acids) (20 min.)
White Labs WLP833 (German Bock Lager), Wyeast 2308 (Munich Lager) or Fermentis Saflager S-23 yeast.

Step by Step

To brew an all extract version of this recipe, substitute the Weyermann Carafa® Special with 2.5 oz. (71g) by weight of SINAMAR® extract.

Mill or coarsely crack the specialty malts. Mix them well and place loosely in a grain bag. Steep the bag in ½ gallon (~2 liters) of 170 °F (77 °C) water for about 30 minutes. Lift the grain bag out of the steeping liquid and rinse with warm water. Allow the bags to drip into the kettle (don't squeeze) for a few minutes while you add the malt extract. Add enough water to the steeping liquor and malt extract to make a pre-boil volume of 5.9 gallons (22.3 L) and a gravity of 1.046 (11.35 °P). Stir thoroughly and bring to a boil. Once the wort is boiling, add the bittering hops. The total wort boil time is 1 hour after adding the bittering hops. Add the flavor hops with 20 minutes remaining and Irish moss or other kettle finings at 15 minutes. Chill the wort to 50 °F (10 °C), pitch the yeast and aerate thoroughly. Follow the remaining instructions for the all-grain version.

Simple Mash Option:

Use 11.0 lb (5 kg) Munich malt instead of the Munich malt extract. Crush the Munich malt and Carafa® Special and put it in a large mesh bag. Heat 1.5 quarts of water per pound of grain (~1.5L) to 163 °F (73 °C) and immerse the grain bag. Gently stir the grain inside the bag with a large spoon to make sure it is wet throughout and check the temperature. The grain and water (the mash temperature) should now be around 152–156 °F (67–69 °C). If not, add a boiling water to the pot to warm it up or cold water to cool it down. Let the mash sit for a half hour. Add more heat by adding boiling water to get the temperature back up in the desired range. Let mash sit for another half hour. At that time, the starches in the Munich malt should have converted to sugars. The liquid in the pot should taste sweet. Heat 2 gallons (8 L) of water in your boiling pot to 165 °F (74 °C). Lift the bag out of the first pot and let it drain for a minute before transferring the grain and bag into the water in the other pot. Let the bag sit in the pot for at least 10 minutes, agitating the bag to rewet the grain and rinse out the sugars. Lift the bag, let it drain and discard the grain. Add the wort from the first pot, adjusting the total volume of pre-boil wort by adding water. Mix well and take a gravity reading. If it's low, add DME to bring the gravity up and you're ready to begin your boil.

a high of 20 °L or more. Generally, the darker the Munich malt the more intense the rich melanoidin flavors and aromas. I've heard some brewers report good results using dark Munich malt, around 20 °L. However, I'm not sure if that is the best choice, as the flavors can be too intense when that is the bulk of the grist. I is not good to use too light a Munich mal either. I prefer Munich malt in the 8 to 12 °L range, which gives plenty of melanoidin rich character, but not so much that i becomes overwhelming. Another factor in choosing Munich malt is the source. When brewing German-style beers, I prefer using malts from German maltsters. While there are excellent products made elsewhere there is something comforting about using German malt for a German beer style When purchasing European malts, be aware that the color listed on the bag is often in degrees EBC, which is roughly twice the Lovibond scale.

By itself most Munich malt results in a beer color that is on the light end of the style. The darkest Munich malts produce the right color, but if you don't like the flavor profile of those darkest malts, you wil still need to darken the color of you Munich dunkel without adding roasty flavors. The proper method is to use dehusked black malt. My preference is fo Weyermann Carafa® Special, a huskless roasted malt. The lack of a husk means fa less bitter roasted flavors. Carafa® Specia comes in several color levels: Carafa Special I (340 °L), II (430 °L), and III (53 °L). I prefer the flavor of Carafa® Special I for this style, although the other colors wil work fine in a pinch. Weyermann als makes Carafa®, which does have a hus and a lot more roasted character, so mak sure you're getting the huskless variety Carafa® Special. Weyermann also make SINAMAR®, a liquid extract of Carafa Special, made in accordance with th Reinheitsgebot. It is easy to use and pro vides as good a result as using the grai itself. Just add it to the boil kettle. On ounce by weight (28 g) of SINAMAR® i 5 gallons (19 L) of liquid adds 6 SRM c color and little in the way of roasted flavo The only problem with SINAMAR® is that i is a bit harder to find at most homebre shops than Carafa® Special.

Extract brewers must find Munic

HOP SUBSTITUTION TIPS

I know the current hop shortage makes it difficult, but for this style try to always use German hops for German beers, such as Hallertau, Spalt, Tettnang, Perle, Magnum or Tradition. Liberty or Mount Hood can be acceptable substitutes if you can't source one of the others. Balance the beer with enough hop bitterness to be evident, but not enough to overcome the malt sweetness of the beer. The balance should be even or slightly sweet, but not more. Late hop additions should be limited to a small addition of noble hops near the end of the boil, but if you're having trouble sourcing the proper hops, it might be better to leave the late additions out. This beer style is, after all, about the malt not the hops.

extract for this beer. Many Munich malt extracts are often a blend of Munich and Pilsner or two-row malt. As long as the flavor is rich and full of bready malt notes a blended Munich extract may be acceptable, but it is worth the trouble to ask your local homebrew shop owner about ordering 100% Munich extract. What about steeping Munich malt? Unfortunately, steeping Munich malt adds unconverted starch to your wort, which can result in haze and other problems in your beer. Luckily, most Munich malts will self-convert if held at saccharification temperature. Perhaps this is a great opportunity to venture into creating your own wort from grains or partial mashing some Munich malt along with a 60/40 Munich extract. All it takes is paying attention to the water/grain ratio and holding the mash in the proper temperature range. Yes, messing with the pH of the mash can help, but it isn't critical for your first time and most tap water will work just fine. Other than that, the process is very similar to steeping grains.

Historically, a brewer would use a decoction mash when brewing a Munich dunkel. While a decoction mash might induce more Maillard reactions, I find that with all of the rich malt flavors provided by today's Munich malts, a single infusion mash works well for this style. Target a mash temperature range of 152 to 156 °F (67 to 69 °C) and keep in mind that Munich malt already makes a wort slightly less fermentable than wort made with pale Pilsner malt. Generally, the darker the Munich malt the less fermentable the wort. If you are making a lower gravity beer, use the higher end of this temperature range to leave the beer with a bit more body. If you are making a bigger beer, use the lower end of the range to avoid too full of a body, which can limit the drinkability.

You can ferment Munich dunkel with any number of German lager yeasts. My preference is White Labs WLP833 German Bock as it makes a beer most similar to my favorite commercial example, Ayinger Altbairisch Dunkel. Good alternatives to experiment with from Wyeast are 2308 Munich and 2206 Bavarian Lager. Good alternatives from White Labs include WLP838 South German, WLP820 Oktoberfest/Märzen and WLP830 German Lager Yeast. You could also try Fermentis Saflager S-23.

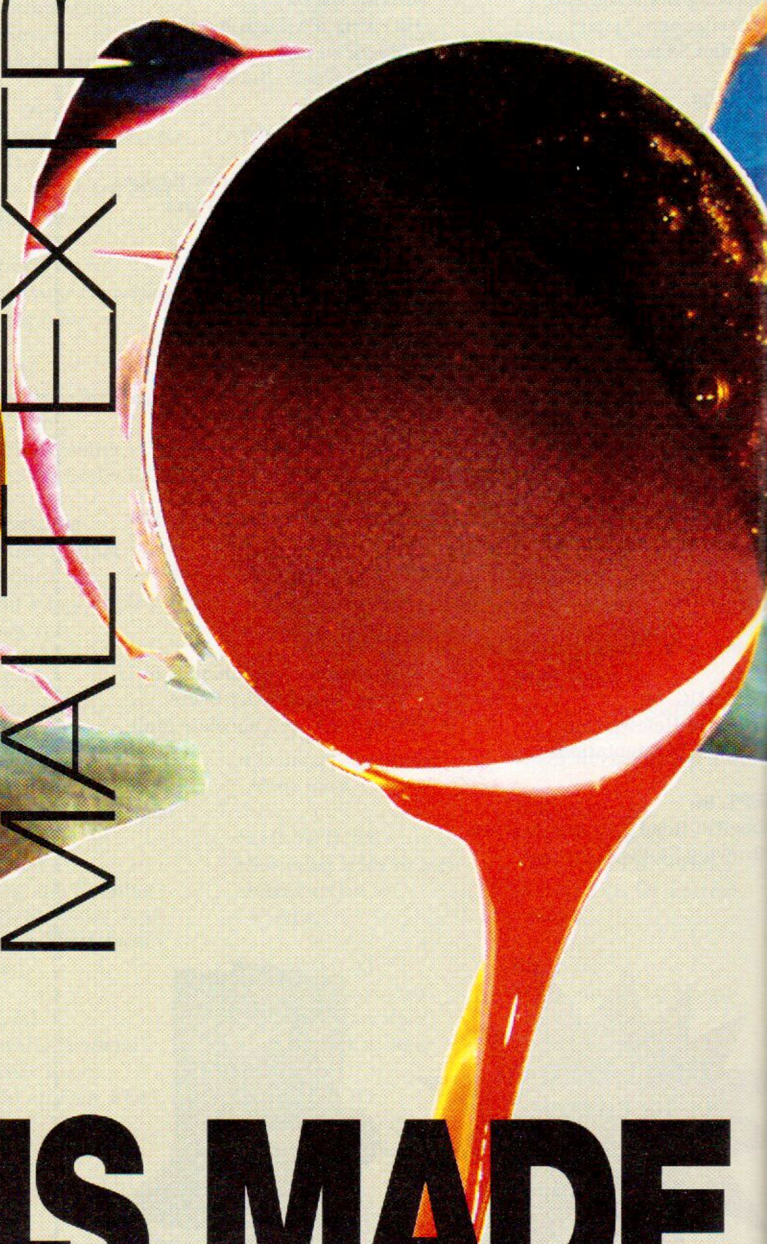
You will need around 375 billion clean, healthy cells to properly ferment 5 gallons (19 L) of this beer, which is double what you would normally use for an equivalent strength ale. For a simple, non-stirred starter, one package of liquid yeast in 2.3 gallons (8.7 L), or 2 packages in 3.7 quarts (3.5 L), will result in the right amount of yeast. If you're not making a starter, you'll need about 4 packages of liquid yeast. If you're using dry yeast, use approximately ¾ ounce (21 g) of fresh, properly rehydrated yeast.

When making lagers, I like to get the wort down to 44 °F (7 °C), oxygenate and then pitch the yeast. I let the beer slowly warm over the first 36 hours to 50 °F (10 °C) for the remainder of fermentation. This results in a clean lager, with very little diacetyl. This is similar to a Narziss fermentation, where the first two-thirds of the fermentation is done cold and the final third is done warmer. The idea is to reduce the diacetyl precursor alpha-acetolactate, which is created during the early phase of fermentation. With a warmer environment, more precursors are formed and more diacetyl is created from those precursors. Yeast will usually convert some of the diacetyl to flavorless compounds, but the lower the initial amount of diacetyl, the less there will be in the final beer. If you start or ferment your lager warmer, you'll need to do a diacetyl rest during the last ⅓ of fermentation. To perform a diacetyl rest, warm your beer up about 10 °F (6 °C) until fermentation is complete and the yeast have had a chance to eliminate the diacetyl. In any case, don't rush things. Good lagers take time and they ferment slower than ales, especially when fermented cold. Once the beer has finished fermenting, a period of lagering for a month or more at near freezing temperatures can improve the beer.

Give this traditional style a try and who knows, maybe you'll feel a little old school yourself.

Jamil Zainasheff is co-author of the book "Brewing Classic Styles." He is also the host of the popular "Jamil Show" on The Brewing Network at www.thebrewingnetwork.com/jamil.php and writes "Style Profile" in every issue of Brew Your Own.

HOW MALT EXTRACT IS MADE



by **Bob Hansen**

The Life and Times of Malt Extract

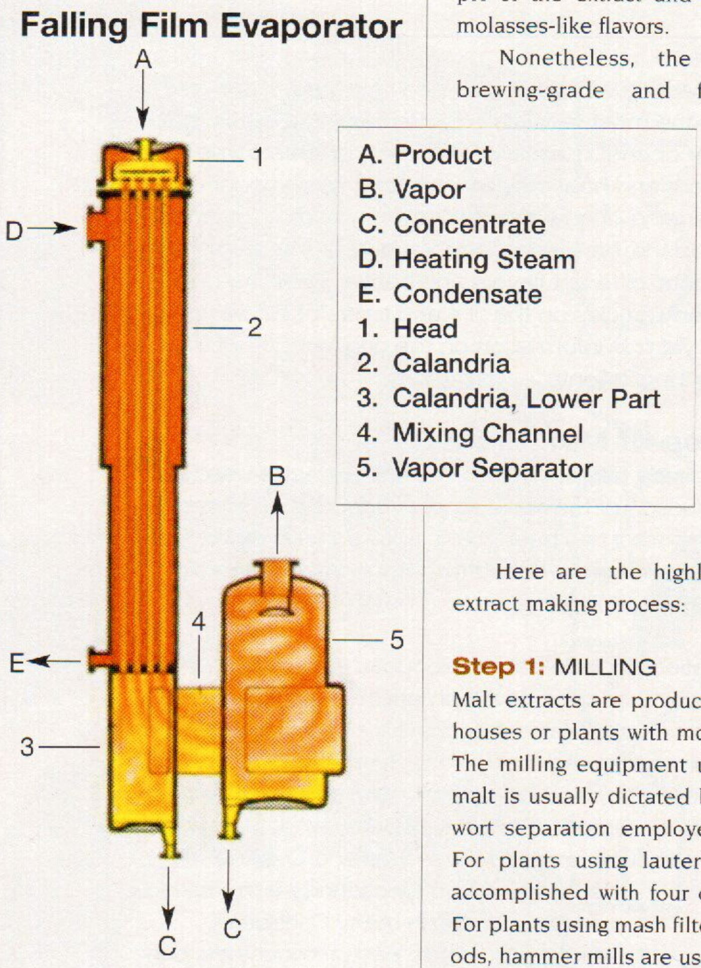
Connecting with your food and its ingredients is one of the most rewarding parts of being a brewmaster or chef. Learning where ingredients come from and how they are made gives an understanding of how the variance in breeding, growing conditions, harvesting, storage and processing creates the ingredients' different flavors and colors. For homebrewers, there are many articles on the "life and times"of different malts and hops, yet little information on the origin of one of their most widely-used ingredients — malt extract.

The Main Use of Malt Extract

On a worldwide basis, much more malt extract is used in the production of food and other products than in brewing. Malt extract has been manufactured for hundreds of years, and was the first grain-based sweetener manufactured naturally using simple technology — long before modern corn syrup.

Food applications include baked products, especially those that require browning or color development such as bagels, pretzels and pizza crusts. Malt extracts are the main source of flavor and color in many breakfast cereals. Malt extract and malted milk powder are also used in confectionery, frozen desserts and non-alcoholic beverages. Malted milk balls, candy bars such as Milky Way®, malt cups, malted milk shakes and Ovaltine® all derive flavor and functionality from malted barley products. In many Caribbean, African and Middle Eastern countries, carbonated malt-based beverages are very popular. It's a common ingredient used to improve the palatability of pet and human medicines. It's used in nutrient broths and agar for growing or culturing microorganisms. Historically, diastatic malt extract was even used in non-food industries as a source of amylase enzymes for applications such as paper sizing. Of course, malt extracts are also used in the brewing industry for finished product and wort stream adjustment, for boosting gravity in craft or regional breweries and also as the main source of wort for homebrewers, microbreweries and pubs, especially those with systems below seven barrels (~220 gallons/820 L).

Depending on the intended use, the manufacturing and quality of malt extracts can vary widely. The main differences in manufacture and quality are between those extracts intended for food and brewing use. This article will cover each of the stages in the process of making malt extract, highlighting the important steps and differences.



Wort enters the top of this falling film evaporator. The liquid that that exits has 25–30% of its water removed.

Brewing vs. Food-Grade Extracts

Brewing-grade malt extracts are made with only the highest quality brewing malts and get additional colors and flavors from using specialty malts. This gives them a flavor suitable for beer or other products where they are the main flavor component. Food-grade malt extracts are often made with non-brewing grade food or distilling malt, and are usually used as a minor ingredient. In many cases, malted barley products for the food industry are blended with corn syrup, caramel color or other ingredients. This might not be apparent from the trade name or brand name of the product, but it will appear on the ingredient statement. Darker versions of food grade extracts are often made by heating them until they darken to the desired color. This lowers the pH of the extract and generates darker, molasses-like flavors.

Nonetheless, the manufacture of brewing-grade and food-grade malt extracts both involve variants of the brewing process in which malted grains are crushed and mashed. The wort is separated from the spent grains and is then concentrated and dried.

Here are the highlights of the malt extract making process:

Step 1: MILLING

Malt extracts are produced in large brewhouses or plants with modern equipment. The milling equipment used to grind the malt is usually dictated by the method of wort separation employed in each plant. For plants using lauter tuns, milling is accomplished with four or six-roller mills. For plants using mash filters or other methods, hammer mills are used.

Step 2: MASHING

Brewing-grade malt extracts are typically mashed under controlled conditions to produce various degrees of starch breakdown and resultant fermentability. This involves carefully controlling the pH and using multiple temperature steps during mashing.

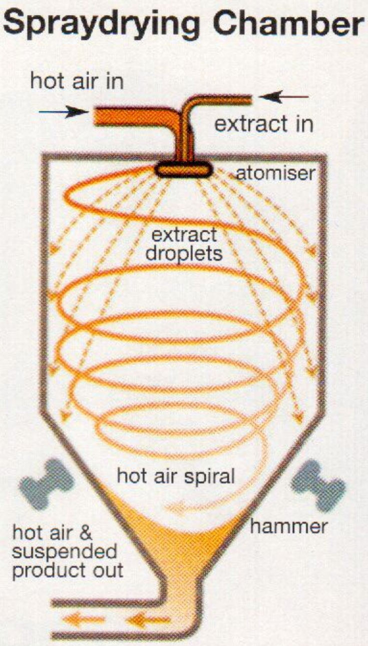
Food-grade extracts may be mashed in a variety of methods, but are usually concerned more with maximum extraction speed and less with producing a particular degree of fermentability. Typically a simple single step mashing process is employed.

Step 3: SEPARATION

In the modern brewing-grade plants, the wort is separated from the spent grains in lauter tuns or mash filters. Both these methods produce high-quality worts and can be set up for high throughput, with as many as 10–14 brews per day.

Centrifuges, vibratory sieves and other solid/liquid separation equipment are sometimes used to separate malt extract in food-grade plants. These means wor well, but typically are producing mal extract with less regards for flavor purity turbidity, color, oil content, tannin extrac tion, hot side aeration and other factor that are important for brewing worts. Som of these systems are batchwise and som are continuous.

Unlike in brewing, in which the brewe strives to make a wort of a defined strengt by manipulating the liquor-to-grist rati and amount of sparge water added, mal extract production plants are set up t



In this spray dryer, a fine mist of concentrated wort falls to the bottom of the vessel as dried malt extract. The droplets lose their liquid in less than a second.

make worts with as little water as possible. Because of the high cost of water remova later in the process, the economics o extract efficiency change somewhat and sparging is limited to the minimum amount needed to rinse the grain. Thus, some yield is often sacrificed to limit the dilution o the wort. Oftentimes the final rinsings (or weak wort) are collected and used as mash-in or sparge water to help increase extrac efficiency. Typically the concentration o worts produced in an extract plant are 16–24% solids (S.G. of 1.064–1.098).

Step 4: BOILING/WHIRLPOOL

Boiling and hot break separation are use in brewing-grade products to achieve sterilization, coagulation of proteins, volatilization of DMS precursors, isomerization of hops, etc. Hopped extracts may be boiled for longer periods in order to achieve better hop utilization, though many are made with hop extracts to achieve better consistency. This also reduces the need for boiling. Unhopped extracts are typically boiled only long enough to achieve good protein coagulation. Because of the large scale of malt extract brewhouses, highly efficient boiling systems are used.

Food grade plants often do not use brew kettles or whirlpool tanks and frequently run wort straight from the lauter tun to buffer tanks to feed the evaporator.

Step 5: WHIRLPOOL TANKS AND TRUB REMOVAL

Brewing-grade plants remove proteins coagulated during the process using whirlpool tanks or centrifuges. This produces a clearer overall extract suitable for brewing. Some also go an extra step and remove additional "cold break" prior to evaporation.

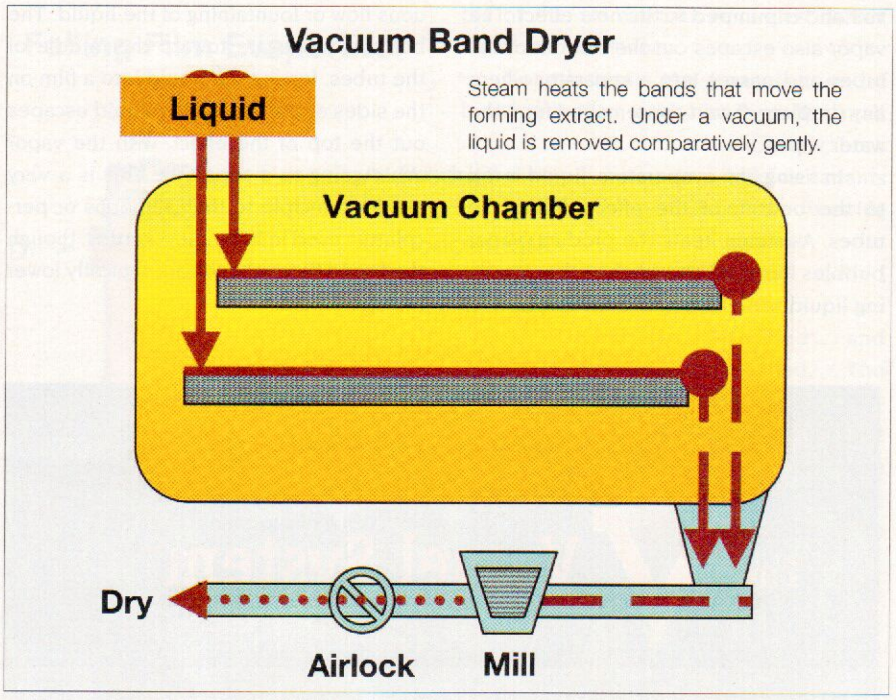
Step 6: VACUUM EVAPORATION — KEEPING THINGS COOL

Though malt extract could simply be concentrated in the brew kettle, the darkening and flavor development that would result would make a terrible tasting product as dark as caramel. This would also use an incredible amount of energy. For these reasons, malt extracts and most other food products are concentrated using vacuum evaporators.

Modern continuous evaporators evaporate the wort very quickly at low temperatures and with high efficiency. Most modern designs are either rising or falling film evaporators. These evaporators consist of multiple columns or "effects" that are a group of straight vertical pipes heated on the outside by direct steam or vapor.

In falling film evaporators, the wort is fed to the top of these columns and is distributed to the tubes where it falls, forming a thin film as it travels down the tubes. Water is evaporated from the thin film of liquid and escapes to the middle of the tube. At the bottom of the tubes the concentrated liquid simply falls into a reservoir and is pumped to the next effect. The vapor also escapes out the bottom of the tubes and passes into a separator where any droplets of wort are removed from the water vapor.

In rising film evaporators, liquid is fed to the bottom of the effect, filling the tubes. As steam heats the product, vapor bubbles form and rise up the tubes, carrying liquid with them and causing a continuous flow or fountaining of the liquid. The bubbles aggregate toward the middle of the tubes, forcing the liquid into a film on the sides of the tubes. The liquid escapes out the top of the effect, with the vapor again going to a separator. This is a very similar principle to the calandrias or percolators used in large brew kettles, though the liquid flow volumes are typically lower in evaporators.



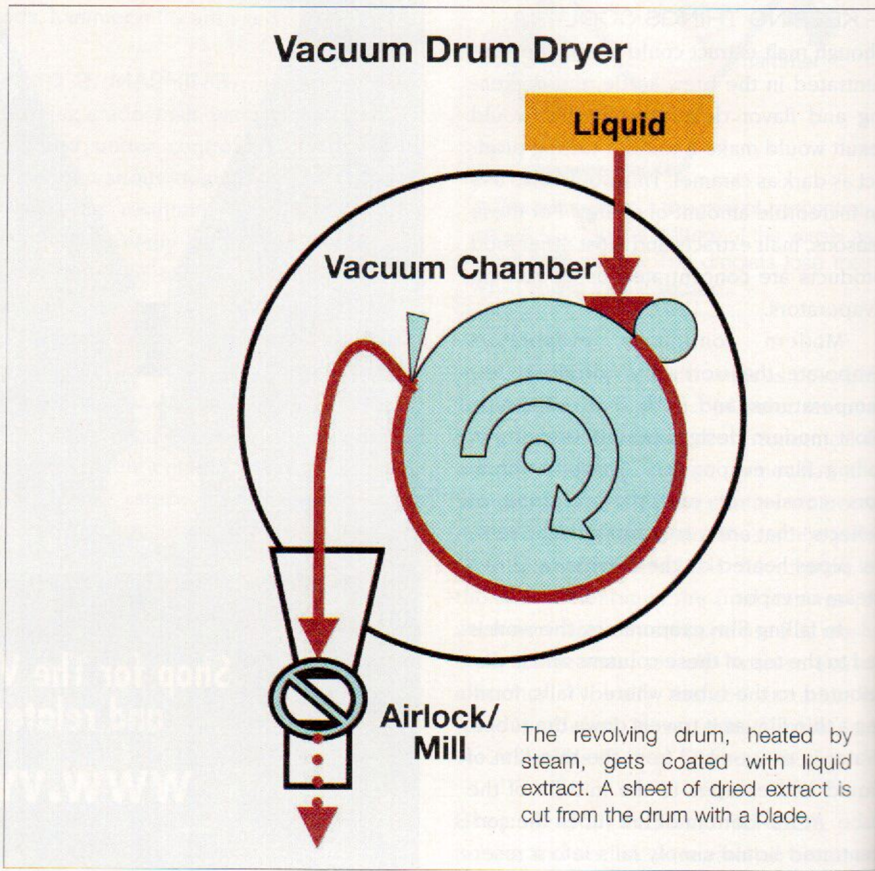
Steam heats the bands that move the forming extract. Under a vacuum, the liquid is removed comparatively gently.

Water vapor created from the product in one effect leaves the separator and is then used as steam in another effect. This can happen because each effect is under a different amount of vacuum and thus boils at a different temperature. Thus water vapor from wort boiling at 160 °F (71 °C) and half an atmosphere of vacuum can be used as steam to heat an effect boiling at 120 °F (49 °C) and three-fourths of an atmosphere of vacuum.

In this way, the latent heat of vaporization of this steam, as well as its temperature differential, can be reused. This leads to very high energy efficiencies, allowing these evaporators to evaporate wort with only 20–30% of the energy required for atmospheric boiling.

Depending on the evaporator setup, as much as 25–30% of the water in the product may be removed in a single pass through an effect. Thus an incredible amount of evaporation occurs in a very short time. Transit times though all the evaporators effects can occur in as little as 15 minutes. This means that the average bit of wort can go from 16% solids (SG 1.064) to 80% solids (SG 1.380) in only 15 minutes, boiling at average temperatures of 120 °F (49 °C). It's easy to understand how a high-quality wort can be produced by this gentle boiling process.

Evaporators are such efficient and gentle water removal devices that they are also used to concentrate the wort prior to drying. Typically 90% of the water in the wort is removed by vacuum evaporation and the remaining amount is removed by drying. Wort is thus concentrated to 50–70% solids prior to drying.



The revolving drum, heated by steam, gets coated with liquid extract. A sheet of dried extract is cut from the drum with a blade.

Step 7: SPRAY DRYING

There are several types of dryers that ca be used to produce malt extract. They ca be divided into two types, atmospher and vacuum.

Atmospheric Dryers

There are two types of atmospher dryers: modified spray dryers, whic are known as filtermats and tradition al spray towers.

In both types of atmospheric dryer concentrated worts are pumped to the to of large open chambers that are 30–50 fee (9–15 m) high. They are pumped unde high pressure to specially-designed atom izing spray nozzles that create a fine mis of very small droplets.

Air is heated to very high tempera tures of 250–400 °F (121–204 °C) and ver low relative humidities and impinges o the fine droplets. With droplet sizes o the order of 200 microns, one gallon (3.8 L of concentrate will create a quarter of billion droplets with an equivalent surfac area of 200 square meters (2,200 sq ft. This is about half the size of an NFL en zone. With this amount of surface area evaporation and drying can occu extremely rapidly. For example, in less than a second the product flashes off most of its moisture as it falls a few feet in the drying chamber.

During this time the product heats up, but due to evaporative cooling of the large amount of water that is flashed off the product, the product temperature only rises 20–30 °F (11–17 °C), minimizing thermal damage. The product falls out of the evaporative zone into the dry zone where it collects.

In traditional spray towers, exit temperatures are lower and the product remains free flowing. In filtermat dryers, the hotter product sticks together to form particles that accumulate on a moving bed. Because the product is thermoplastic (hot and sticky), as it lands on the mat screen it builds up into a layer, like snow.

Vacuum Dryers

Vacuum band dryers are large horizontal, sealed chambers that are maintained at a high level of vacuum. Inside the chambers are long horizontal belts or bands on which the concentrated product is distributed. These bands pass over plates that are heated by steam or hot water which, in turn, heats the product to drive off moisture. Much like evaporators, this type of drying takes advantage of the lower boiling point under vacuum to gently dry the product.

A second type of vacuum dryer is the vacuum drum dryer. It contains two stainless steel drums that are heated by steam. Concentrated liquid forms a puddle between these two drums which boils, aiding in concentration. As the drums turn toward each other, a thin film from this puddle coats each drum surface and passes between them.

Traveling around the outside of the rotating drum, the water in the thin film boils off, creating a dried film of product. Near the top of the drum, a doctor blade removes this thin film from the drum surface and it comes off complete, almost like a sheet of paper. The cleaned surface of the drum turns back into the puddle to receive more product which is fed contin-

Extracting the Key Points

Brewing-grade malt extract is made from brewing grade barley and processed to yield suitable flavor and fermentability for brewing applications. Malt extract made for food applications may be made from food-grade or distilling barleys, and is processed without regards to fermentability or flavor suitability for brewing. They may also include other sweeteners or coloring.

Brewery-grade malt extract begins as wort. It is briefly boiled to volatilize DMS and coagulate the hot break, which is removed in a whirlpool. The wort is condensed in a series of evaporators — each at progressively lower temperatures and higher degrees of vacuum. It is dried to 80% solids (SG 1.380) in 15 minutes.

Dried malt extract is made by spray drying, vacuum drying or drum drying. Some dried malt extract must be agglomerated to prevent it from being too powdery and balling upon hydration.

uously into the puddle.

Different Dryers for Different Extracts

Food grade extracts are often dried on spray towers. Drum drying and spray drying are the two most common types of dryers used for liquid food products. Because of the their physical characteristics and the ease of thermal damage, malt extract drying requires special modifications of these driers to be done successfully.

Spray towers produce powders that are very fine, due to small droplets required to get these materials to dry in a very short time. This fine particle size is great for dispersing evenly in dry mixes used by bakeries. They are very poor at going into solution by themselves, however, as they tend to ball up and form clumps in water that resisting dissolving. They are also very prone to dusting in the air, which can make a big mess while brewing or handling in a humid environment. If meant to be used in beverages or quickly dissolved, spray dried extracts must typically be agglomerated after drying.

Agglomeration

Agglomeration is a process of slightly rewetting a powder to allow the fine particles to stick together. This creates larger particles with porosity that allow for improved handling and dispersion.

Products dried on filtermats, vacuum band or vacuum drum dryers tend to be coarser and larger in particle size. Because they are broken pieces of a dried cake or agglomerate, they are full of pore spaces which facilitate the entry of water and natural dispersion of the product. Thus these products are naturally agglomerated during the drying process. Drum dried products can look flaky or crystalline, while band and filtermat dried products are more irregular.

After drying, the malt extract is conveyed and packaged in environments containing chilled dried air. If air of too high a relative humidity ever contacts malt extract, it will absorb water and can then either clump, or remelt and solidify to a rock-like consistency. Malt extract is always packaged in bags with complete moisture barriers to prevent this.

Applied Understanding

What is gained by a further understanding of the manufacture of malt extract? A brewmaster should, of course, understand that they should specifically use one manufactured for brewers. (Historically some articles critical of malt extract for brewing focused on malt extract products that were never intended for brewing beer.)

Understanding the process also helps homebrewers better appreciate the care that goes into creating malt extracts with the quality needed to produce beer. Maintaining quality requires constant control of temperatures and time to minimize any ill effects upon the finished product.

This attention to control needs to be continued even after the liquid is produced. One of the most frequent mistakes extract brewers make is using extract that is old or improperly stored. Storage temperature is the critical factor. Liquid extract stored cold will maintain its flavor almost indefinitely — stored warm, it will darken noticeably in a few months.

To Boil or Not to Boil

Given that malt extract has already gone through a brewing cycle, many brewers have questioned the amount of additional processing that must be done to successfully brew beer from extract. Specifically, the question of whether worts made from extract require boiling often arises. Understanding their manufacturing process and the main goals of boiling malt extract provides the answer.

There are 5 main "-ations" that brewers are concerned with when boiling their wort or concentrated worts. These are:

- •Carmelization (of sugars)
- •Volatilization (of DMS precursors)
- •Sanitation
- •Coagulation (of proteins) and
- •Isomerization (of hops)

Carmelization and Volitization: Brewing-grade extract has already undergone a kettle boil and extensive volatilization. Beneficial colors and flavors have been developed from carmelization and Maillard reactions in the kettle boil. Any volatile off aroma or flavors from the grain or DMS precursors have been removed. If the extract is diluted to wort and held boiling temperatures without prop additional volatilization, additional pr cursors can be generated. In genera worts from malt extract do not need to b boiled to remove DMS precursor However, if they are boiled, the boil mu be vigorous enough to remove these pr cursors as more are created when wort held hot.

Coagulation: All brewing-grade manufa turers remove hot break from their ma extracts. Some manufacturers also remov the cold break.

Sanitation: Though not a sterile produc brewing grade malt extract has gor through a boiling step and has a very lo microbial count. It exists as a low wat activity product, not permitting growth spoilage. Contamination is normally s low that simple pasteurization of wort 160 °F (71 °C) for 2–5 minutes is enough provide reasonable assurance of a uncontaminated finished product. Thus, using a hopped malt extract or ho extracts, brewers can get away with ver short or nonexistent boils, dependin upon hop aroma desired and confidenc in yeast and sanitation.

Isomerization: Boiling is necessary to iso merize the alpha acids in hops in order t make them soluble. If you are brewin with unhopped malt extract, you will nee to boil your hops in wort. However, yo can withhold a sizeable amount of you malt extract and add it late in the boil o at the end of the boil.

Now Brew Some Beer

With a better understanding o malt extract productio brewers can better unde stand when and how to use the extrac properly and how to store it. When chose and used properly, high quality mal extracts can produce world class beer.

Bob Hansen is a Brewmaster and Fo Scientist for Briess Malt and Ingredients. He ha won GABF medals for extract brewed beers an commissioned brewhouses for making beer a malt extract. (More information on evaporatio and drying processes can be found a www.niroinc.com.)

olive oil

Photo Courtesy of www.montalbano.toscano.it

can you **skip the middle man,** and **use olive oil** as a **replacement** for **AERATION**?

by **John McKissack**

Olive oil is rich in oleic acid, a fatty acid that is found in the cell walls of yeast.

an unusual ingredient

Who on earth would purposely add oil to their beer? As it turns out, a brewer at New Belgium did just that . . . and he may be onto the path to lengthening beer flavor stability.

A while back I received an email from a craft brewer in Australia. He had heard from another brewer about a post on a forum by a home brewer in the United States who had heard about a brewing experiment that involved using olive oil in place of wort aeration. It is amazing how anything new and exciting in the brewing world can jump all around the globe in such a short time.

At first, the thought of adding olive oil to beer sounded ridiculous. Wouldn't that make the beer taste horrible? And what about head retention? After some searching, I found out that Grady Hull, a commercial brewer with New Belgium Brewing Co. was scheduled to speak about using olive oil in place of wort aeration to a group of commercial craft brewers. I contacted Mr. Hull to find out more about the process and principles behind using olive oil as a replacement for aeration.

To begin with, one might wonder why anyone would want to replace wort aeration — don't yeast need oxygen? In brewing, cold wort is aerated prior to fermentation to supply the yeast with oxygen. The yeast take up this oxygen and use it to produce sterols and unsaturated fatty acids (UFAs) that are required for healthy cell walls.

Although aerating cold wort leads to healthy yeast, it also causes the oxidation of some wort compounds and primes the beer to become stale later down the road. Commercial brewers work hard to exclude oxygen from every step of

Photos Courtesy of Wikipedia

the brewing process. If a substitute for wort aeration was found, wort oxidation could be reduced and the flavor stability of beer could be increased.

One obvious solution would be to supply the yeast with the oxygen they need before they are pitched, thus eliminating the need to aerate the wort. However, when yeast are harvested from a previous fermentation, they have a store of glycogen and trehalose to power their metabolic processes when revived. If oxygen is added to the stored yeast, the yeast begin depleting their stores of glycogen and trehalose.

Enter Olive Oil

One of the specific UFAs that yeast cells make is oleic acid. This is an 18-carbon chain with carboxylic acid group (-COOH) on one end. Oleic acid is monounsaturated, meaning that it has one double bond in its carbon chain that is otherwise satu rated (made up of single bonds). The dou ble bond in oleic acid comes between th ninth and tenth carbon atoms, countin from the carboxylic acid end. (Take awa the double bond and you would hav stearic acid.) Oleic acid is found in man plant oils, especially olive oil (which ca contain up to 80% oleic acid).

The idea behind olive oil aeratio was to directly give the yeast the UFA that they would normally synthesize fro oxygen. This would eliminate the need t aerate the cold wort (which primes th beer to stale more quickly) or the yeast i storage (which causes them to burn u their glycogen and trehalose reserves Essentially, the idea was to "skip the mic dle man."

Previously, brewing scientists ha tried the same thing with linoleic acid. you added an extra double bond to ole acid, between the 12^{th} and 13^{th} carbo molecules, you would have linoleic aci (not to be confused with linolenic acid, relatively abundant compound found i barley malt). Linoleic acid, however, is no naturally occurring in yeast cell walls an is more expensive than oleic acid. [On th other hand, (pure) oleic acid has a meltin point of 61 °F (16 °C) and would be soli at lager-brewing temperatures.]

The Experiments

Mr. Hull conducted his experiments a part of his work towards his MS in Brewin and Distilling from Heriot-Watt Universit located in Edinburgh, Scotland. He gra ciously shared his paper on the topic wit me and has given me permission to mak it publicly available on my BrewCrAz website (www.brewcrazy.com/hull-olive oil-thesis.pdf). The file explains in deta the process and results of all four batche of beer fermented, with detailed compa isons to the control batches.

Mr. Hull conducted experiments b adding measured amounts of olive oil t stored yeast 5 hours prior to pitching. (H did not add the olive oil directly to th wort at pitching time.) Four commercia sized batches of New Belgium's Fat Ti were brewed with olive oil and witho aeration. In each subsequent batch, th amount of olive oil was increased. In th fourth and final batch, he added 1 mi ligram (mg) of olive oil per 25 billion cell

The first batch was 360 hectoliters (hL) (9,500 gallons); the second, 720 hL (19,000 gallons) and the last two were 2,100 hL (over 55,000 gallons). The first two batches were blended into "regular" Fat Tire prior to bottling, but the final batches were sold unblended. You may have drank some of the experimental beers and did not even realize it.

Control batches of the same size were brewed concurrently using New Belgium's normal wort aeration procedures.

In the experiment, Hull compared the fermentation time, yeast density, viability, ester production, head retention and more between the experimental olive oil beers and the controls (regular Fat Tire). In addition, all the beers were evaluated by the brewery's normal tasting panel.

The Results

Overall, the experimental beers and the controls were very similar — similar enough that the brewery released the final experimental batches to the public. Head retention times in the experimental beers

Photo by John McKissack

Homebrewers have been experimenting with this method ever since it became known. Here, two starters are being prepared — one is aerated and the other uses olive oil.

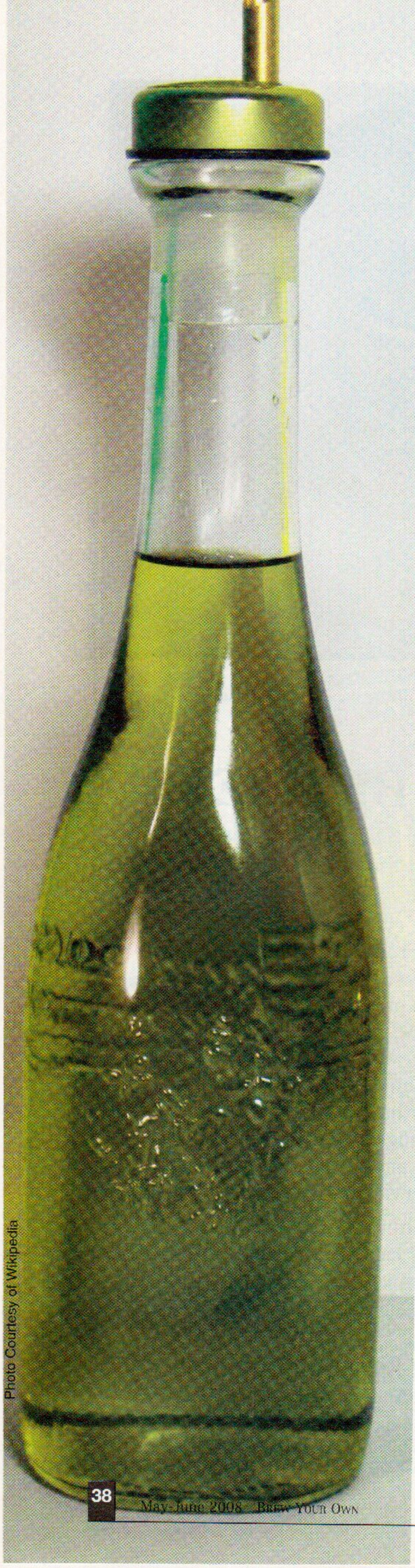


Photo Courtesy of Wikipedia

were only slightly less than that seen in controls. Fermentation times were slightly longer, but the differences between the experimental and control groups shrunk as the amount of olive oil increased. And, the beers made with olive oil attenuated as well as the control beers. Ester production was greater in the experimental beers (and remember that ester production increases as wort aeration decreases), but not to the degree that the tasting panel thought it was outside of the brand's specifications. In fact, the tasting panel preferred the olive oil beers to the controls. And finally, when the tasting panel compared beer samples that had been aged warm for three weeks, they detected less oxidation in the olive oil beers than the aerated beers. In short, Hull's four experiments supported the idea that olive oil could be used as a replacement for aeration, increasing the flavor stability of a beer — at least in the case of average-strength ales.

These experiments continue the work done with linoleic acid and no doubt their success will inspire more experiments. In his paper, Mr. Hull suggests several further experiments that could be conducted. Adding olive oil supplies the yeast with a UFA (oleic acid), but does not supply any sterols. As such, Hull suggests adding ergosterol to the stored yeast — both alone and in conjunction with olive oil. He further suggests that manipulations of the pitching rate, contact time between the oil and yeast and overall amount of oil added may close the gap in fermentation times.

Relevance to Homebrew

When thinking about using olive oil at a homebrew scale, it pays to review a few differences between commercial beer brewed on the scale of Fat Tire and homebrew. The reason the experiment was conducted was to find a way to extend the flavor stability of a commercial beer. Modern commercial brewhouses allow their brewers more control over the wort and beers' exposure to oxygen compared to most homebreweries. However, we homebrewers have much better control over how our beer is handled and stored. Most of us do not have to have our beer trucked anywhere and we wouldn't store our beer warm — or perhaps bathed in UV light, as it is in some retail locations. Also, wher as commercial brewers have little contr over how old their beer is when a co sumer buys (or drinks) it, homebrewe know when their beer is fresh and ca drink it before signs of oxidation occur.

If you are brewing beers that fermer and condition quickly — and you stor them cold and drink them before the leve of oxidation bothers you — using olive o as a replacement for aeration might b something to try if you are interested, bu it certainly isn't something that you nee to do.

The difference between the yeas used in the experiment and that availabl to most homebrewers is worth consider ing, too. In the experiment, Hull addec olive oil to yeast harvested from a bee fermentation. Most often, homebrewer use commercially raised yeast, perhap added to a yeast starter a few days before brewing. Commercial yeast is grown unde different conditions than a brewery fer mentation. Commercial yeast suppliers raise their yeast such that fresh packages contain yeast that is healthier than "used" yeast. And, in a commercial brewery, the stored yeast harvested from a fermenter has no access to a carbon source or nutrients, as is the case in homebrew yeast starters. (This is why it's good to aerate a yeast starter, but bad to aerate stored yeast. Imagine letting a yeast cake sit around for a couple days, then aerating it without adding any fresh wort.) If you usually make yeast starters, you could try making your starters slightly larger (~25%), aerating them thoroughly (perhaps more than once), then pitching the yeast into your un-aerated primary fermenter. (Pitch the slurry only, leaving the wort behind.)

Still, there are reasons a homebrewer may want to try olive oil. Some homebrewers do collect yeast from their fermentations and repitch. Some homebrewers — especially those who enter contests — may wish to extend the amount of time their beers are free from detectable oxidation. Some homebrewers may simply find it easier to add a tiny bit of olive oil to their yeast starter than to aerate their wort. And, of course, it's tempting to speculate about uses that have not yet been tested — if you're making a monster big beer, might a drop of olive oil help the yeast complete their task better? We're all taught that high-gravity fermentations are stressful to yeast.

I discussed Grady Hull's olive oil experiments on my podcast (BrewCrAzY) in November 2007 and since then quite a few homebrewers have tried adding olive oil to their starters.

How To Do It At Home

Depending on whether you are harvesting your yeast from a previous brew or making a yeast starter, there are a few ways you could adapt the technique for use at home. In any case, you will need to know how much olive oil to use. In Hull's experiments, he used a maximum of 1 mg per 25 billion cells. By calculating how many yeast cells you will pitch (perhaps by using Jamil Zainascheff's pitching rate calculator at mrmalty.com), you can figure out how much olive oil you need by taking the number of cells (in billions) and dividing by 25. For example, 5 gallons (19 L) of average-strength ale requires about 150 billion cells. This would require (150/25 =) 6 mg of olive oil.

But how do you measure 6 mg, given that most home scales only weigh to the nearest gram (g)? If oil were soluble in water, you could add 6 g to 1 L of water and then add 1mL to your yeast. But, oil is not miscible with water, so you have to take a different tack. Unless you have access to micropipettors or a serious lab scale, you are just going to have to wing it a bit. The way I add olive oil is by stripping the wire out of a twist tie, sterilizing it and inserting about ¼" of the wire into the olive oil. I then stir the chilled starter wort with the wire. If you are using yeast from a prior 5-gallon (19-L) fermentation, you could probably stir a tiny drop of olive oil into the yeast cake, then take only the amount of yeast you need to pitch.

When choosing an olive oil, look at the nutritional label and compare the amounts of monounsaturated fatty acids. (Also, keep in mind that both safflower oil and sunflower oil come in high oleic acid and high linoleic acid versions).

Now I wonder what the next exciting brewing idea bouncing around the globe will be?

John McKissack hosts the podcast BrewCrAzY at www.brewcrazy.com.

CZECH PILSNER

recreating a brew revolution

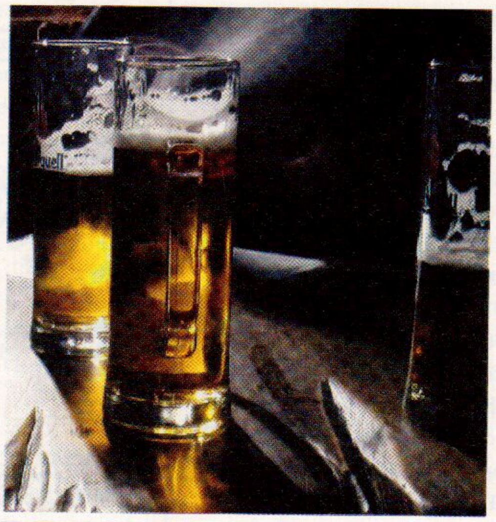


Photo Courtesy of Wikipedia

by **Horst Dornbusch**

Czech Pilsners, including Budweiser Budvar (Czechvar), Staropramen and — of course — Pilsner Urquell, are known for their soft, malty flavors. Many have just a hint of sulfur in the nose and, unfortunately, some examples also show a bit of skunk — a byproduct of often being bottled in green bottles for the North American market. Czech Pilsners are also called Bohemian Pilsners because the first Pilsner was brewed in the Bohemian section of what is now the Czech Republic.

Its imitators are everywhere, but Czech Pilsner is the original golden lager beer. Learn how to brew this classic style in your homebrewery.

Photos Courtesy of Wikipedia

Groll's Pilsner
(5 gallons/19 L, all-grain)
OG = 1.046 FG = 1.014
IBU = 40 SRM = 6–7 ABV = 4.2%

Ingredients
6.0 lbs. (2.7 kg) Weyermann Bohemian Pilsner malt (~2.5 °L)
1 lb. 15 oz. (0.88 kg) Weyermann Carafoam® (2 °L)
1 lb. 9 oz. (0.70 kg) Munich malt (10 °L)
6.2 oz. (0.18 kg) Weyermann Acidulated malt (~2.2 °L)
8.8 AAU Czech Saaz hops (75 mins) (2.5 oz./71 g of 3.5% alpha acid)
1.0 oz. (28 g) Czech Saaz (15 mins)
1.0 oz. (28 g) Czech Saaz (0 mins)
Wyeast 2001 (Urquell), Wyeast 2000 (Budvar), White Labs WLP800 (Pilsner) or White Labs WLP802 (Czech Budejovice) lager yeast
1 cup corn sugar (for priming)

Step by Step
For the most authentic results, your brewing liquor should be "soft." Two ways of preparing this water include diluting your tap water with distilled water or by boiling it for 30 minutes, letting it sit for a few hours and siphoning the water into a fresh container, leaving behind an inch (2.5 cm) of undisturbed water and sediment. You can mash using a single infusion mash at 150 °F (66 °C) or follow the mash schedule below. Heat brewing liquor to 100 °F (38 °C). Use 2.5 gallons (9.3 L) of brewing liquor to dough in for a very thick mash. Let rest for one hour to properly hydrate. At this temperature, phytase enzymes become active and slightly acidify the mash. Next, bring the brewing liquor to a full boil and use about 1.3 gallons (5.0 L) to thin the mash and raise its temperature to approximately 120 °F (49 °C) for a protein rest of about 30 minutes. Repeat the hot-water infusion, this time to raise the mash temperature to 150 °F (66 °C) for a 30-minute beta-amylase rest. Repeat the infusion to raise the mash temperature to 160 °F (71 °C) for a 30-minute alpha-amylase rest. Infuse a final time to reach a mash-out temperature of 170 °F (77 °C). Recirculate until the run-off runs clear. Start sparging with the remaining water while maintaining the mash-out temperature. Discontinue lautering at a kettle gravity of about 1.042 (10.5 °P).

Boil for 90 minutes. Add the bittering hops 15 minutes into the boil, the flavor hops 75 minutes into the boil, and the aroma hops at shutdown. After evaporation losses during the boil, the kettle gravity should be at the target OG of 1.046 (11.5 °P). Stir the wort around gently to create a whirlpool effect. Let the trub settle for about 30 minutes. Then siphon the wort off the debris and heat-exchange it to a fermentation temperature of 50–55 °F (10–13 °C).

Aerate the cool wort vigorously before pitching the yeast. Ferment until still (about two weeks). Rack into a clean vessel for about six weeks of lagering at a temperature as close to freezing as possible. Finally, rack again, prime (if bottle conditioning) and package.

Groll's Pilsner
(5 gallons/19 L, extract with grains)
OG = 1.046 FG = 1.014
IBU = 40 SRM = 8+ ABV = 4.2%

Ingredients
5.25 oz. (150 g) Weyermann Bohemian Pilsner malt (~2.5 °L)
1 lb. 15 oz. (0.88 kg) Weyermann Carafoam® (2 °L)
1 lb. 9 oz. (0.70 kg) Munich malt (10 °L)
3.0 oz. (85 g) Weyermann Acidulated malt (~2.2 °L)
4 lbs. 6 oz. (2.0 kg) Weyermann Bavarian Pilsner liquid malt extract (late addition)
8.8 AAU Czech Saaz hops (75 mins) (2.5 oz./71 g of 3.5% alpha acid)
1.0 oz. (28 g) Czech Saaz (15 mins)
1.0 oz. (28 g) Czech Saaz (0 mins)
Wyeast 2001 (Urquell), Wyeast 2000 (Budvar), White Labs WLP800 (Pilsner) or White Labs WLP802 (Czech Budejovice) lager yeast
1 cup corn sugar (for priming)

Step by Step
This extract recipe contains 4.0 lbs. (1.8 kg) of grains. You can brew it by following the general instructions for countertop partial mashing or by the instructions below. Malt extract already has some minerals dissolved in it. So, for the most authentic flavor, mash or "steep" the grains in distilled water with a pinch of calcium chloride. Use distilled water for the rest of your brewing liquor.

Crack the grains and place them in a large steeping bag. Immerse the bag in 5.5 qts. (5.2 L) of distilled water (with a pinch of calcium chloride added) and "steep" for 45 minutes at around 150 °F (66 °C). Rinse the bag with four cups of cool water. Add water to "grain tea" to make brewpot volume 3.0 gallons (11 L) and bring wort to a boil. (There is no DME to add.) Add hops at times indicated in the ingredient list. Stir in liquid malt extract at the end of the boil. Let it sit for 15 minutes before cooling the wort. Dilute wort to 5 gallons (19 L) and follow the remaining all-grain instructions.

Hop Substitutions: Try Sterling hops, or a mixture of Sterling and Vanguard hops, if you can't find Saaz.

CZECH PILSNER

If you focus on the recipe, water and conducting a good fermentation, brewing this style of beer is easier than understanding the history and changing political boundaries of the region.

History
On October 5, 1842, at the Mestansky Pivovar (Burghers' Brewery), in the city of Pilsen, in the Bohemian part of what is now the Czech Republic, a Bavarian brewmaster named Josef Groll mashed in the world's first pale lager. Forty-four days later, on November 11 — Saint Martin's Day — Groll served his new beer for the first time to the good burghers of Pilsen. The brew's Czech name was Plzensky Prasdroj, meaning Pilsen's original source, but it quickly became better known by its German name, Pilsner Urquell (*ur* means original and *quell* means source), because, in those days, Bohemia was part of the Austro-Hungarian Empire, whose official language was German. The Plzensky Prasdroj was clean, mellow and malty. It was rounded, full-bodied and pleasant, with a rich golden color and a dry, fragrant, floral-aromatic hop finish. It represented a pivotal event in brewing history, considering that today perhaps nine out of 10 commercial beers are derived, in one way or another, from that original source.

The Revolution
Groll's creation was revolutionary on several fronts, both locally and globally: It was fermented with lager yeast, even though the city of Pilsen had been an ale-brewing center ever since 1295, when Bohemian King Wenceslas founded Pilsen and gave its burghers the right brew. It was made with pale malt instead of brown malt, the latter having been the standard grist of virtually all beers, ales and lagers anywhere in the world for centuries. The Plzensky Prasdroj's finish was hop-accented,

while most beers of the day, especially in Central Europe, finished on a malt accent. And naturally it was made with Pilsen's ground water — perhaps the softest brewing liquor in the world.

Brewing techniques and brewing raw materials have evolved since 1842. To recreate an original Bohemian Pilsner with modern means, therefore, requires a bit of imagination, especially in the composition of the grist.

Pilsner Malt

By today's standards, Josef's grist — now called Pilsner malt — was almost certainly undermodified and protein-rich. It consisted of very malt-aromatic, two-row summer barley varieties from Moravia (like Bohemia, part of the modern Czech Republic). Most important for Groll's mash composition was Hanna. Hanna is a barley variety which is still grown today, but as a feed crop, no longer as a brewing barley. The Hanna genes, however, have been preserved in the gene stock of many of the best modern brewing barley varieties, such as Hanka, which is grown in the Czech Republic. Hanka is the source of many top Bohemian-style malts, including the readily available Weyermann Bohemian Pilsner malt for our all-grain recipe here. While decoction was obviously a necessity in Groll's days, with modern malts, a single infusion mash is arguably sufficient.

Groll's Pilsner malt was a novelty for its day, because it was kilned to a golden color, unlike the darkish foundation malts for the standard brews of the early 19th Century, such as dunkel, porter and brown ale. Josef chose a malting technique, patented in 1817 by its British inventor, Daniel Wheeler, as an "Improved Method of Drying and Preparing Malt." The Wheeler kiln was indirect-fired. Unlike traditional direct-fired kilns, it used clean, hot air to dry the grain. Thus, residues from coal or wood fuels did not get imparted to the malt. It also prevented the grain from being scorched. The Wheeler method allowed brewers for the first time to produce uniform, clean-tasting malt of any color, including pale.

Groll's choice of malt seems unremarkable today, but in his time and place, it put him at the cutting edge of technology. In Central Europe, the Wheeler method had been introduced only a year earlier, when the Dreher brewery of Vienna brought out its Vienna Lager and the Spaten brewery of Munich brought out its Munich Märzen, each brew based on new Wheeler-kilned malts called Vienna malt and Munich malt, respectively. Groll's Pilsner malt was the third Continental malt type made possible by Wheeler's malting invention.

Saaz Hops

The hops prescription for Bohemian Pilsner could not be simpler: Saaz, Saaz

CZECH PILSNER

and Saaz — for bittering, flavor, and especially aroma. Saaz is the German name for the Bohemian region of Zatec, which arguably produces the most fragrant and aromatic of all the noble hops varieties in the world. Now Saaz hops is cultivated in many parts of the world, but, compared to its North American-grown equivalent, imported Czech Saaz usually has fewer alpha acids and more aroma oils. Saaz gives the Pilsner its soft signature finish. If you can't find any Saaz in the current market, try substituting Sterling or a mixture of Sterling and Vanguard hops.

Lager Yeast

Before Josef Groll, Bohemian beers were ales. But Josef, having learned his craft in Bavaria, was more familiar with lager-making. Getting suitable yeast, however, was a problem because, as a protectionist measure, Bavaria had slapped a ban on the exportation of its lager yeasts. According to an unconfirmed story, Josef had to persuade — and probably bribe — a Bavarian monk to smuggle some lager yeast into Bohemia. Whatever yeast strain Josef used in his first Pilsner, it has obviously mutated over time and, as Mestansky Pivovar's house yeast, acquired unique, un-Bavarian flavor characteristics. Typical Bohemian lager yeasts leave a slightly buttery diacetyl note in the brew. You can decrease the amount of diacetyl you leave in your beer by conducting a partial diacetyl rest or kräusening your Pilsner.

Today, Bohemian specialty yeasts are readily available to the homebrewer. (See the yeast strains listed in the recipe.) They all ferment best at roughly 50–55 °F (10–13 °C), which is slightly higher than the fermentation temperature of most Bavarian lagers. A 4–6 qt. (~4–6 L) yeast starter should provide enough yeast for a proper pitching rate.

Soft Water

An authentic Pilsner mash should have a pH of about 4.5–4.8, which is significantly lower than the typical recommended range of 5.2–5.6. The low Pilsner pH, therefore, results in a slightly lower brewhouse yield, but its effect on the mash, the wort and the beer also help to define the Czech/Bohemian Pilsner as a distinct lager style.

In the mash, the low pH-value furthers the breakdown of proteins, which was an advantage when Groll brewed with undermodified malts. Proper protein degradation also results in plenty of free amino nitrogen (FAN), which helps promote healthy yeast. However, lautering can become more difficult if the pH gets too low.

In the kettle, lower pH-values improve hot break formation and protein precipitation, which results in cleaner wort in the fermenter. However, low pH-values also suppress alpha acid isomerization and thus hop utilization during the kettle boil.

In the fermenter, higher wort acidity accelerates the pH-drop during the initial stages of fermentation, and thus enhances the beer's microbiological stability. It also results in a beer with great foam stability and head retention.

On the palate, therefore, the Pilsner tastes very soft, fresh, rounded, balanced, drinkable and pleasantly — not assertively — bitter, with lingering aroma reverberations.

The easiest way for homebrewers to create a pH-baseline and to ensure proper acidity, is to use soft water (water with very few minerals dissolved in it) and to add up to 5% acidulated malt to the mash (based on total dry grist weight).

You can check your mash-pH with a pH-meter or pH-strip at the start of the mash and figure out the difference between your reading and 4.8. If need be, mill a small additional amount of acidulated malt and mix it into your mash. This pH-correction may change your gravity and color slightly, but it is a small price to pay for getting the mash pH right. The usual method of lowering mash pH, adding calcium to the mash, should not be used as your water will no longer be soft.

As an option, extract brewers could purchase lactic acid preparations. For a 5-gallon (19-L) batch, use about 0.1 fl. oz. (3 mL) in the brew kettle.

How Did a Bavarian Brewer Become the Inventor of Bohemia's Signature Beer?

Pilsen had been a well-known ale-making city ever since the 13th Century. The dirty secret about traditional brewing, however, was its unpredictability. For unknown reasons, brews often turned out bad, with off-flavors that sometimes made them undrinkable. For example, we know of one incident in 1838, when the city council of Pilsen even ordered 36 casks of ale to be dumped in public. They had been judged unfit for human consumption. In neighboring Bavaria, by contrast, barley-based beer — all bottom-fermented — was brewed only during the cold months of the year and it tended to taste reliably good.

With our modern knowledge of microbiology, we know, of course, that the chill of winter tends to slow the growth of beer-spoiling bacteria. But to brewers of the early 19th Century, the reasons for the quality of Bavarian beer were a mystery. Not surprisingly, imported Bavarian lagers were rising in popularity in Bohemia as elsewhere, while local ales were losing ever more market share. To salvage their own breweries, the burghers of Pilsen decided to invest in a new, state-of-the art brewery capable of making Bavarian-style lagers. They named it Mestansky Pivovar (Burghers' Brewery) and dispatched the brewery's manager Martin Stelzer across the border to hire a true Bavarian lagermeister. This is how a 29-year old fellow named Josef Groll, a brewmaster, whom Stelzer had found in the Bavarian village of Vilshofen (some 100 miles northeast of Munich) got to Pilsen.

Little did Stelzer know how big a find he had made! In his effort to clean up Pilsen's beers, Josef Groll created the Pilsner on October 5, 1842. When Groll's contract with Mestansky Pivovar was up, on April 30, 1845, he went back home to his native Vilshofen, where he died, aged 74, in relative obscurity, on October 22, 1887. Old Josef departed from this earth apparently without ever having realized the magnitude of his brewing achievement!

Pilsner Grain Bill

In a system with an extract efficiency of 65%, a five-gallon (19-liter) batch at an OG of 1.046 (11.5 °P) requires just short of 10 lbs. (4.5 kg) of grain. At an FG of 1.014 (3.5 °P), this grain bill yields a brew of about 4.2% ABV. (The modern Pilsner Urquell has 4.4% ABV). For an authentic Pilsner malt flavor, select Weyermann Bohemian Pilsner malt, which is made from Czech-grown Hanka barley, a distant genetic relative of Groll's original Hanna barley. For the proper mouthfeel from unfermentables, add up to 25% of the grist bill in Carapils®/Carafoam® malt. This is more than most modern recipes call for, but it is within Weyermann's usage guidelines and should capture the fuller-bodied nature of historical Pilsners. (For a more modern-style Czech Pilsner, try 5–10% Cara malt.) For additional malt aroma and some depth of golden color, use up to 20% Munich malt at about 10 °L. Use up to 5% Weyermann biologically acidulated malt for the proper pH.

Extract Tips

To keep your color under control, be sure to use fresh malt extract. Begin your boil with at least 3 gallons (11 L) of wort in your brewpot, and don't let the volume dip below 2.5 gallons (9.5 L); add boiling water to top up, if this occurs. Add only half or less of your malt extract at the beginning of the boil. (In our recipe, a partial mash supplies the initial extract.) Add the remaining malt extract at the end of the boil and let it sit for 15 minutes to sanitize the wort before cooling.

With soft brewing water and a big yeast starter, every homebrewer can be a revolting lagermeister. And, if you bottle your beer in brown bottles, you can serve fresh, unskunked Pilsner beer that would make Groll proud.

Horst Dornbusch is the author of "Prost: The Story of German Beer" (1997, Brewers Publications).

INCREASING your EXTRACT EFFICIENC

by **Chris Colb**

If you handed two identical sacks of ingredients to two all-grain brewers, and asked each to brew a 5-gallon (19-L) batch of beer, the resulting beers would likely differ in a variety of ways. Each brewer would be brewing with different water, different equipment and using different techniques. One potential difference between their beers would be a difference in the original gravities. If each sack contained, say, 10 lbs. (4.5 kg) of pale malt and 1.0 lb. (0.45 kg) of crystal malt, it's possible that one brewer might yield 5.0 gallons (19 L) of wort at an original gravity of 1.048 (12 °Plato). The other might yield 5.0 gallons (19 L) at SG 1.060 (15 °Plato). This is because different homebrewers achieve different levels of extract efficiency. (In this case, the difference would be 60% vs. 75% efficiency.) With malt prices on the rise, we thought we'd review the ways to increase your extract efficiency and help you get the most from your malt.

Extract efficiency is essentially a measure of the amount of "stuff" you get out of your grains. This "stuff" is mostly carbohydrates. By dry weight, malt is 70–85% carbohydrate. Around 60% of the total dry weight of 2-row malts is starch. This starch is dissolved in the mash liquor and gets degraded into maltose and other sugars during the mash. However, there are other things present in malt that also end up in wort and contribute to its specific gravity. Malt contains proteins — between 9 and 12% for most 2-row malts — and mashing and lautering extracts some proteins, as well as polypeptides and amino acids resulting from the breakdown of these proteins. Other materials such as glucans, tannins and silicates are also extracted.

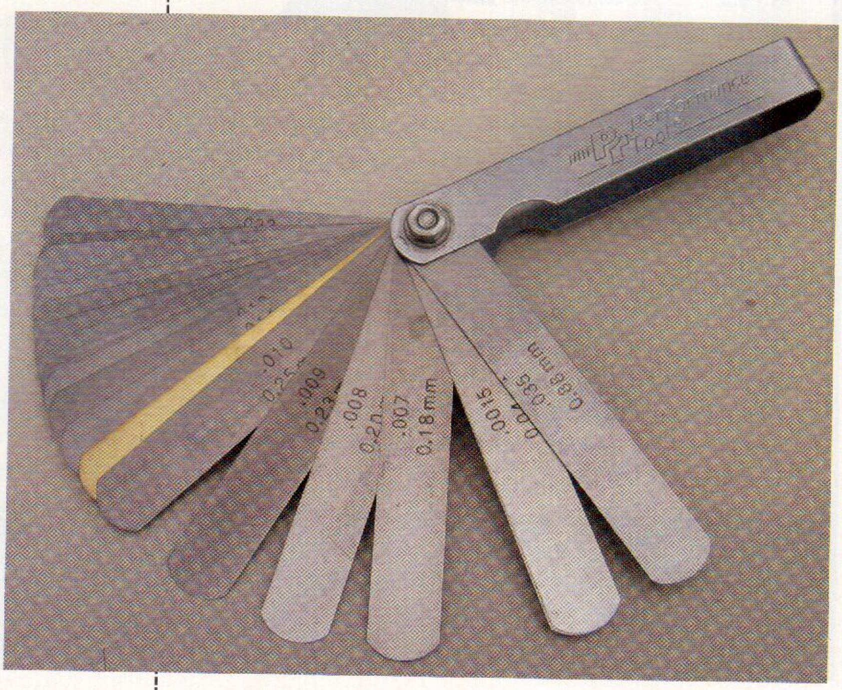
Brewers use the word "extract" to refer to all these various materials. "Extract" — the noun that refers to all the collective "stuff" that comes from your grains — should not be confused with malt extract (a condensed form of wort) or the verb "extract," which means to take or draw out. Extract efficiency could thus be, somewhat confusingly, defined as, "the amount of extract you extract from your grains."

If you rinsed all the materials that you possibly could from your malt, your extract efficiency would be 100%. In practice, however, brewers do not extract every last bit of soluble material. Comparing the actual amount of extract you get from your malt with the theoretical maximum gives you your extract efficiency. See the sidebar on page 48 for how to calculate this. Large commercial breweries typically achieve 90–98% efficiency. Any estimate of the average extract efficiency for homebrewers would just be a guess — but if I had to guess, I'd say 70–75%. (*Brew Your Own* recipes assume an extract efficiency of 65%.)

Achieving a high degree of extract efficiency is obviously a benefit — you're getting more from your grain. And, there are many factors that influence extract efficiency. However, higher rates of extraction always come at a cost. These costs may be a longer brewday or lowered wort quality. Thus, brewers strive to achieve the best efficiency possible given the constraints of time and quality. In this article, I'll describe how the average homebrewer can increase his or her extract efficiency without greatly extending their brewday or lowering their wort quality and what tools can help you reach your goal.

For most homebrewers, the crush, amount of wort they collect, the grain bed temperature and total wort collection time will be the most important variables. You can check your mill's gap by using a feeler gauge (below).

getting THE MOST from YOUR MALT



Calculating Extract Efficiency

What's the easiest way to calculate your extract efficiency? Let someone else do it. Most homebrew recipe calculators will give you an extract efficiency based on your recipe, batch volume and actual original gravity (OG). (On some, you may have to enter the recipe and adjust the extract efficiency until the projected OG matches your actual OG.)

To calculate it by hand, you need to to know a few different values — the weight and extract potential of each grain, adjunct and sugar in your recipe, your wort volume and your original gravity. The formula is:

$$\text{Extract Efficiency} = \frac{\text{OG} * \text{Volume}}{\text{Weight} * \text{Extract Potential}}$$

where OG is original gravity in "gravity points" or GP (i.e. a wort with a specific gravity of 1.052 has 52 GP); Volume is given in gallons; Weight is given in pounds and Extract Potential is given in GP per pound (for example, if a pound pale malt yields a wort with maximum OG of 1.037, its Extract Potential would be 37.

Note that, in order to get a meaningful value from this equation, the numbers you plug into the formula need to be meaningful. If you can't accurately measure the weight of your grain or the volume or original gravity of your wort, the number you get from this formula will be useless. If you haven't already calibrated your fermentation buckets or carboys, you should if you plan on trying to increase your extract efficiency.

Is My Efficiency OK?

Many homebrewers ask, is my efficiency OK? Here is my suggested test: go pour yourself one of your homebrews and taste it. Does it taste good? Did you have fun brewing it? Then your efficiency is probably OK.

Another way to look at the issue would be to ask, are there any beer styles that require a high efficiency to be brewed correctly and taste right? The short answer here is "no." There is no readily identifiable flavor or aroma that comes with higher extract efficiencies. If you tasted two pale ales — one brewed with 70% extract efficiency and the other with 80% — it's unlikely you could tell any difference, provided the amount of malt in the grain bill was adjusted so that the original gravities were the same (and all the other relevant variables were held to be the same).

I do think that some beer styles — especially lagers brewed mostly from malty base malts (such as Vienna and Munich malt) — taste best when they have a grainy/husky flavor that falls just short of astringent. This character comes from sparging right up to the point of disaster. As such, beers brewed this way tend to show fairly high efficiencies. But, it's really the sparging, not the efficiency per se, that yields this character. (Water chemistry plays a role here, too.)

This is not to say that extract efficiency is irrelevant. Better extract efficiency leads to lower grain costs — although, at a homebrew scale, this difference may be trivial. More importantly for many homebrewers, better extract efficiency makes it easier to produce big beers. If you get a good extract efficiency, you can fill your mash tun to the brim and get a bigger beer than if your extract efficiency is poor. A big hint when making high-gravity beers is to keep your mash thickness relatively dense (about 1 qt/lb. or 2 L/kg), stir the mash frequently if you can do so without losing heat, then sparge as slowly as is feasible with water that keeps that grain bed at 170 °F (77 °C). Look for a point to cutoff sparging that represents a good tradeoff between efficiency and boil length for you. Also, if you are going to need an extended boil to bring your volume down, bring the wort to boil while wort collection is still proceeding. This will save time overall in the brewday.

Crush

In order for malt to be successful mashed, it needs to be crushed first. Ar for most homebrewers, the crush is th variable that they can most easily manip late to increase their extract efficienc Simply put, the finer the malt is crushe the more extract can be yielded from (assuming all other variables are equa However, overly fine crushes lead to a va ety of problems.

As malt is crushed increasingly fine lautering times will increase. The flow liquid through the grain bed slows ar may even stop. Below a certain size, hu particles will be too fine to provide a filt bed that is porous enough for the wort be drained efficiently. Likewise, the mo the husks are degraded, the more hus surface area is exposed to the mash ar sparge water. As such, more tannins ma be extracted from the husks.

So, in practice, a balance must b struck between the fineness of the crus and the ability to lauter the grain bed in reasonable amount of time. And, of cours you also want your wort to be free of exce sive tannins. As a rough guide, in wel crushed malt, the husks are usually broke into two or three pieces. The starchy inte rior of the malt should be reduced t roughly equal portions of flour, fine gri and coarse grits. A really good crush woul consist of slightly more coarse grits an fine grits, and slightly flour than a strict to ⅓ to ⅓ mix.

Learning what properly-crushed ma looks like takes a little experience, but th can easily be gained by examining you crush every brew and keeping track of you extract efficiency. However, even an inex perienced brewer can detect major prob lems. If you see uncrushed kernels and li tle or no flour, your mill gap is too wide Conversely, if your crushed malt looks lik it is half flour, all the husk particles are tin and you experience slow (or stuck) laute ing, your mill gap is too small.

The best way to take control of you crush is to adjust the gap on your malt mil For homebrew two-roller malt mills, a ga of 0.045 inches (1.1 mm) is a common "al purpose" setting that yields a good crus with most 2-row malts.

You can check the size of your mill ga by using a feeler gauge — available a most auto supply stores. The feeler gaug consists of a series of "plates," each with a different thickness. To measure your mill gap, you see how many of these "plates" will fit in the gap, then total their thicknesses.

However, the look of your crushed malt is more important than the size of your mill gap. When milling your grain on brewday, run a pound or so of malt through, then examine the crush. If necessary, adjust the mill and crush another pound or two. Repeat until your crush looks good, then crush the rest of your malt. Many homebrewers, myself included, rely on a mill gap that works well in most situations and only adjust the mill if they see an obvious problem — for example, when milling wheat malt or thinner 6-row malts.

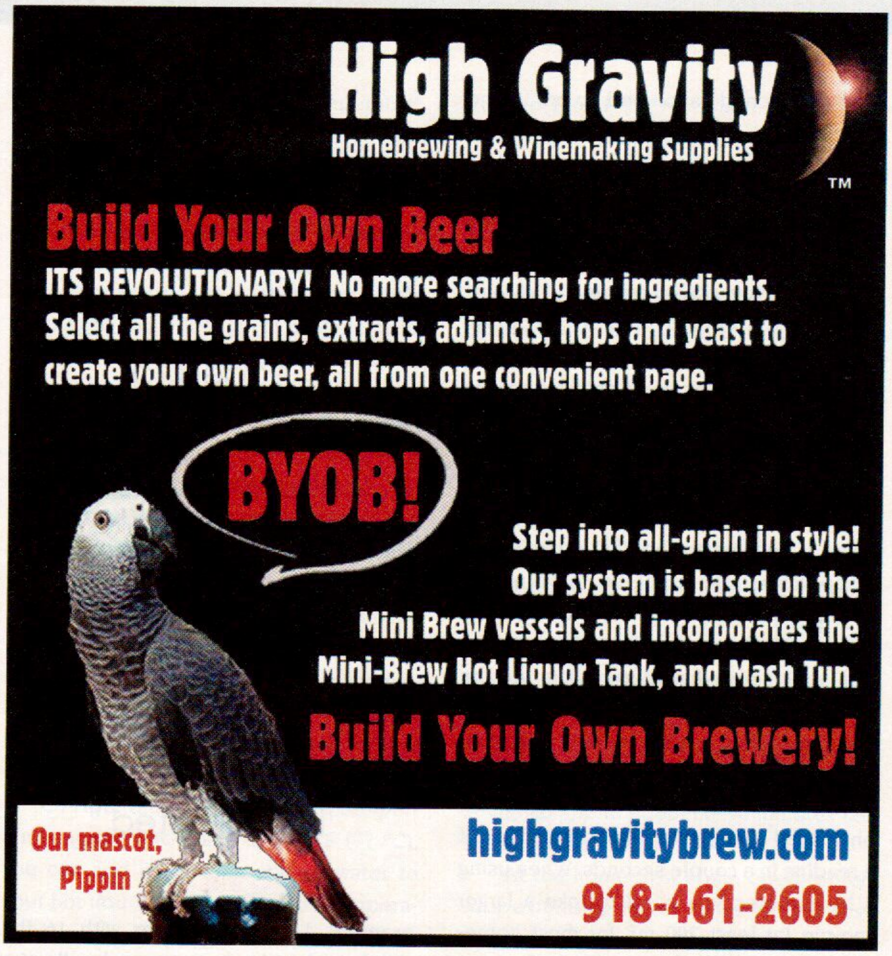
If you have a fixed gap mill or you get your malt crushed at your local homebrew shop, and it appears to be undercrushed, you can run the grains through the mill a second time. "Double milling" will reduce the average particle size in your crush, although it is not as effective as adjusting the mill gap appropriately. Homebrew shops don't adjust their mill gap for every crush. Their mills should be set to a gap that will yield a good crush for most malts. However, with heavy use, this gap adjustment may change. If you get your grains milled at your local shop, check the crush before you leave the store.

Using uncrushed malt, you can get at least 35% extract efficiency. (Don't ask me how I know this.) If you move from moderately undercrushed grain to an appropriately fine crush, your extract efficiency can easily increase by 10% or more.

Sparge Length

Once the crushed grains have been mashed and the first wort has been run off, the grain bed is rinsed with water (called sparge water) to recover extract that did not flow out with the first wort. The more sparge water is applied, the more extract will be rinsed from the grains. However, brewers quit sparging and collecting wort when recoverable extract is still present. There are a couple reasons for this.

For starters, the amount of extract recovered per unit of sparge water declines as more sparge water is used. Put more simply, the first gallon of sparge water is going to rinse out more extract



than the second gallon and so on. In and of itself, this isn't a drawback. However, excess water needs to be boiled away in order to hit your target volume and gravity and most brewers do not want to extend their boil time significantly to gain only one or two gravity points.

More importantly, the character of wort being run off changes as more sparge water is applied. As the runnings from the grain bed decrease in specific gravity, the pH of the wort rises. And, at higher pH values, tannins are extracted at higher rates. In excess, they cause astringency in beer. So, it is recommended that sparging be stopped when the pH of the final runnings rises to 5.8–6.0. (This usually corresponds with a specific gravity of 1.008–1.010, but can vary somewhat depending on the minerals dissolved in your water.)

The easiest way to measure the gravity of the wort as you run it off is to use a refractometer. With a refractometer, you only need a drop of wort and you can get a reading in a couple seconds. When using a hydrometer, you need to take a larger sample (at least 200 mL for most homebrew hydrometers) and cool it before you can take a reading. Alternately, you can take the reading hot and consult a temperature compensation chart.

Another way of looking at this is, for every unit of grain added to your mash tun, a certain volume of wort can be collected. If for example, you brewed two beers — one with 10 lbs. (4.5 kg) of grain and the other with 16 lbs. (7.3 kg) — the one with more grain would require more sparge water to be completely sparged (i.e. sparged to the point that only low-quality wort could be run off). On my system, 10 lbs. (4.5 kg) of grain would yield about 6.5 gallons (25 L) of wort while 16 lbs. (7.3 kg) would yield over 10 gallons (4.5 L). (I'm more concerned with astringency than efficiency, however, and you may be able to collect more.)

Of course, some homebrewers collect the same amount of wort for every grain bill — enough to yield the full wort volume after their boil. For example, the brewer may collect 6 to 7 gallons (23 to 26 kg) of wort and boil 60 to 90 minutes to hit a 5.0-gallon (19-L) target. This works well with average-strength beers, but extraction efficiency gets progressively worse for bigger and bigger beers. If, for example, I brewed a beer with 16 lbs. (7.3 kg) of grain, but stopped collecting wort at 7.0 gallons (26 kg), I would be leaving behind the extract that would have come with the final 3.0 gallons (11 L) of sparge water.

> "[. . .] for every unit of grain added to your mash tun, a certain volume of wort can be collected."

When brewing bigger beers, you need to decide if you want to maximize your efficiency by fully sparging your grain bed, or accept a lower efficiency. If you fully sparge the grain bed, your efficiency for your big beers will be the same as it is for your normal-strength beers. However, you will have to boil your wort longer to condense it. Conversely, if you collect only the amount needed for a 60–90 minute boil, you will be lowering your efficiency, but keeping your boil time down. To compensate for lower efficiency, you can add more malt to the grain bill or add malt extract to your boil.

The flip side of this argument is that you can easily oversparge your grain bed when brewing lower gravity beers. For example, when I brew 5.0 gallons (19 L) of bitter, my grain bill is usually around 7.0 lbs. (3.2 kg) with a target original gravity around 1.036. At 7.0 lbs. (3.2 kg), I can collect 4.5 gallons (17 L) of wort before I need to stop sparging. Thus, in order to reach my target pre-boil volume, I need to add water. If I collected 7.0 gallons (26 L), my efficiency would increase beyond what I normally get, but the beer would be excessively astringent. So, if you have been collecting enough wort for a full-wort boil on your weakest beers, and you have been encountering astringency, this may be the reason.

If you are a batch sparger, your kettle volume is determined by how much sparge water you add for the two (or three) sparges. Larger grain bills are going to force you to scale up the amount of sparge water (assuming you aim to equalize the volume of wort obtained in the first and second wort). You should experiment to find a total-liquor to grist ratio that works best with the beers you usually brew. For beers brewed with more or less grain, keep this ratio the same to preserve your rate of extract efficiency.

After the crush, completely sparging your grain bed is the variable that will be most helpful to most homebrewers looking to increase their efficiency. For brewers of big beers, it may be the most important variable if they are already getting a good crush.

Temperature

If you heat a thick sugar solution, it becomes less viscous. Heating the wort in your grain bed will likewise lower its viscosity and let it flow more freely. As such, the hotter your grain bed and sparge water are, the higher your extract efficiency. Once again, however, there are opposing considerations.

At some point during the mash, the temperature needs to be in a certain range (roughly 148–162 °F/64–72 °C) for starch conversion to occur. Afterwards, however, you could heat the grain bed to boiling temperatures and sparge with boiling water. If you did so, your extract efficiency would almost certainly exceed its present value (assuming everything else was the same). However, your beer would also be awful.

Heat not only lowers the viscosity of the wort, it increases the solubility of solids in it. Excess heat can leach undesirable compounds from the malt husks. This is especially true near the end of wort collection when the specific gravity of the runnings is low and the pH is high (relative to mash pH). Brewing scientists have determined that, at the end of wort collection, the temperature of the grain bed should not exceed 170 °F (77 °C).

For the homebrewer looking to increase his or her extract efficiency, there are a couple options for managing temperature during lautering. The standard recommendation is to perform a mash-out — heating the mash to 170 °F (77 °C) after starch conversion is complete — then sparge with water hot enough to maintain that temperature in the grain bed throughout wort collection. The key here is that it's the temperature of the grain bed that matters, not the sparge water itself. When sparging, use a temperature probe to check a few places at the top of the grain bed every 5 minutes or so. Adjust the temperature of your sparge water so the top of the grain bed stays as close to 170 °F (77 °C) as you can manage, without going over.

Some homebrewers do not have the capability of heating their mash after conversion and do not have enough room in their mash tun to hold enough water to achieve a proper mash-out temperature. For example, if you are using a picnic cooler as a mash/lauter tun and it is almost full, you may not be able to do a mash-out. In that case, you still have one option. Heat your sparge water such that the grain bed temperature rises throughout wort collection. You will begin at mash temperatures — or whatever mash out temperature you can achieve. Sparge with water hot enough to raise the temperature of the mash progressively as you sparge, letting the grain bed temperature settle into 170 °F (77 °C) near the end of wort collection. Finding the proper sparge water temperature will take some experimentation on your part. The rate of heat loss from the lauter tun, the rate at which you add sparge water and amount of time you collect wort over will all play a role. (When I've done this, I've started with sparge water heated to about 190–195 °F/88–91 °C.) Note that, if the grain bed temperature quickly increases to 170 °F (77 °C), you can add room temperature water to your hot liquor tank to lower the temperature to 170 °F (77 °C). Then simply keep sparging to maintain the grain bed temperature at 170 °F (77 °C).

Time

The last of the major factors affecting extract efficiency is time. The longer your sparge water is in contact with the grain bed, the higher your efficiency (assuming all other things are equal). However, as with the amount of water you add, there are decreasing returns with longer and longer lautering times. In a commercial brewery, lautering generally takes about 120 minutes when a mash tun is used (as opposed to 60–90 minutes when a mash filter is used). The grain bed depth in most homebrew lauter tuns is less than that in most commercial breweries — 3–4 ft. (0.9–1.2 m) is common, but deeper vessels are not unheard of. Correspondingly, most homebrewers (who use continuous sparging) spend about 60–90 minutes lautering their grain bed.

At the homebrew scale, one problem with extending lauter times is heat loss.

The relatively small volumes of grain we use means that the volume of the grain bed is fairly small, has a comparatively large surface to volume ratio and thus loses heat fairly quickly. Although many homebrew mash tuns can easily keep temperatures at 170 °F (77 °C) for 60–90 minutes (with the appropriately heated sparge water), extending this to two or more hours might be difficult. With a slow enough sparge, it might be possible for the top of the grain bed to be hot while the bottom is relatively cool. If this were the case, a faster, hotter runoff would likely yield better efficiency.

While mashing, you can calculate the total volume of wort you will collect. If you know how long you want your sparge to last, just divide the total volume (in gallons, quarts or liters) by the time of the sparge (in minutes). This will tell you how fast you should collect your wort (in those units per minute). If you collect wort at a constant rate, even for brews with different sized grain bills, you will take longer to collect the wort for big beers than for small. This isn't wrong, but you might gain a couple of gravity points on your smallest session beers, and save a little time on your biggest barleywines, if you adjust your wort collection rate to keep your total lautering time constant.

Of all the variables presented so far, time spent lautering is going to mean the least. Anecdotal evidence suggests that quick lauters — with total times of 30–45 minutes — don't cause extract efficiency to drop precipitously. If you're trying to add a couple points to your beers, you'll want to take the time here. If your time is more important than a half pound of malt, you might consider speeding up your wort collection.

> "Anecdotal evidence suggests that quick lauters — with total times of 30–45 minutes — don't cause extract efficiency to drop precipitously."

When batch sparging, wort collection proceeds much more quickly because sparge water is actively stirred into the grain bed once or twice. And, once stirred, all the wort in the vessel is of a constant volume. Hence, the sparge water is not going to dissolve more extract with longer contact times. Standard batch sparge practice is to drain the mash/lauter tun as quickly as the grain bed and equipment will allow.

Minor Factors

Many other factors affect extract efficiency, including stirring the mash and the design of your lauter tun. (See the March-April 2007 issue for more on lauter tun design.) Stirring can help if your malt is under-crushed or your mash time is short. However, you may also lose a significant amount of heat when you open up your vessel to stir it. With a good crush and a 60–90 minute mash, stirring is not likely to cause much of a gain in efficiency.

Your mash temperature and water chemistry also matter, but the values for best efficiency — 149–154 °F (65-68 °C) at a pH of 5.2–5.4 — overlap the range required for the enzymes to do their work. (The basic connection here is that a maltose solution is less viscous than a starch solution at the same temperature.)

Finally, the German author Kunze states that the highest extract efficiency comes from adding your sparge water in three to four additions rather than continuously. To see a difference due to this, however, your extract efficiency would likely need to be very high already.

Conclusions

So, if you are looking to maximize your extract efficiency, here is an approach that will likely be fruitful:

First, take a look at your crush. If you think you could crush a little more finely, try it. If you get better efficiency and have no problems lautering, try crushing a little finer next time. Keep adjusting your grain mill until you reach an acceptable tradeoff between extract efficiency and ease of lautering. (And keep some rice hulls on hand in case your mash does set up.)

Measure the temperature of your grain bed, not your sparge water, as you lauter. Check the bed in a few places every 5 minutes or so and boost the temperature of your sparge water if the grain bed temperature falls.

Add enough sparge water to fully rinse the grain bed. (Note: you can heat the wort in your kettle as you collect it, so that the boil can start as soon as the full volume had been collected.) Most homebrewers should yield at least 1 gallon of wort from every two pounds of grain (~4 L/kg), and probably more — up to perhaps 1.5 gallons per 2 lbs of grain (~6 L/kg), but you'll need to determine this value for yourself in your own brewery. Collecting this wort over 60–90 minutes is a good compromise between time and efficiency, although cutting the time to 45 minutes will likely only drop your efficiency a little bit.

Achieving very high extract efficiency requires getting all of your "ducks in a row." Conversely, if your efficiency is markedly low, it is most likely because of a single factor (rather than a conglomeration of many factors). The good news is, if you can identify that key factor, your efficiency can rise by fixing it. (The even better news may be that the variable is most often the crush.)

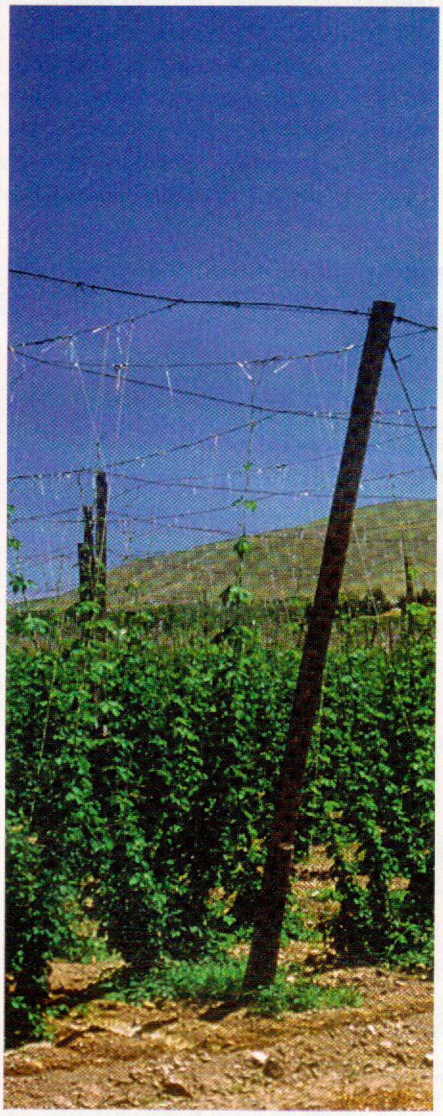
Chris Colby is the editor of BYO.

Hops at Home

How to process homegrown cones

by Jon Stika

So you planted some hop rhizomes, watered them, trained them up a trellis or twine and now they are sporting an abundance of nice plump, flower-like cones. How and when should you harvest them? Do they need to be processed somehow? How should they be stored? How could they be used in your beer? Growing hops is an exciting addition to any home brewery. Here's how to get a hop crop from the yard to the brew pot.



Hops bines can grow as high as 30 feet if grown in the right conditions. To keep them upright, train them up a trellis line.

First a little background. Common Hops (*Humulus lupulus*) are a hardy perennial plant that dies back to the ground each winter then grows up again in the spring. The plant grows as a bine, which will wrap clockwise around anything handy and cling to it with the aid of stiff bristles on the stem. The female fruit are often referred to as cones for their resemblance to spruce cones, only green and leafy. These are the hops that we know and love in our beer. The place where hops are grown is referred to as a yard.

Harvesting

Knowing when hops are ready to harvest is an art that combines the senses of sight, smell and touch. Hops are ready to harvest when the cones are a deep green color, but before they start to develop any brown color, which usually begins on the very tips of the bracteoles (the little leaves that make up the cone-like flower). The other important visual clue is the development of lupulin, a powdery yellow substance that forms in tiny glands near the base of each bracteole. At first the glands containing lupulin are very pale yellow, but as the cone matures, the gland and lupulin attain a deep yellow color in contrast to the deep green color of the bracteoles. When you suspect your hops are nearing harvest, simply pick a few cones and either pull them apart or split them lengthwise with a sharp knife to get a better look at the lupulin.

While you are manipulating the hops cones to get a look at the lupulin, you should also rub them between your thumb and fingers and smell the resulting aroma. If the hops are ready to be picked the aroma should be quite pronounced. If you pick an immature cone, the aroma of lupulin will be detectable, but faint.

The last clue to the harvest readiness of your hops is to gently squeeze the cones between your fingers. A hop cone ready for harvest will feel papery, rather than succulent. It will spring back when squeezed, rather than remaining squashed, after you release it. The oth thing to feel for is the stickiness of t lupulin when rubbed between your fi gers. The quality and quantity of lupulin a ripe cone will leave a resinous sticky ye low residue on your fingers. Your finge should develop a sticky lupulin glaze them after several minutes of pickir With experience, you will soon be able compile all of the sensory indicators determine when your hops crop is at t peak of harvest readiness.

Harvesting hops on a commerci scale involves cutting the bines and fee ing them into large specialized machin that strip the cones from the plant. Befo the advent of such equipment, hops we harvested by hand by multitudes of se sonal employees. For home hops growe harvesting hops by hand the "old-fas ioned" way is the only practical method get the job done. I harvest my hops b climbing a ladder to reach the top of th bines and work my way down. I fasten a empty ice cream pail by the bail onto m belt so it hangs at my hip, allowing me pick with both hands and drop the cone easily into the pail. Some folks use a mes bag or fruit-harvesting bag slung over the shoulder or fastened about their waist stuff the cones into as they pick. Anothe harvesting approach, if you are not com fortable working from a ladder, is to lowe the bines to the ground and then pick th cones from them.

In a commercial operation, the ho harvest is done all at once, which term nates the plants for that growing season. you choose to cut your bines down to ha vest them, rather than climb a ladder, yo will reduce the potential quantity of hop you harvest that year, but save yourse trips up and down a ladder.

If you don't mind the climbing, pro ceed with caution and avoid over-reachin while picking. Picking from a ladder whil leaving the bines intact allows you to pic only the cones that are ready at a give time, then come back to pick more late Also, hop bines will continue to produc some new cones throughout the growing season if left in place to grow. After you pick the first batch of cones from your bines you can return every two to three weeks to pick again until the end of the season. Where I live in western North Dakota (47 °North latitude) I pick hop cones from about the middle of August to late September. Places farther south would begin harvest earlier and can continue later into the growing season. Hop cones should always be handled gently during harvest and handling to minimize the loss of lupulin.

Drying

After harvesting hop cones they will need to be dried as soon as possible. Drying hop cones will permit them to be stored for an extended period of time and provide a uniform product that can be weighed to consistently determine quantities for use. Hops can be dried in a variety of ways depending on your climate and facilities at hand. If you have a food dehydrator, spread the hop cones in a single layer on the dehydrator trays and run the dehydrator between 90 °F and 115 °F (32 and 46 °C). Depending on conditions, it may take up to several hours to dry the hop cones sufficiently for storage. The cones are dry (very light and papery) when they have opened up, and make a rustling sound when handled.

If you do not have a food dehydrator, hop cones can be dried by spreading them out on screens or cloth in a place where they are protected from the elements. Before I owned a food dehydrator, I spread my hop cones on old window screens propped up on wooden blocks in the attic above my garage. I left the access door to the attic open to allow for air flow, and the hops dried nicely in a couple days during the heat of late summer.

Storage

Once the hop cones are sufficiently dry, they should be handled carefully and placed in some type of sealed container for storage. Unless the hops will be used shortly after drying, they should be stored in the freezer to prevent deterioration.

A vacuum seal-and-store machine that draws the air out of a plastic pouch then seals it shut is a good way to store your hops. Weigh out either a half or full ounce of hops and place them in a plastic pouch designed for your machine and process them according to the manufacturers' instructions. If you do not have a seal-and-store machine, good quality zip-seal freezer bags also work well. I place my dried hops in a zip-seal bag and press the seal closed until only a small opening remains, then press most of the air out of the bag, and quickly close the remaining seal. Other types of containers that seal tightly, like foil coffee bags (read more about this method at www.byo.com/mrwizard/923.html), will also work to store hops if you prefer not to use plastic bags. Once your hops are securely stored in the container of your choice, simply keep them in the freezer until use. If the stored hops lose color or start to look like frozen spinach, you may not want to use them in your brew. I have successfully stored hops in plastic zip-seal bags in the freezer for up to two years before using them in any of my brews.

Using homegrown hops

Homegrown whole hop cones can be used in the same manner as store bought hops by adding them to the boil, placing them in a hopback, or using them to dry hop in the fermenter. I usually place my hops in a cheesecloth bag tied shut with a piece of cotton string, before adding them to the boil. This prevents the hops from clogging the spigot on my brewpot when I transfer the wort from kettle to carboy. I also use homegrown hops to dry hop some of my beers in the secondary fermenter. Homegrown Cascade hops work particularly well for dry hopping pale ales.

Perhaps the biggest challenge in using homegrown hops for bittering is not knowing their alpha acid content. Alpha acid content is not a critical issue when hops are used in a hopback or to dry hop beer because the hops are not boiled to produce bitter isomers of the original alpha acid. However, if the hops are to be added to the boil, the alpha acid content is a significant factor in the resulting bitterness of the finished beer.

While some preliminary experiments have been conducted in an attempt to link the pH of hop tea to alpha acid content, these experiments have not been sufficiently broad in scope to serve as a reliable indicator of alpha acid content of hops (if this was possible commercial brewers would have done this long, long ago as alpha acid determination is a pain). Another approach that can be used to determine hop bitterness level is to brew some tea by boiling a hop of known alpha acid content and compare it in taste to a tea brewed with the same quantity of unknown alpha acid hops. While this method is also very subjective, it may provide some insight into your hops' alpha acid content.

Another approach to get an idea of your homegrown hops' alpha acid content is to look at the typical alpha acid content for the varieties of hops that you grow (see the online hop chart at www.byo.com/re erenceguide/hops/) and use that as starting point for using your hops in th boil. I used this logic when experimentin with my own homegrown hops. Afte checking the expected alpha acid conter from the chart, I brewed a few batche with my own hops and found that the apparent alpha acid content seeme quite low (around 2%) compared to th bitterness I achieved with similar hops c known alpha acid content used in th same recipe.

Growing your own hops can be a ver rewarding complement to any home brew ery. With a little luck and experimentatio you to can produce, process, store an use your own treasured herb of beer. The you can also take pride in brewing bee that includes a vital ingredient that yo also produced yourself.

Jon Stika is an avid homebrewer fro Dickinson, North Dakota where he is a member c the Heart River Homebrewer's club. He write "Techniques" for every issue of BYO.

Feed Your Head

The fantastic facts behind beer foam

by John Palmer

When logic and proportion have fallen sloppy dead/And the White Knight is talking backwards/and the Red Queen's "off with her head"/ Remember what the dormouse said/ "Feed your head/Feed your head."

— "White Rabbit" by Jefferson Airplane

There are two aspects of good beer foam: formation and stability. Beer foam is formed by the interaction of various malt proteins, isomerized alpha acids, metal ions, and carbon dioxide (and beer). The three main proteins are protein Z, hordein species and lipid transfer protein 1 (LPT1). If you think about the structure of foam being like building a skyscraper, protein Z and hordeins are the girders, LPT1 are the struts, isomerized alpha acids are the gusset plates and metal ions are the rivets. The iso-alpha acids and metal ions act to connect the proteins and bind the structure together.

When a beer is first poured, the foam is considered to be "wet" and contains a relatively high proportion of beer. As the beer drains from the foam, the foam dries out, and the bubbles begin to collapse or coalesce. The coalescence of the bubbles is driven in large part by the surface viscosity of the beer, which is partly driven by alcohol content and the type of gas in the bubble. Highly stable foams will exhibit more lacing on the sides of the glass. The stability of the foam depends upon the relative amounts and types of the various components listed above, the surface viscosity and on any foam inhibiters present. The primary foam destabilizers are lipids. Lipids are a broad class of fat-soluble natural compounds, including fats, oils, waxes, sterols, glycerides and fatty acids. If you are wearing lipstick or eating a bag of chips, the head on your beer will dissipate quickly.

Foam proteins: protein Z

The malt proteins are the building blocks of foam. The first malt protein to be specifically identified with beer foam was protein Z, an albumin (water soluble) with a molecular weight of 40,000 that is often glycosylated (combined with a sugar molecule) as a result of Maillard (browning) reactions during malting and boiling. Protein Z has been found to have the highest surface viscosity and elasticity properties of the malt proteins, and these properties are further enhanced by glycosylation. Modern malting barley varieties with high diastatic power typically have high amounts of protein Z, and it appears, along with LPT1, to be the primary building block in beer foam. The amount of protein Z in the wort is primarily dependent on barley variety and is not significantly affected by proteolytic enzymes in the mash, but it is does seem to depend on a minimum degree of malt modification. Experiments have shown that malts with a Kolbach Index (ie. soluble-to-total protein ratio) less than about 40% generally have low amounts of protein Z, while malts with a ratio greater than 40% (i.e., well-modified) have generally high levels. In less-modified malts, the contribution of protein Z to foam is substantially aided or supplanted by malt hordein proteins.

Foam proteins: hordein

The hordein family of proteins are the major storage proteins of barley, and are generally insoluble until hydrolyzed by enzymatic action, either during malting or mashing. The amount of hordein in the malt, like protein Z, is fairly consistent for each malting barley variety. Various hordeins have been isolated from beer foam, and these range in size from a molecular weight of less than 5,000 to more than 50,000, but one in particular that has been found to be concentrated in beer foam versus the beer has a molecular weight of 23,000.

While large hordeins can be broken down into smaller and potentially more foam-active hordeins by the mash, it needs to be pointed out that haze-active hordeins span the same size range as foam-active hordeins, so using a protein rest on highly modified malts to promote foam will also tend to promote beer haze. Interestingly, research has shown that some hordein species foam more easily than protein Z, and appear to preferentially displace protein Z in the foam structure, but the hordein-based foams are less stable. Going back to our analogy, protein Z is a better girder, but hordeins are faster and cheaper.

Foam proteins: LPT1

Lipid transfer protein 1 is expressed in the aleurone layer of the malt during germination and has a molecular weight of about 9,700. LPT1 has two roles — in its native form, it is an effective foam former, but not a foam stabilizer. In the boil, however, it slowly denatures, and denatured LPT1 is an effective stabilizer when combined with protein Z or hordein. To use our skyscraper analogy, it works like a strut to strengthen the overall structure. The native form of LPT1 also acts as a lipid binding protein, preventing the lipids from destabilizing the foam structure. You could think of this as the struts being covered with guard wires to keep the pigeons off. Overly long boils can denature most of the LPT1 in the wort and impair foam formation and lipid scavenging ability.

Other lipid binding proteins are puroindolines (PIN) from wheat and hordoindolines (HIN) from barley. These proteins are very hydrophobic and should be strong foam promoters, but experiments have shown that these proteins do not survive the brewing process and are not detected in beer or its foam. Their value as foam promoters may be realized during the wort boil, removing lipids that would later reduce the foam capability. However, certain types of lipids in the wort are essential for yeast nutrition. The key is to strike the appropriate balance between removing lipids that impair foam, and not impairing fermentation.

Hops and metal ions

Isomerized alpha acids have been known to be foam promoters for many years. Several experiments have shown that foam stability is enhanced by an increase in IBUs. The iso-alpha acids are thought to facilitate cross-linking of the malt proteins via hydrogen bonds. Their function can be likened to the gusset plates that reinforce a skyscraper's girders and strut joints.

The molecular structure of the iso-alpha acids is an important factor. Isohumulone is a much more effective foam stabilizer than isocohumulone, and so it stands to reason that today's high alpha hops, which were bred for low cohumulone percentage of alpha acids, have better foam stability than older hop varieties. Ironically, the light-stable hydrogenated pre-isomerized alpha acid extracts have the greatest foam stability by far. The use of these extracts in beers will yield whipped egg white type foam that will last until it is time to wash the dishes. These are often referred to as tetra and hexa hop extracts. Note that there are both hydrogenated and non-hydrogenated pre-isomerized alpha acid extracts available.

The rivets for the gusset plates and girders are divalent metal ions, such as manganese, aluminum, nickel, tin, magnesium, zinc, calcium, and barium. Metal ion hydrides form hydrogen bonds between hop acids and proteins and stabilize the molecular structure. Zinc additions of as little as 2 ppm have been shown to have significant increases in foam stability. Unfortunately, most of the metal ions in the wort are lost to the trub during wort boiling, and the only ion that doesn't impart off-flavors in the list above is calcium. Other ions that will benefit foam with a low risk of off-flavors are zinc, aluminum and magnesium. Aluminum is the strongest foam promoter, but the hardest to get into solution. Divalent metal ions like copper and iron are known to catalyze beer staling reactions.

What are lipids?

Lipids are naturally occurring substances that include fats, waxes, oils, gums, fatty acids, glycerides, sterols and sterol esters. Most of the lipids in wort come from the malt though some come from the hops. Yeast will synthesize short fatty acids, but these have been determined to have little effect on foam stability. One of the most damaging types of lipids are the hydroperoxides formed by the malt enzyme lipoxygenase acting on linolenic acid (a common malt lipid). Lipids and their hydroperoxides are highly hydrophobic and will cause the bubble film to rupture, leading to rapid coalescence of the bubbles and collapse of the foam. These same hydroperoxides are also a primary cause of beer staling.

Most of the lipids in wort are removed during the brewing process, either in the spent grains due to vorlauf, in the hot break or utilized by the yeast. Unfortunately, any hydroperoxide forms that make it into the fermentor will not be utilized by the yeast and will need to be dealt with by LPT1 and other yet-to-be-identified lipid binding proteins.

Brewing process effects

Malts and adjuncts Barley, wheat and rye malts and adjuncts contain lots of the necessary proteins for good foam. The other adjuncts like maize, rice and refined sugars, do not. Initial levels of protein Z, hordeins and LPT1 depend on the barley variety, but modern varieties can all be considered adequate. Barley varieties grown in wetter regions are known to have higher levels of LPT1, which biologically is a plant defense protein, but these same conditions are also known to stimulate the level of lipoxygenase, so barley selection on this basis may be self-defeating. New varieties are being selected by barley breeders with reduced lipoxygenase levels, and these may be a good option. The kilning of malt denatures protein Z and LPT1, and so high-color malts (most everything beyond Munich) don't contribute significant levels of foam active protein. However, the melanoidin these malts contain has been demonstrated to produce stable foams.

Mashing Once in the mash, hordein can be broken down into smaller foam-promoting proteins, but protein Z and LPT1 are mostly unaffected. A multi-step mashing schedule that includes a protein rest can be used with less-modified malts to bring hordein levels to the same levels as well modified malts. However, overlong protein rests can breakdown the foam-promoting proteins and in turn produce excess FAN and basic amino acids, which are known foam destablizers.

In general, the foam of beer brewed from highly modified malts benefits from high mash temperatures. When the malt is mashed in at temperatures above 150°F (65°C), a greater proportion of foam-promoting hordeins survive into the beer.

The detrimental enzyme lipoxygenase is most active from 95–140°F (35–60°C), so that region should be avoided if you are brewing with highly modified malt — it is unnecessary and most likely detrimental. If you are brewing with a high proportion of unmalted adjuncts, or with less-modified malt, then you will need to use rests in that region, but take care not to aerate the mash while stirring because this will promote lipid hydroperoxide formation and staling.

In addition, industrial high gravity brewing practices are known to impact foam quality.

Boiling There are several foam positive and negative reactions that occur during the wort boil, and this is the step that really levels the playing field. A lot of protein and lipids are removed from the wort by thermal denaturing and coagulation in the hot break. The impact of wort boiling is such that even though proportions and trends of protein levels are carried through the boiling process, the concentration of all species is reduced by an order of magnitude, and so large differences become smaller differences. In other words, a malt that is 50% higher in LPT1 will make a wort that is only 5% higher in LPT1 compared to a normal malt.

The severity and gravity of the boil are the primary factors. Although not a concern for homebrewing systems, the high hydrostatic pressure in deep boil kettles in professional breweries can elevate the boiling temperature past 217 °F

(103 °C). This greatly increases the thermal stress on the wort, and can further reduce the final LPT1 levels from 20 ppm to 2 ppm, having a large impact on foam stability. In short, only boil as long as necessary to achieve the hot break, reduce dimethyl sulfide precursor, and isomerize the hops. Do not oversparge and overboil to concentrate the wort.

As noted above, a large difference in wort protein before the boil becomes a smaller difference in wort protein after the boil. The data would seem to indicate that there is a relatively small range of post-boil protein concentrations that are apparently independent of sugar concentration. This issue is especially pertinent to extract brewers who are doing concentrated boils on the stove and diluting in the fermenter. The foam-active proteins will also be diluted, and result in poor head retention.

Fermentation If we assume that healthy yeast produce a healthy fermentation and thereby produce a typically high quality foam, all else being equal, then factors that stress the yeast will also affect the foam. Yeast produce a variety of byproducts and waste products, including lipids, during fermentation, and produce even more when they are stressed. Common examples of stressed yeast byproducts are elevated levels of fusel alcohols, esters, acetaldehyde and vicinal diketones (VDKs). Yeast also excrete an enzyme called proteinase A, which particularly effects proteins around 10,000 Daltons in size, including LPT1. It has been shown that stressed yeast produce higher levels of proteinase A and lower levels of foam stability as a result. Factors that are known to contribute to increased proteinase A secretion are low FAN levels, and high levels of alcohol, dissolved carbon dioxide and hydrostatic pressure. Proteinase A will continue to be secreted by yeast after fermentation is complete, and will remain active in the beer, even if the yeast is filtered, unless the beer is pasteurized. Experiments have shown that foam active proteins will continue to be degraded in the bottle and that the enzyme is more active at room temperature than at refrigerated temperatures. So store your beer cold if you want to preserve the foam.

Finally, if the yeast are stressed to the point of autolysis, the rupture of the yeast cell will release a variety of foam degrading lipids and enzymes into the beer, greatly impacting foam stability and flavor.

Foam finale

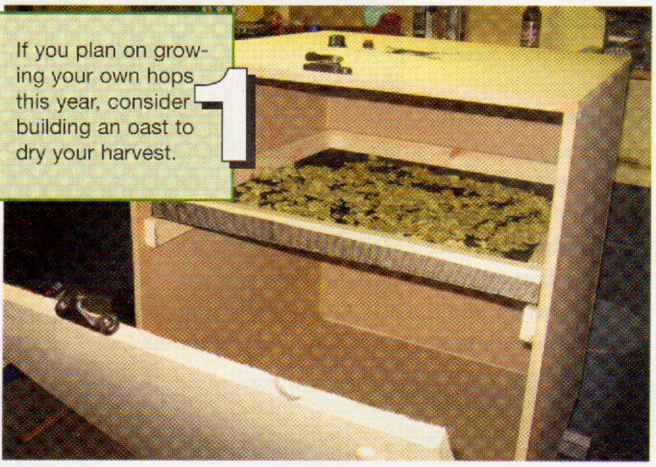
The road to good foam seems to be full of pitfalls and barriers; it's a wonder we can produce any foam at all! Hopefully this discussion has presented the structure of beer foam and the levers you can use for promoting good foam. Remember: Don't use protein rests on well-modified malts. Avoid overlong boils and avoid excessive thermal loading. Malt extract brewers should avoid concentrated boils and diluting in the fermenter. (Use the "extract late" method instead.) And finally, avoid stressing the yeast during fermentation.

John Palmer is Brew Your Own's Advanced Brewing columnist. For further reading into foam, see the references at byo.com.

Build An Oast

How to make your own hop dryer

Story and photos by Forrest Whitesides



If you plan on growing your own hops this year, consider building an oast to dry your harvest. 1

Historically, hops were dried in two- and three-story round brick buildings called oasts, which made their first appearance in England in the 16th century. You can recreate this same basic convection-driven drying effect at home on a scale to match your own homebrew-sized hop harvest.

Concept overview

What we're building is a dehydrator that uses active convection (driven by a small fan) as the main means of dehydration. The hops are suspended on a drying rack and the fan pulls a constant flow of air over the hops, which carries the moisture away.

The following build guide is just one of many ways to put together your own oast. The size, shape, look, and general construction of the oast can be almost anything you want to match your needs (or whatever you can manage to bang together, as in my case). What is critical to the design is that there is an adequate flow of air across the hops. Everything else is negotiable.

Tools and materials

A miter box and back saw, hand saw, keyhole saw and sanding block, along with a power drill and a staple gun will suffice for this project. If you have power tool equivalents to these hand tools, use them at your discretion.

I built my oast primarily from ½" medium-density fiberboard because it is an easy material to cut, it takes glue very well, and it is economical. I used inexpensive 1 ½" by ¾" pine stock to make the drying rack frame and the interior rack supports. (Note: These are great materials for prototyping and proof-of-concept builds, but if I had to do it over I would've gone with a thicker, higher-grade plywood for the box and some hardwood stock for the rack). I used vinyl-coated fiberglass screen to finish the drying rack but you could also use stainless steel screen.

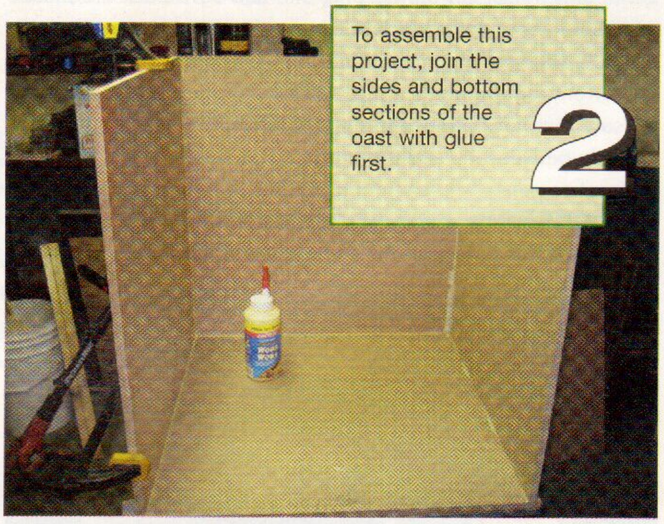
I used two small utility hinges to create a "front door" for the oast. And to keep the door closed, I used a sash lock commonly used to latch windows. You can also add a knob- or bar-style drawer pull to complete the door paradigm. I used a medium-duty staple gun to attach the screen to the drying rack. Look for a gun that uses T50-sized staples. I don't recommend using staples smaller or thinner than the T50.

Electronic components

To generate the convection current, I used a 65-mm (2.5") 12 Volt DC fan. This is the type commonly found inside computers to help keep the processor cool. They move a lot of air (about 25 cubic feet per minute) and have a low current draw (about 0.125 amps). A fan like this will "turn over" the entire interior air volume of the oast two or three times per minute. You can scavenge one from an old PC or you can buy one new from big-box consumer electronics stores or Radio Shack. But you don't need to use a 2.5" fan specifically. The most common size you're likely to find at a store or in a computer is 80 mm (3.125"), which will also work.

Traditional oast designs require a heat source, although from what I've read about DIY dehydrating, heat is not a necessary component. This design does not use heat, however, a very simple and relatively safe way to go about it would be to position a typical electric space heater a few feet away from the air vents that are drilled into the bottom of the oast. The fan on top would pull the warm air through the bottom holes and out the top.

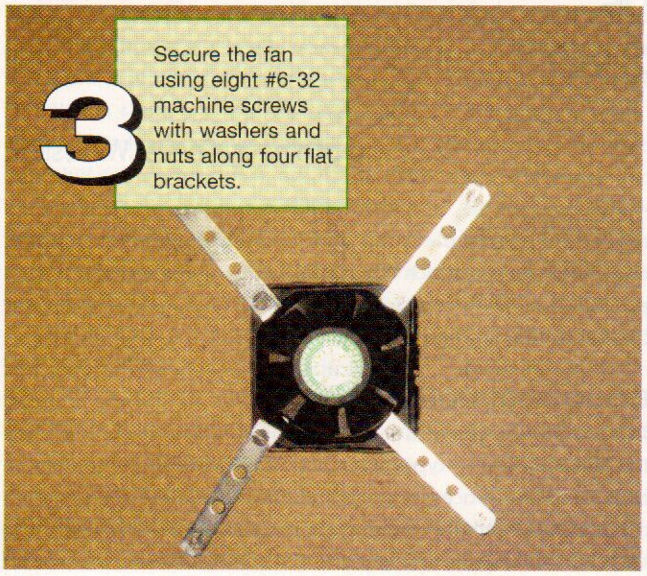
I also added two simple controls to the fan: an on/off power switch and a variable fan-speed control. The power switch I used is a simple "pushbutton" SPST (single-pole, single-throw) switch.



To assemble this project, join the sides and bottom sections of the oast with glue first. 2

Any style of SPST switch will work, whether it's a toggle, pushbutton, slide, rocker, etc. Avoid "momentary" type switches, which will only allow current to the fan while you hold the button down.

The speed control is a 500-ohm linear potentiometer, which, along with the SPST switches mentioned above, is available at most Radio Shack stores. If you can't find a 500-ohm potentiome-



3 Secure the fan using eight #6-32 machine screws with washers and nuts along four flat brackets.

ter, you can use higher values, such as 1k-ohms or 2.5k-ohms. Higher values than this will work, but as you go higher, the useful range of the potentiometer decreases and the touch sensitivity of the control increases until it is almost like an on/off switch.

To fasten the fan to the top of the oast, I used #6-32 machine screws (along with the corresponding washers and nuts) and four flat pre-drilled brackets.

Additionally, you'll need a DC power supply to run the fan. Just about any DC supply will work, from 5 volts up to 12 volts. You probably have a few of them laying around your house left over from electronic gadgets you no longer use or own. What you're looking for is the typical black, square adapter that plugs into a wall socket and has a round adapter plug with a metal or plastic/metal tip. Just cut off the plug end and strip back the plastic insulation about half an inch to expose the wires. Use a voltmeter to verify wire polarity (i.e.: which wire is ground). Check your fan for current requirements, which will be specified on the fan case. Be sure that your power supply can deliver the specified current (usually between 0.1 and 0.2 amps).

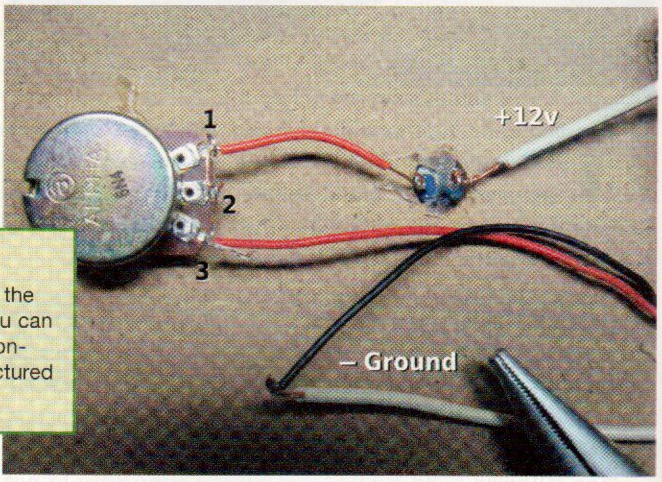
Dimensions and structural design

Because it was easier for me to visualize in my head, I built my oast as a cube (my wife affectionately calls it the "big box 'o hops"). Each side is roughly 24" (61 cm) because the fiberboard I bought came in 48" x 24" sheets, so going with that size saved me a few cuts at the beginning. You can build yours in any size or shape that fits your brewing space. So long as the air is flowing inside, the shape of your oast is irrelevant. Following is a general guide you can follow to build your own DIY hop dryer. There are many ways to get the job done, and this is just one of them. Feel free to deviate from the process below at your discretion.

5 Use butt joints to join the rack, then reinforce the joints with staples.

General build guide

Assuming you want to go with a box-like shape, you'll need to cut six sections of fiberboard or plywood. The dimensions of each section will vary based on your design and also based on how you intend to join the sections together. For simplicity, I chose to use common butt joints, but I reinforced each joint with dowels for added strength. You could opt for any style of joinery that you're comfortable with (miter joints or rabbet joints would work exceptionally well here, as would butt joints reinforced with biscuits).



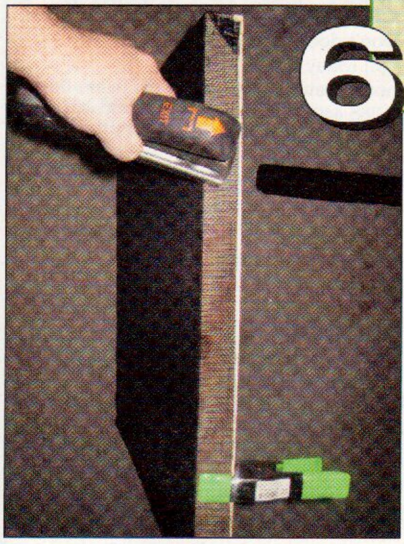
4 Once you have the fan in place, you can solder all the connections, as pictured here.

I opted to join the sides and rear sections with the bottom section first, and left attaching the top and front for the last part of the build (Figure 2). Before gluing, drill a few ½" holes near the bottom of the left, right, and rear sections of the box. These holes serve as intake vents from which the fan can pull air up through the oast. Also drill a ¼" hole at the top of the back section for the power supply wires.

Now apply glue to the sections, fit and clamp them, and wait for the glue to dry. With most wood glue, the joints will set up enough to remove the clamps after about 30 to 45 minutes, but I would advise that you take your time and let the glue fully cure (which takes about 24 hours) before taking the clamps off. Better safe than sorry.

With the bottom and sides clamped and drying, now is a good time to mount and wire the fan and electronic controls to the top section of the soon-to-be oast. Lay the fan flat on the board where you want to mount it (I recommend close to the center for more even airflow) and trace the outline with a pencil or pen.

For my oast, I decided to mount my fan flush with the board, but you can also mount it directly on top of the board. This is much easier than



6 Once the joints are together, you can staple the screen along the edges.

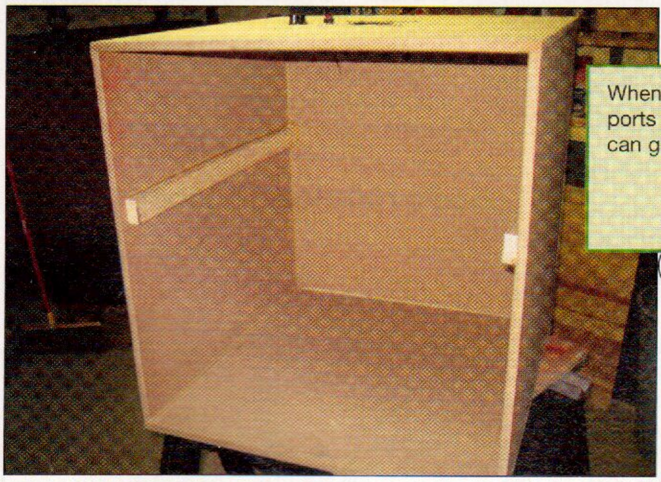
flush mounting, and the overall performance is practically identical.

For flush mounting, cut around the fan outline you traced on the board. You can use a rotary tool (Dremel, RotoZip, etc), jigsaw, or keyhole saw to cut the hole. The fan should just fit inside the hole. To secure the fan, use eight #6-32 machine screws with washers and nuts along with four flat brackets (Figure 3). I made brackets from #4 mirror hanging eyes.

For top mounting, come in about a ¼ of a inch from each side of the fan trace and cut the hole. Use four of the #6-32 machines screws, washers, and nuts to secure the fan.

Once your fan is mounted, choose a spot for the controls, drill a 5/16" hole for the potentiometer shaft to fit through, and also drill a hole for the power switch (the size of which will depend on the switch you choose). I recommend positioning the controls near the fan, as this makes for a cleaner, shorter wiring run.

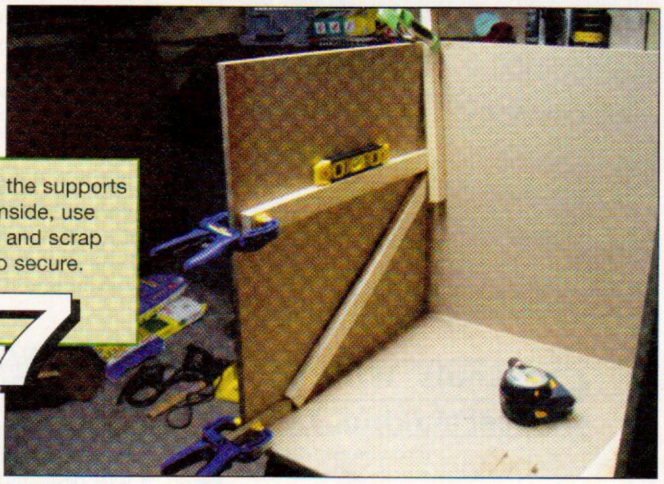
Most potentiometers and switches were not designed to be mounted to materials thicker than about a ¼ of an inch, so you'll need to glue them in place. An all-purpose adhesive like Gorilla Glue is ideal, but I found that craft-grade high-temperature hot glue works admirably.



8 When the rack supports are dry, you can glue the top on.

Connect the positive wire from the power supply to one of the lugs on the SPST switch (it doesn't matter which one), and use a short piece of shielded wire to connect the other lug on the switch to lug 3 of the potentiometer. Connect lugs 2 and 3 of potentiometer to each other. Connect the red (positive) wire from the fan to lug 1 of the potentiometer. Finally, connect the black (ground) wire from the fan to the ground wire of the power supply. The complete wiring, left unsoldered for clarity, is shown in Figure 4. I recommend soldering all connections — except for the ground wires which can be spliced together with a small wire cap connector — but it's not 100% required.

Now that the wiring is finished, and the glue is *still* curing, let's move on to the hop-drying rack. Cut four pieces of wood



7 To glue the supports to the inside, use clamps and scrap stock to secure.

stock for the rack's frame. The lengths for these should be about a ¼-shorter than the interior width of your oast, and at least an inch shorter in depth, but this will vary some depending on how you join them. As with the oast box itself, I used butt joints to join the rack and reinforced the joints with staples. Corner clamps make this job very easy, but they aren't required (Figure 5). When the glue is dry, cut a piece of vinyl screening about an inch wider on each side than the frame itself. Staple the screen to the frame along the side edges (Figure 6), and also add a row of staples along the bottom side edges. Make as many racks as you need for your hop harvest.

By now, the glue securing the oast joints will be dry, so you can add the interior supports that the rack will sit on. I'd suggest using at least ½" (0.23 cm) thick stock for these. Cut two pieces (per rack) about 2" (5 cm) shorter than the interior depth of your oast. I glued the supports to the oast using clamps and scrap stock to secure it and used a bubble level to get it even (Figure 7).

When the rack supports are cured and dry, glue the top section to the rest of the oast (Figure 8). Now all that remains is to attach the front section to the oast with hinges. I chose to have the front open forward like an oven, but you could also have it open from the side like a cabinet or refrigerator. I chose to have the front open forward like an oven, but you could also have it open from the side like a cabinet or refrigerator. To keep the door closed, you'll need some type of latching mechanism. I used a window-style sash lock.

Forrest Whitesides is NOT a professional carpenter, but he does drink a lot of tasty homebrew, which makes him a pretty smart guy.

Stroke of Guinness

The bright future of two homebrewers-to-be

Alex Garofalo and Ben McCartney • Newark, Delaware

"What is this wort?" It would be safe to say our teacher had absolutely no idea what we were talking about when we first presented her with the idea for our one-of-a-kind science project. If she did, "The Beer Project," as it became known by the students in our class, would have likely been put down before it even had the opportunity to flourish. As it was, two kids, only 15 and 16, pulled off possibly the greatest science fair project ever.

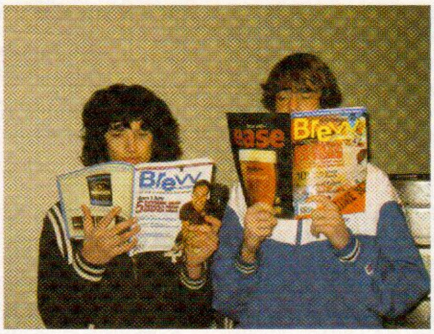
The idea behind our project was relatively simple: create an original project that no one else would ever match. Alex's dad owned a home brewery, opening up the opportunity to use beer as the subject of our investigation. In order to adapt this topic to the regulations of the science fair, and to remain on the right side of the law, we had to test something that didn't involve drinking the beer, and did not involve us handling alcohol.

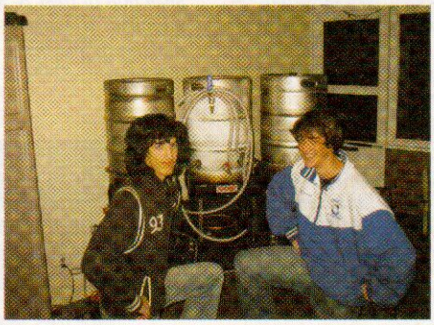
We thought we were dead in the water until we hit the idea of utilizing that wonderful, magical, non-alcoholic liquid we all know and love as wort. We simply tested the influence of the water used on the color of the wort. And, by using the word "wort" rather than "beer" in our proposal, our cheerfully unsuspecting teacher couldn't turn us down.

The next few months were spent pouring through books and magazines about brewing and brewing several different 5-gallon (19-L) batches of a Guinness clone using several different water profiles. We even used a recipe straight out of *Brew Your Own*. Homework had never been so enjoyable.

Once finished, we discovered that the water did in fact have a distinct influence over the color of the wort. Water that possessed a high pH and alkalinity levels, based on the mineral content, produced a darker beer than water with a low pH and low alkalinity levels due to its effect on the speed of Maillard reactions that produce color.

After another month, it was finally time. The first person to view the finished project in all its glory was our teacher, who candidly remarked, "Wow, I didn't think this was going to be any good." We had a reputation for being slackers, but we had exceeded everyone's expectations.





Alex Garofalo and Ben McCartney tapped into the chemistry of homebrewing and wort to score an A at their high school science fair.

Our school, the Charter School of Wilmington, is ranked 41^{st} in the nation by US *News* and is riddled with would-be geniuses. They could not believe that the "Beer Project" could hold up against their standard, boring projects on cell growth, alternative energy or water quality. Despite this, we moved on fully expecting to dominate the opposition. On the day of the fair, it appeared that we would do just that.

We were swarmed with masses of judges and spectators alike, ogling our project with intense fascination. One judge came just to say, "I'm not judging your project, but as a homebrewer, I think this is great." We had a teacher come to us who had finally realized what our project was and stayed to talk to us for 15 minutes laughing at and praising us for our achievement (and for passing it through the approval process).

As the night wore on, the real judges of our category stopped by with much to say on the content of the project. Some loved it, but the majority of the chemistry professors and teachers were just too set in their ways to accept it for what it was: a glorious masterpiece.

The biggest criticism of the project was that it didn't help the community. They just didn't understand, and to our dismay we didn't win. We eventually accepted it as the conspiracy it was. It was just another chapter in craft brewing's continual struggle to be accepted as the art form that it truly is.

In the end we both gained a keen understanding of the brewing process, but arguably more important, we came to appreciate quality beer. Though we may not be able to enjoy beer as a beverage yet, we are future "beer snobs" in the making. We are already disgusted by less superior offerings. Those sorry excuses for a drink will never touch our lips.

Our parents can also find comfort in the fact that we will never end up binge drinking under their noses — if for no other reason then it would be far too expensive. Both of us can not wait to enjoy the quality work of masters such as Dogfish, Stone and Rogue. We may even be interested in working in the brewing industry once we are old enough.

In the end, we believe our project was a (s)mashing success. No, we didn't win, but we did get an "A." In addition, no other project has reached the level of fame within our school. Also, no project could have been more entertaining and satisfying. As Ben's dad remarked, "Beats anything I did in high school."

Finally, we must mention Alex's dad Eric Garofalo, the homebrewer, and the reason this project was able to happen. I don't think he has ever been more proud, and it is part of his dream to have his Fairfield Brewing Company documented in this magazine.