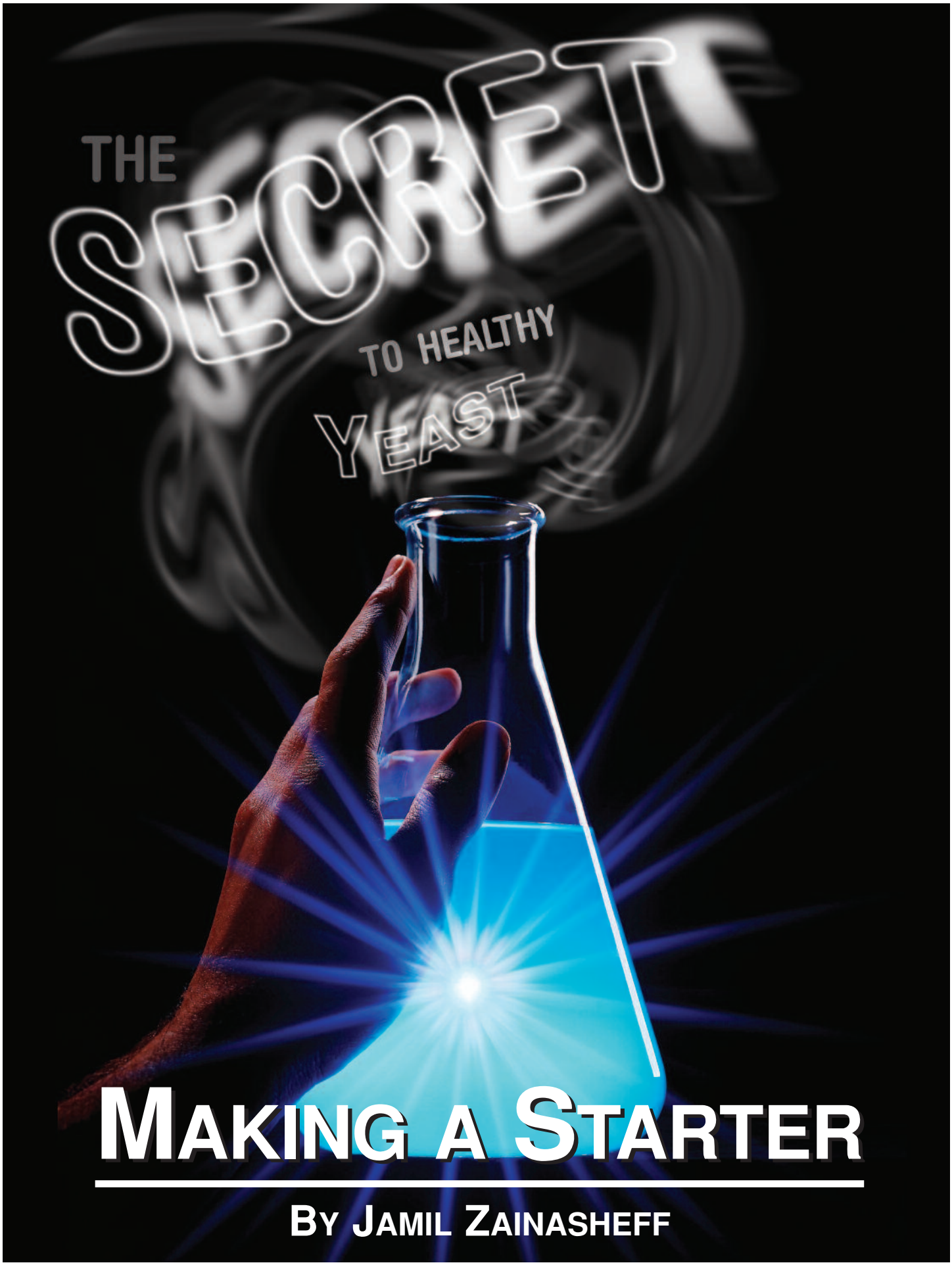


Making a Starter

By Jamil Zainasheff

You might have heard your fellow brewers talking about starters and how important they are for making great beer. Proper fermentation is what sets apart great beers from just OK beers, and starters can help by ensuring a beer with the correct appearance, flavor, body and aroma profile. The resulting beer is also clean, complete, consistent and reproducible.

In order to have proper fermentation, you must have the right amount of clean, healthy yeast to ferment your wort. If you're a professional brewer with plenty of yeast every few days, this isn't too hard. If you're an amateur brewer, you're often starting with a new pitch of yeast, and employing a starter can often improve the performance of that yeast.

Many brewers have questions about the "best way" to make and use starters. The answers to these questions are not only based on my experience and lab work, but from conversations with David Logsdon, founder/owner of Wyeast Laboratories, Inc., Greg Doss, Wyeast microbiologist, and Neva Parker, White Labs Inc. laboratory manager. I would also like to thank Graham Sanders for his extensive feedback on this article.

Q: What is the purpose of a starter?

A starter is a small volume of wort that yeast use as an initial step to become healthy, multiply and prepare themselves to ferment a batch of beer.

The starter's purpose is to create enough clean, healthy yeast to ferment your batch under optimal conditions. The primary focus of a starter should always be yeast health first and increased cell growth second. It is much better to have a smaller number of very healthy, young cells than it is to have a large number of weak cells. As Logsdon puts it, "Would you rather have an excess of 80-year-old people building your house or a smaller amount of really healthy 20-year-olds?"

Q: Do I always need to make a starter?

No. However, in many cases, making a starter will provide better fermentation. You should always make a starter if you suspect the viability (overall health) of your yeast might be low. If you have an old vial or pack of yeast or the yeast has been left out warm for an extended period of time (for example yeast in shipping for several days), you should make a starter.

You can also make a starter to grow a smaller amount of yeast into an appropriately sized pitch for your batch. Larger volume batches, higher gravity worts and lager fermentations require more yeast. Of course, you can pitch more containers of yeast or repitch yeast from a previous batch to get good results, but starters from a vial or pack are an excellent solution.

Q: When shouldn't I make a starter?

You should never make a starter if you can't handle the steps in a sanitary way or you can't provide proper nutrition for the yeast. Also, for some small batches or low gravity beers such as an ordinary bitter, there is a slight chance you might end up over pitching if you get carried away. High pitching rates can result in a less than ideal fermentation profile (e.g. low or unexpected esters, yeast autolysis flavors, poor head retention). This is also a consideration in beer styles where the yeast-derived flavors are foremost, such as Bavarian-style wheat beers. Though I don't concur, a number of experts believe it is better to pitch at lower rates when brewing these styles of beers to increase ester formation.

Another case where you generally don't want to make a starter is with dry yeast. It is usually cheaper and easier to just buy more dry yeast than it would be to make a starter large enough for most dry yeast packs. Many experts suggest that placing dry yeasts in a starter would just deplete the reserves that the manufacturer worked so hard to build into their product. For dry yeasts, just do a proper rehydration in tap water.

Q: How do I make a starter?

You'll need a clean, sanitized container able to hold the starter plus some headspace, aluminum foil, dried malt extract (DME), yeast nutrients and some water.

When making starter wort, keep the starting gravity between 1.020 and 1.040 (5–10 °P). You do not want to make a high gravity starter to grow yeast. As a ballpark measurement, use about 6 ounces (by weight) of DME to 2 quarts of water. If you're working in metric, use a 10 to 1 ratio. Add 1 gram of DME for every 10 milliliters of final volume. (If you're making a 2-liter starter, add water to 200 grams of DME until you have 2 liters total.) Add 1/4 teaspoon of yeast nutrient, boil 15 minutes, cool and add yeast.

Using an Erlenmeyer flask made of borosilicate glass (such as Pyrex or Bomex) is even easier. Just put the DME and water in the flask, drop in any nutrients you desire, put a piece of aluminum foil over the top and put the flask directly on the stove burner. Boil gently for 15 minutes, then let it cool.

You should add oxygen to your cooled starter or at the very least shake it every few hours to increase the amount of oxygen available to the yeast. If you have a stirplate, that works even better (for an article on how to build your own stirplate, see the January/February 2007 ***Zymurgy***).

Every time you make a starter, keep in mind the four main factors that affect yeast growth and health: nutrients, temperature, sugars and pH.

Key nutrients include oxygen, zinc, amino acids and nitrogen. Oxygen is critical to the survival and growth of yeast, and tends to be the most limiting factor for most starters.

Keep the starter around room temperature (72° F, 22° C).

Use an all-malt wort for starters. The sugar in the starter needs to be maltose, not simple sugar. Yeast that have been eating a lot of simple sugars stop making the enzyme that enable it to break down maltose, which is the main sugar in wort. The yeast quickly learn to be lazy and the ability to fully attenuate a batch of beer suffers.

The pH of a starter should be around 5, but if you can't test it, don't worry. Typical wort ranges from 4 to 6 pH, so use a high quality DME to be safe.

When adding yeast to the starter, work in a draft-free area and try to keep the containers

open for as short a time as possible. The design of White Labs packaging keeps the yeast out of contact with the outside surfaces of the vial. However, it is possible for dust-borne wild yeast and bacteria to settle on the protruding lip near the top, so it doesn't hurt to sanitize the vial to keep any settled dust from dropping into your starter. If you shake the vial to loosen the yeast inside, let it rest a few minutes and slowly open the top to prevent excessive foaming.

It isn't required to "smack" a Wyeast pack before making a starter. The yeast is not in the little part that gets popped, but rather in the main pack. However, the liquid inside the little pack is a high quality nutrient and sugar source. It also helps rinse the yeast out from the main pack. Even though the chance of contamination while pouring is extremely low, you should sanitize the outside of the Wyeast pack before opening, as well as scissors if you use them.

Q: Should I add hops when I make my starter wort?

No. The antibiotic effect is minimal. Remember, the final product of a good starter is healthy yeast, not beer. It is better to have less material floating around, less expense and fewer steps to worry about.

Q: Should I add oxygen to my starter?

Yes. You'll get far healthier yeast and far more yeast growth if the yeast have oxygen throughout the process. Adding oxygen at the beginning helps, but the most effective starters provide a continuous source of oxygen. Oxygen is critical to yeast growth. Yeast use oxygen to synthesize unsaturated fatty acids and sterols, which are critical to creating a healthy cell membrane and good cell growth. With oxygen present, yeast convert sugar to carbon dioxide and water and they grow rapidly. With no oxygen, yeast create alcohol, grow far more slowly and reach a lower total mass of cells.

There are several ways to add oxygen: intermittent shaking, a stirplate, pure oxygen, or an air pump with a sterile filter.

Shaking the starter as much as possible, every hour or two, makes a large difference in the amount of yeast growth and health. In my tests, vigorously shaking a starter every hour resulted in approximately double the number of cells versus a non-shaken starter.

A stirplate is perhaps the most effective method. In tests, a stirplate resulted in a 40-percent gain over a shaken starter. Logsdon says, "The stirplate drives off the CO_2 (which suppresses yeast activity) and allows for an exchange of air into the starter (increasing oxygen levels) and eliminates dead spots in the starter liquid, ensuring that the yeast have easy access to the sugars." When using a stirplate, don't plug up the starter vessel with an airlock. A sanitary piece of aluminum foil or a breathable foam stopper is all you need. Bacteria and wild yeast can't crawl and a loose fitting cover will allow for better gas exchange. Be aware that some stirplates can generate enough heat to push the starter into a temperature range that is detrimental to the yeast. Using a thin piece of Styrofoam between the flask and the stirplate can help minimize the transfer of heat to the starter. Another thing to be aware of is that the stirplate's action of drawing air into the liquid causes the temperature of the starter to fluctuate quickly with changes in the temperature of the surrounding air.

Continuous air from a pump and sterile filter can be effective too. The major drawbacks are being able to control the flow of air to prevent excessive foaming and evaporation of the starter. Shaking is just as effective as intermittent aeration with a pump.

Continuous pure oxygen from a tank or generator is both expensive and unnecessary.

Q: How much yeast or how big a starter do I need?

A White Labs Pitchable Yeast vial and a Wyeast ACTIVATOR™ 125 XL Smack Pack both contain an average of 100 billion cells and are enough to pitch directly into 5 U.S. gallons (18.9 liters) of an ale wort at 1.048 SG (12 °P). This is a pitching rate of 5.3 million cells per milliliter, which is close to the pitching rate many professional breweries begin with when starting a new pitch of ale yeast. This rate works well because the health and vitality of fresh laboratory cultured yeast are superior to yeast harvested from normal fermentation. Higher gravity worts, especially once they exceed a specific gravity of 1.060 (15 °P), larger wort volumes and lager fermentations all require higher pitching rates (or a starter) for optimum results.

You might have heard that when using yeast harvested from a previous fermentation, the optimal pitching rate for ales is 6 to 10 million cells/ml, and 10 to 15 mil-

Scientific Equipment

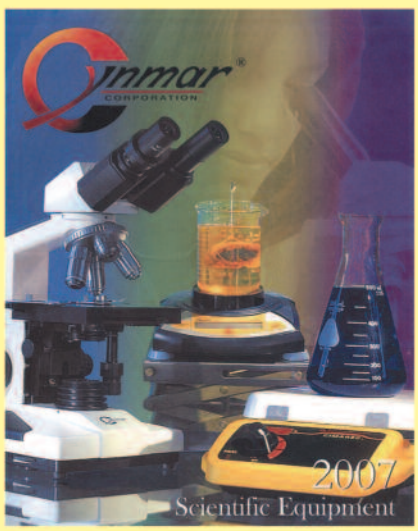
Quality Products . . . . . Discounted Everyday Prices!

Microscopes, balances, meters, thermometers, pipets, hardware, glassware, plasticware, chemicals, health/safety, and much more for the **brewing business!**

Check out our hydrometers, refractometers, agars, and other wine/beer making products in our catalog and website.

Contact us today for a **free** 2007 Cynmar catalog.

800-223-3517 • www.cynmar.com
cynmar@cynmar.com



lion cells/ml for lagers. That is a generally accepted ballpark, but it doesn't take into account the starting gravity of the wort. Higher gravity worts require more yeast and lower gravity worts require less. You want to pitch around 1 million cells of viable yeast, for every milliliter of wort, for every degree Plato (a little less for an ale, a little more for a lager.) In his book *An Analysis of Brewing Techniques*, George Fix states that you need to pitch 0.75 million cells per milliliter for an ale and 1.5 million cells per milliliter for a lager.

Here is the simple math to calculate the number of cells needed for an ale.

(0.75 million) X (milliliters of wort) X (degrees Plato of the wort)

There are about 3,785 milliliters in a gallon, and about 20,000 milliliters in 5.25 U.S. gallons.

One degree Plato is close to 1.004 of specific gravity (SG). Just divide the decimal portion of the SG by 4 to get the approximate degrees Plato (e.g., 1.060 is 15 °P).

The proper amount of yeast for 5.25 U.S. gallons of 1.060 wort is around 225 billion cells if you are pitching 0.75 million per milliliter.

(750,000) X (20,000) X (15) = 225,000,000,000

Another way to put it: you need about 3.75 billion cells for each point of OG when pitching into a little over 5 gallons (20 liters) of wort. Double that number for a lager.

With each vial or pack having around 100 billion cells, you would need two vials or packs (approximately 200 billion cells) to get close to that rate, if you didn't want to make a starter.

In general, a 2-liter starter doubles the amount of yeast in a single vial or pack. For the above example, you would only need one package of yeast if you made a 2-liter starter. To make it easier to figure out how much yeast you'll get out of a starter, Wyeast created a calculator that estimates the amount of growth from a given starter size, which will be available soon at www.wyeastlab.com. Another easy way to determine how much yeast you need is the free Pitching Rate Calculator™ at www.mrmalty.com.

There is also an upper limit to how much yeast you should add. Logsdon says, "I try to stay within 20 percent of my ideal pitch rate and I prefer to slightly under pitch rather than over pitch. This causes more cell growth, more esters and better yeast health. Over pitching causes other problems with beer flavor, such as a lack of esters. Changes in the flavor profile are noticeable when the pitch rates are as little as 20 percent over the recommended amount."

Q: Does a starter need to be kept at the same temperature as it is going to ferment the batch of beer later?

No, but there are practical limits to how high or low you can go. Warmer starters (up to 98° F, 37° C) equal more rapid yeast growth, but using these very high propagation temperatures negatively affects the viability and stability of the resulting yeast. Very rapid growth or excessive growth can result in weaker cell membranes. Lager yeasts tend to be especially sensitive to high temperatures.

The cooler you ferment the starter (down to the planned fermentation temperature for the main batch) the slower the yeast growth, but the yeast can be healthier than yeast coming from a high temperature starter. Keep starters between 65° F (18° C) and 75° F (24° C). A temperature around the low 70s (72° F, 22° C) strikes the best balance for the propagation of yeasts. Lager yeast starters can be kept a few degrees cooler and ale yeasts can be kept a few degrees warmer.

If you are going to pitch the starter at high krauesen, it is best to keep the starter within 5° F (3° C) of the wort temperature of the main batch. Pitching a very warm, active starter into cold wort can stun the yeast and with lager yeasts this can cause a higher incidence of petite mutants, which can negatively affect attenuation, flocculation and hydrogen sulfide production.

You can add small amounts of cool wort to the starter over time to bring the temperature down gradually, but it is really better to keep everything closer to fermentation temperatures from the beginning. Any time yeast sense a big drop in temperature, they slow down and drop out.

Q: At what point do I pitch the starter into the wort?

Discussion rages over this topic. Should the starter be fermented completely, the spent liquid decanted and the yeast pitched, or should the entire starter be pitched when at the height of activity?

Artwork © 2007 Corbis

Most yeast experts say that when propagating yeast, moving at high krauesen is optimal. The time of high krauesen can range anywhere from a few hours to 24 or more. It depends on the amount of yeast added to the starter wort, yeast health, temperature, and several other factors.

Doss says a starter made from an XL pack of yeast into 2 liters of wort will reach its maximum cell density within 12 to 18 hours. If you're starting with a very small amount of yeast in a large starter, it can take 24 hours or more to reach maximum cell densities.

I like to pitch starters while they're still very active and as soon as the bulk of reproduction is finished, usually within 12 to 18 hours. This is really convenient, because I can make a starter the morning of the brew day or the night before and it is ready to go by the time the batch of wort is ready.

Of course, if you have a large starter volume in relation to your batch of beer or a starter that was continuously aerated, then you probably don't want to pitch the entire starter into your wort. Adding a large starter or a heavily oxidized starter to your wort can alter the flavor of the finished beer.

If you're going to pitch only the yeast from the starter, make sure the starter attenuates fully before decanting the spent wort. The yeast rebuild their glycogen reserve at the end of fermentation and it is this glycogen that they use when preparing to ferment a new batch of beer. Separating the spent wort from the yeast too early also selectively discards the less flocculent, higher attenuating individuals in your yeast population. You may end up with a pitch of yeast that won't attenuate the beer fully. Allow the fermentation to go complete cycle, chill, decant the beer and pitch just the yeast.

Q: Can too small or too large a starter can be bad for the yeast?

Parker says putting a fresh vial of yeast into 500 milliliters of wort and letting such a small starter go to completion can actually leave the yeast less ready to ferment a batch of beer. The yeast do not rebuild their reserves and have very little increase in cell mass.

The minimum starter size for significant yeast growth from a vial or pack of yeast is 1 liter. One vial or pack into 1 liter results in approximately a 50-percent increase in cell mass.

Some brewers make a small starter volume (500 ml or less) with the sole intent of "waking" the yeast. When making small starters, it is best to pitch the entire volume at the height of activity.

Q: If I'm making a high gravity beer, shouldn't I make a high gravity starter so the yeast become acclimated?

No. In general, starter wort should be between 1.020 and 1.040 (5–10 °P). Lower gravity starters are easier on the yeast, but result in less growth. High gravity starters result in more growth, but are more stressful for the yeast.

Logsdon says, "Generally, you'd use the lower end of that range [1.020 SG, 5 °P] for coming off a plate or slant or very old yeast. Yeast don't get used to a high gravity environment, and the high osmotic pressure can really stress the yeast."

Q: When increasing a starter in steps, should the steps be a certain size?

Yes, but there is plenty of leeway in the size of the steps. A "step" is when you take an active starter and increase the volume with more wort. Brewers do this to increase cell mass while keeping the rate of growth consistent.

The size ratio of one step to the next can affect the health of the yeast and the amount of cell growth. A very large step can result in a change in yeast metabolism, where the sugars that are fermented last can fall out of favor with the yeast. The yeast become lazy and subsequent generations can become less attenuative.

Making a greater number of small steps increases the chance of contamination. Every transfer, every feeding, every bit of handling you do increases the chance of contamination. Five to 10 times the size of the prior step is considered correct. Try to balance the practical considerations of handling, sanitation and cell growth.

Q: Can I pitch a smaller portion of yeast into the same sized starter and get the same amount of cells at the end?

No. If you're trying to grow a lot of yeast from a small amount, grow the yeast in steps to get to the final cell count desired. Keep the starter aerated and provide all of the essential nutrients for the yeast. Pushing yeast to large amounts of cell growth can negatively affect the vitality of the final yeast if they lack enough oxygen-produced sterols.

When making a bigger beer or when the yeast has been abused or is old, a clean, properly prepared starter will result in consistent, well-fermented beers. Always try to keep your process simple and ask yourself if the beer is the way you like it. If you're making starters, keep track of your process and the results. In the end, keep the big picture of yeast handling in mind, which is to have healthy yeast first and proper quantities second.

Jamil Zainasheff is a former Ninkasi winner at the National Homebrew Competition. Visit his Web site, www.mrmalty.com, for more information.

Russian Imperial Stout

Black as a moonless night, this is a big, rich, warming beer with huge chocolate, coffee and dark fruit flavors. This big beer requires a starter or repitching yeast from a previous batch to ferment properly. Brewers that make the effort will be rewarded with a beer fit for special occasions that will age well over many years.

Ingredients

for 6 U.S. gallons (23 liters)

19.50 lb	(8.85 kg) British Pale Malt 3°L
1.50 lb	(680 g) Roasted Barley 450°L
1.0 lb	(454 g) Special B Malt 120°L
0.50 lb	(227 g) CaraMunich 75°L
0.50 lb	(227 g) Chocolate Malt 350°L
0.50 lb	(227 g) Pale Chocolate Malt 200°L
1.2 oz	(34 g) Magnum or Horizon pellet hops, 15% alpha acid (60 min.) (59 IBU)
2.0 oz	(57 g) British Goldings pellet hops, 6% alpha acid (10 min.) (7.9 IBU)
2.0 oz	(57 g) British Goldings pellet hops, 6% alpha acid (1 min.) (6.6 IBU)
	White Labs WLP001 California Ale, Wyeast 1056 American Ale Yeast, or Fermentis Safale US-56

Original Target Gravity: 1.100 (23.86 °P)
Approximate Final Gravity: 1.025 – 1.030 (6.32 – 7.56 °P)
Brewhouse Efficiency: 70%
Anticipated SRM: 55.4
Anticipated IBUs: 73.4
Anticipated ABV: 9.4 - 10%
Wort Boil Time: 60 minutes

Directions

Single infusion mash at 152° F (67° C) using a ratio of 1.3 quarts water to 1 pound of grain. Cool the wort to 68° F (20° C), pitch the yeast and add oxygen or aerate the wort. With enough healthy yeast, fermentation should be complete in less than 2 weeks, but don't rush it. Carbonate to between 2 and 3 volumes and serve at 45 to 50° F (7.2 to 10° C). If you have the patience, this beer will change beautifully over time, developing new flavors and mellowing with age. Try to save a few bottles for sampling over the years or make one batch for now and one for the future.

Yeast: Ferment this beer around 68° F (20° C) using a clean fermenting ale yeast with attenuation in the mid-70-percent range. White Labs WLP001 or Wyeast 1056 American Ale are excellent choices. This is a big beer and you'll need to make a starter with two packages of liquid yeast in 1 gallon of 1.040 starter wort or one package of yeast in a 2.5-gallon starter. (The starter can be a bit smaller with some form of continuous aeration.) A good dry yeast option is Fermentis Safale US-56. If you're using dry yeast, you'll need about 20 grams for this batch. Make sure to rehydrate the yeast properly before pitching.

Extract with Specialty Grains: Substitute 14 lb (6.35 kg) of English pale malt extract for British pale malt. Increase 60 minute hops to 2.25 oz (64 g). Steep grains in 2 gallons (7.6 L) of water, bring to 170° F (77°C) and rinse with 0.5 gallons (1.9 L) of hot water. Remove from heat, stir in extract and bring to a boil. Add hops as directed in recipe. After 60 minute boil, strain into fermenter with enough cold water to make 6 gallons. Pitch yeast and aerate when temperature drops below 68° F (20° C). Follow fermentation directions above.