Build a Burton Union System: Projects

by Forest Whitesides BYO article from 2006

Our homebrew interpretation of a Burton Union system can be used for harvesting yeast or reclaiming beer that would have been lost out the blow-off tube. Save the beer for your glass, not your floor.

The Burton Union system derives from England. The setup circulates yeast blow-off into a collection vessel then back into the primary fermenter. Here you can see the scaled-down version that we created for home-brewing.

Of the many unique and often complex fermentation systems over the long history of beer making, perhaps none can match the style and distinguished legacy of the famed Burton Union system. At present, you'll have to travel to the Marston, Thompson and Evershed brewery in England's Burton-upon-Trent to see a working Burton Union fermentation system in operation. The brewery, which produces the world famous Marston's Pedigree ale (among others), is the only known commercial brewery still using the Union system.

Traditionally, a union system (later referred to as a Burton Union after becoming linked to its use in the Burton area) is a network of several wooden casks and troughs interconnected via copper plumbing. All of the casks work in union during fermentation, commingling their beer and yeast. As the beer ferments, pressure pushes some liquid up into long troughs above the casks (like blow-off in a homebrew setup), where the yeast settles out of suspension and the remaining volume of beer trickles back into the casks. This allows for easy harvesting of yeast — essentially a form of top cropping — for immediate reuse. It also minimizes the loss of beer through blow-off.

We can make use of two of the biggest advantages of a true Burton Union at home: easy yeast harvesting and minimal loss of brew volume. The second advantage also allows for brewing a given batch size in a smaller carboy — or use every bit of available volume in a larger carboy — because most of the blow-off liquid will be returned to the carboy during fermentation. In my experiments with this system, liquid loss from blow-off is kept at about 3–4 ounces (84–112 g) per 5 gallons (19 L) of wort. Volume loss from siphoning, however, is not affected by the union setup.

For this project, it is assumed that the carboy will be maxed out in terms of volume. This will give better results as far as yeast reclamation is concerned and will ensure that plenty of wort gets cycled through the collection vessel.

The parts

Our homebrew-sized system will be a union of just two vessels: a 5-gallon (19-L) carboy and a 2-liter blow-off collection vessel. For the sake of safety and convenience, I chose a 5-gallon (19-L) PET plastic carboy and a generic square HDPE (high-density polyethylene) plastic jar, respectively. The two vessels will be connected via food-grade tubing and two plastic bulkheads. One piece of

tubing delivers the pressurized blow-off foam (kräusen) from the carboy to the collection vessel. Once in the collection vessel, the foam returns to liquid form, allowing the yeast to settle to the bottom. The reconstituted wort is then returned, by gravity, to the carboy through the second piece of tubing.

Most of the parts for this project are available at many homebrew retailers (exceptions are noted). To find what you'll need to get your own Burton Union going at home take a look to the left, (assuming you already have a carboy and a standard airlock).

PARTS

- (1) 2-liter, square HDPE jar (available from scientific supply shops or from US Plastic at www.usplastic.com) $4
- (2) 5/16-inch OD polypropylene bulk head fittings (available from US Plastic) $3
- (4) Rubber gaskets, Grolsch bottle style $2
- (1) Rubber airlock grommet from fermenter bucket lid $3
- (1) 24-inch plastic racking cane $3
- (1) plastic carboy cap $3
- 4 feet, 5/16-inch tubing $3
- 4 feet, 3/8-inch tubing $3

A quick bit of drilling

First, we'll need to drill some holes: three to be exact, and all three will be approximately 1/2-inch in diameter. I used a 1/2-inch paddle bit, but anything that will make a 1/2-inch hole will do the job. WARNING: Always wear safety glasses when using power tools!

Drill the first hole approximately 1.25 inches (3.2 cm) from the bottom and the second hole approximately 2 inches (5 cm) from the top of the 2-liter square plastic jar (Fig. 2). Now drill a hole in the center of the jar's screw-off lid.

(FIG 1) Here is a common 2-liter HDPE plastic jar. This will be the yeast collection vessel for your Burton Union and costs about $4.00 (U.S.).

(FIG 2) The collection vessel now has two 1/2-inch holes drilled to accommodate the bulkhead fittings.

Grommets, gaskets, and bulkheads

Unscrew the removable nut from one of the bulkhead fittings (Fig. 3) and slide a Grolsch-style gasket on the shaft until it is flush with the stationary nut (Fig. 4), and then push the shaft through the inside bottom hole of the square plastic jar (Fig. 5). Now slide another gasket onto the shaft until it is flush with the jar and then tighten the removable nut on the shaft to seal the bulkhead (Fig. 6). Repeat the same procedure for the top hole bulkhead fitting.

(FIG 3) Here are two 5/16-inch outside diameter polypropylene bulkhead fittings used to create tubing connections in the collection vessel.

(FIG 4) Here you can see the bulkhead with a gasket flush against the stationary nut, forming a tight seal that will lock over the outside of the yeast collection vessel.

(FIG 5) Here is the bottom bulkhead inserted into the collection vessel that will help circulate the yeast.

(FIG 6) The bottom bulkhead with the outer gasket seated for a snug fit.

To complete the seals on the collection vessel, fit the bucket lid grommet into the hole in the square jar lid (Fig. 7). Just add an airlock, and you've got a working blow-off collection vessel (Fig 8). We're halfway finished.

(FIG 7) The lid of the collection vessel drilled with a 1/2-inch hole and with the grommet seated.

(FIG 8) Here is the completed collection vessel, with both bulkhead fittings tightly in place and the airlock installed in the lid.

Plumbing the delivery system

Now we need to use the carboy cap, racking cane and tubing to create a system to get the blow-off to the collection vessel and provide a way for the wort to return to the carboy. The collection vessel needs to sit at least 6 inches (15 cm) or so above the carboy, so go ahead and figure out where you're going to be using your new Burton Union system. Once you have that determined, you'll be in a better position to determine how long your blow-off and return tubing should be.

(FIG 9) Here is the carboy cap with a modified racking cane inserted. This will allow for hook up to the collection vessel.

But before you cut the tubing, remove the small white caps from the orange carboy cap and slide the racking cane in the larger diameter center nipple. This will take a little bit of effort, but it will fit. The idea here is to slide the racking cane in far enough so that when the carboy cap is seated on the carboy, the racking cane will dip a few inches below the level of the wort during fermentation. You may want to fill the carboy with water to figure out exactly how far in to slide the racking cane. Once you have the racking cane at the right depth, use a felt-tip pen to mark a line on the cane approximately 2 to 3 inches (5–7 cm) above

where it sticks out of the carboy cap. Remove the racking cane and cut it on the line you marked. Depending on where your collection vessel is positioned in relation to the carboy, it may be advantageous to cut the bottom of the racking cane and leave the 90-degree elbow intact. Each setup will be unique, so use common sense in determining how to cut the racking cane.

(FIG 10) An alternative collection vessel design, using a 2-liter Nalgene LEXAN square bottle.

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Now replace the racking cane in the carboy cap with the cut end of the cane sticking a few inches above the large center nipple of the cap (Fig. 9). Connect the 5/16-inch tubing to the racking cane and measure off the appropriate length to connect it to the bottom bulkhead fitting on the collection vessel. Again, this length will vary from setup to setup. Now fit the 3/8-inch tubing over the smaller diameter nipple on the carboy cap and measure off the right length to connect it to the top bulkhead fitting. The Burton Union is complete.

Greed: wort volume vs. yeast

Choosing a recipe for use with your new Burton Union will depend on whether or not you are interested in using it primarily for minimizing brew volume loss or as a means to harvest yeast.

If your main objective is to end up with more volume, then any recipe will work just fine. All you need to do is make sure that the final volume that goes from your kettle into the fermenter makes the most use of the volume of the carboy. Fill the carboy up to approximately 2–3 inches (5–7 cm) below the bottom of the neck to be certain you get maximum utility from the wort-saving capabilities of the Burton Union system.

However, if your interest in this system lies in its ability to capture yeast during the height of fermentation, then recipe formulation is important in order to get the best results. Perhaps most critical is the choice of yeast. You should use a vigorous strain that is categorized as top-cropping. Possible yeast choices from Wyeast include WY1007, WY1010, WY1318, WY2565, WY3068, WY3333, WY3638, WY3787 and WY3944. Possible top-cropping strains from White Labs include WLP022, WLP300, WLP320, WLP350, WLP400 and WLP570. The preceding lists are a starting point and are by no means exhaustive. Any yeast that ferments vigorously and exhibits at least minimal top-cropping behavior will likely yield a healthy yeast deposit in the collection vessel. Pitching a large, healthy starter will help as well. Also, you may want to consider pellet hops when you formulate your recipe, as leaf hop particulate matter can easily clog the blowoff tubing.

I've tested this specific setup with several recipes, the most effective of which for yeast harvesting was a simple extract hefeweizen using a big starter of WY3333. If you can get enough yeast going into the collection vessel, it will overflow back into the fermenter, effectively repitching continuously during the height of fermentation. Another interesting consideration when using our small-scale Burton Union is that there are two simultaneous active fermentations happening in a more or less closed system: one in the fermenter and one in the collection vessel.

Alternative design considerations

The above guide for putting together a Burton Union system at home is just a general suggestion; just one way in which such a system could be put together. There are probably dozens, if not hundreds, of alternate methods to arrive at the same end product. For example, you could use a drilled carboy stopper instead of a carboy cap, or you could use a completely different type of container for the collection vessel. I actually designed a second yeast collection vessel using a Nalgene LEXAN square bottle (see fig. 10). Or, for a more true-to-the-original union setup, consider connecting two (or more) carboys to a single collection vessel. Yet another possibility includes leaving the top off of the collection vessel, creating a pseudo-open fermentation. Feel free to substitute the parts listed above with those you find available to you or parts you feel would better suit your specific brewing setup.

However there is one key design concept that should be followed in order to make things work: the positioning of the racking cane. The racking cane must dip below the wort in the fermenter in order for the Burton Union to work efficiently. The reason for this is because when the pressure from the CO2 in the fermenter builds up, the kräusen is pushed up toward the top of the carboy. Positioning the bottom of the racking cane below the wort level allows it to act as a simple check valve.

The pressure building in the carboy is released much easier by blowing off the kräusen than by pushing out the much heavier wort. This keeps the blowoff coming out of the carboy in one tube and the wort returning to the carboy in the other. Just about everything else is configurable to your specific needs or whims.

Mike's Commentary – A Little More to Think About

Consider replacing the air lock on the collection vessel with a screen or piece of muslin under the screw cap. One of the features of the original Burton Union system is that it utilizes open fermentation. In Eric Warner's book, GERMAN WHEAT BEER, he stresses that German brewers get hundreds of generations of their yeast with no problems because of the open fermentation. When the same yeast is used under an air lock, the yeast will mutate after 5 to 10 generations.

I think the science behind this is CO_2 saturation. The tiny amount of extra pressure in the vessel because of the airlock is enough to maintain too much CO_2 gas in solution. It apparently takes a toll on the health of the yeast causing it to mutate or lose vitality. Even if this explanation is incorrect, we can still perform the "monkey-see, monkey-do" routine until one of us can figure it out.

Good luck,
Mike