Principles of Cleaning & Sanitizing For Homebrewers

your partner in food safety

Keeping homebrewing equipment clean and sanitized is one of the best ways homebrewers can ensure good, clean tasting beer, batch after batch. Regardless of whether the beer is made from malt extract, grain, or a combination of the two, the equipment must be kept clean and sanitized or the beer will either have problems, or will develop them later on. It only takes a few of the wrong type of microbes or the improper use of cleaning and/or sanitizing chemicals to impart off-flavors in beer.

There are a lot of ways to keep the equipment clean. Ask ten homebrewers how they clean a fermenter, for example, and you are likely to get ten slightly different answers. As long as the soil is removed and no chemical residues remain, there really aren't any right or wrong answers. There are, however, cleaning and sanitizing products available to homebrewers that can assist in making consistent, great tasting beer and maybe even save some elbow grease at the same time. This article looks at the chemistry of soils encountered in the brewing process and effective cleaning and sanitizing methods for homebrewing equipment from the mashtun to the keg or bottle and everything in between.

There are three main types of soil to contend with in the brewing process. They are: carbohydrates, proteins and scale. Carbohydrates are made up of starches, cellulose and sugars. Proteins are complex, organic polymers with amino acids making up their basic structure. Scale comes primarily from the calcium found in hard water and in beer itself. The combination of carbohydrates, protein, hard water, plus heat (or cold) can create some difficult cleaning problems.

Cleaning vs. Sanitizing—What's the difference?

Although often used synonymously, there is a big difference between cleaning and sanitizing. Cleaning agents remove dirt, debris and scale from the surface of the vessel, hose or implement. While they make equipment look clean, they are not designed to sanitize your equipment. On the other hand, a sanitizer has specific bactericidal (bacteria-killing) properties. Let's review these two groups and give some examples, starting with cleaners.

In some cases, hot water and a little scrubbing can remove all visible dirt from homebrew equipment. In these cases, you don't need a dedicated cleaning agent. But some beer soils like kraeusen can be fairly hard to remove. And in other cases, you face the challenge of cleaning surfaces that you cannot visually inspect. In these and other situations, dedicated cleaning agents are recommended.

Most general cleaning agents are alkaline formulations, including caustic, as well as a number of non-caustic products. Professional breweries have long used caustic as a cleaner. Also known as lye, caustic is sodium hydroxide (NaOH). It is also extremely dangerous to skin and eyes and is corrosive to soft metals like brass and copper.

For homebrewers, I feel non-caustics are the only way to go. Non-caustics are safer to deal with and are generally safe for most metals. In addition, they perform as well as or better than caustic cleaners. The primary difference is that caustic hydrolyzes or emulsifies soil while the non-caustics use displacement chemistry to remove it. A good example of displacement chemistry is automatic dishwashing detergent. In this case, you are not necessarily trying to totally dissolve the soil but rather loosen it off of the surface so it can be suspended and then rinsed away. Caustic tends to saponify (make soap out of) soil, especially fatty acids.

Once a surface is clean, it must be sanitized. Sanitizers must have specific bactericidal properties. In the United Sates, claims for bactericidal efficacy cannot be made unless or until the product carries a current EPA registration as a sanitizer. By the US Environmental Protection Agency (EPA) definition, an EPA registered sanitizer must be able to provide a 5 log (100,000 fold) reduction of bacteria. In other words, it must be able to kill over 99.999% of the original bacteria present to be approved as a sanitizer.

The sanitizer is tested at a prescribed dilution for specific amounts of time against selected types of pathogenic (disease causing) organisms, then re-tested the same way a year later. If the sanitizing product passes both tests, it is granted an EPA registration number as a sanitizer but only after the label has been approved and the registration fee has been paid.

One term commonly used with regard to sanitizers is “post rinse”. Post-rinse sanitizing mean that rinsing is not required after the sanitizing step (when the sanitizer is used at an appropriate concentration and then properly drained). In other words, the beer (or wort) can come in contact with the equipment that has been sanitized without the sanitizer imparting a flavor profile to the finished product. The four best sanitizers I know of for post-rinse sanitizing are: chlorine dioxide, peracetic acid, iodophor, and phosphoric acid/anionic surfactant. Conversely, chlorine bleach is the worst, followed closely by quarternary ammonium compounds. Bleach iimparts a chlorine flavor and quat (being cationic) will kill head retention in addition to giving the beer a medicine-like flavor profile. Here is a look a few common sanitizers used by small brewers.

Bleach: Homebrewers are familiar with 5.25% sodium hypochlorite, commonly known as household bleach. For the money and performance, bleach is hard to beat. In *The Complete Joy of Homebrewing*, Charlie Papazian recommends using two ounces (59 ml) of bleach per 5 gallons (19 L) of water to sanitize corks, hoses, carboys, bottles, etc. This dilution provides about 200 parts per million (ppm) of available chlorine, and works fine as long as whatever is being sanitized is triple rinsed as not to flavor the beer. Chlorine bleach is hard on stainless steel and the flavor is detectable at extremely low

ppm levels in beer. For this reason, bleach does not qualify as a post rinse sanitizer for brewing.

Iodophor: Iodophor is an iodine based sanitizer used by many home and commercial brewers. Like bleach, iodophor is a halogen type sanitizer. Unlike bleach, however, iodophor is a good post rinse sanitizer when used at a concentration of 12-25 ppm active iodine (1 oz. [29.5ml] of 1.75% titratable iodine sanitizer per 5 gallons water). At this dilution, the iodine does a good job of destroying unwanted organisms but does not flavor beer if the equipment is drained properly. There are a couple of things to be aware of when using iodophor. One, the concentrate stains plastic, leaving an unsightly, rust colored appearance. Secondly, if measured improperly, iodophor can flavor beer, giving the beer a tinny, medicinal, Band-Aid like flavor.

Chlorine Dioxide: Chlorine dioxide (ClO2) sanitizers are gaining a following in the brewing industry. Shipped as stabilized sodium chlorite, (NaClO2) ClO2 is generated by adding food grade acid (phosphoric or citric, typically) to drop the pH to the acid side and form the ClO2 gas in solution. The equation for this reaction is:

5NaClO2 +4H+===> 4ClO2 (g) + 5NaCl + 2H2O

Chlorine dioxide has several advantages over other sanitizers used in brewing. Chlorine dioxide is an oxygen donor so it is more environmentally friendly than either bleach or iodophor, both of which can form trihalomethanes (THM's) when they break down in waste water. (THM_s are compounds that include chloroform and are carcinogenic.) One reason Chlorine dioxide is used for drinking water disinfection is that it does not form THM's and does not have a chlorine-like flavor profile. This makes it ideal for use as a post rinse sanitizer. Another advantage of Chlorine dioxide is that it is more forgiving if the amount is not accurately measured or drained. The normal concentration used for post rinse sanitizing is 50-100 PPM active ClO2. (1.5-3.0 oz. of Oxine per five gallons of water).

There are some disadvantages for Chlorine dioxide sanitizers. The concentrate tends to be much more expensive than other sanitizers and requires activation with acid to be effective. Chlorine dioxide is not a good residual sanitizer. In other words, if you want to store the activated solution for a long period of time, don't. The best advice with chlorine dioxide is: use it and lose it. (Discard the spent sanitizing solution down the drain after you are done using it and start with a freshly activated solution each time).

Anionic/Acid Sanitizers: The bactericidal properties of anionic surfactant/acid sanitizing products have been known for decades. These compounds typically contain about 50% active phosphoric acid, (H3PO4) and 15% active dodecylbenzene sulfonic acid (DDBSA). For the homebrewer, anionic/acid products make an excellent post rinse sanitizer. Used at a dilution of 1 oz. (29.5 ml) of sanitizer per 5 gallons water, (200 ppm active anionic surfactant) this sanitizer does a good job of killing unwanted organisms and can also be used to remove scale buildups, too. About the only downside is that DDBSA is extremely foamy so keep the agitation to a minimum if you don't want to see

a lot of foam. As long as fermenters, bottles, kegs, etc. are drained properly, this product will not flavor beer.

Specific Cleaning Challenges

Now that we have reviewed the different types of cleaning and sanitizing agents, let's look at specific portions of the brewery and their specific needs.

Mashtun: For homebrewers making beer from all grain rather than malt extract, the mashtun is normally pretty easy to clean. Since the mash is generally not boiled, carbohydrates and proteins do not get "baked" on due to extremely high heat. Typically, rinsing the mashtun followed by cleaning with a general purpose cleaner is all that is necessary to keep the mashtun looking good. Using alkaline, oxygenated or chlorinated cleaners do a good job of removing and keeping protein stains from the screen.

If a hard water scale develops in the mashtun, using citric acid, phosphoric acid, or even household vinegar (acetic acid) will typically pull the scale fairly easily. If there are soft metals (i.e. copper, brass) in the mashtun using these same acids will also remove tarnish, too. Sanitizing the mashtun after cleaning is unnecessary. The temperatures used in mashing and in the brewkettle are sufficient to destroy the undesirable microbes that infect beer. Be extremely careful when using caustic (lye) based products. If you have soft metals in your brewing equipment, Caustic will corrode copper, brass, aluminum and galvanized metal very easily and is hazardous to the skin and eyes.

Brewkettle: Due to the amount of heat required to boil wort, the brewkettle is harder to clean than the mashtun. This is especially true if the soil in the kettle has been allowed to accumulate over a long period of time. The best way to keep the soil from building up in the kettle is to clean it after each brew, not simply rinsing it out and putting it away until next time. Cleaning on a regular basis with one of the alkaline noncaustic cleaners available at homebrew shops does a good job of removing carbohydrate and proteinaceous soil from the kettle with a minimum amount of scrubbing.

If the kettle has baked on soil, it more than likely is going to require some fairly aggressive chemistry and elbow grease (scrubbing) to remove it. Here is a nifty trick that commercial brewers use that will save you a lot of time, too:

- Start with 1-2 ounces (29.5-59 ml) of phosphoric acid cleaning solution per gallon of water. This will drop the pH of the water to below pH 1.5, even with extremely hard water. Heat the solution to about 140°F (60°C) and allow to soak for at least 15-30 minutes.
- Drain the cleaning solution and refill the kettle with hot water again and immediately add 1-2 ounces of noncaustic alkaline cleaner per gallon of hot water used. Dissolve the cleaner by mixing well allow the solution to soak for 15 to 30 minutes, keeping the cleaning solution at a minimum of 140°F (60°C) the whole time.

- Towards the end of the soak, put on rubber gloves and eye protection and give the kettle a good scrubbing with a green pad. The remaining attached soil should be very soft by this point and will come off very easily with a minimum amount of effort. Then, simply rinse with warm potable water, drain, and put the kettle away until your next brew day.

Hot Liquor Tank: If a dedicated vat or keg is used for heating water for sparging or cleaning, it may require an acid wash from time to time to remove hard water scale. Calcium hardness, especially calcium carbonate, CaCO3 (chalk) and calcium hydroxide, Ca(OH)2 (lime) are virtually insoluble in hot water. The quickest way to dissolve calcium based scale is by using an acid/surfactant cleaner. Hydrochloric acid (HCl) is extremely efficient in pulling calcium but is very corrosive to stainless steel. As with the mashtun, using citric, phosphoric, or even vinegar should pull the scale in a homebrewing hot liquor tank quite easily. Follow the acid cleaner with a good rinse and then clean with an alkaline cleaner to neutralize and condition the metal. Rinse, drain, then put away until the next brew day.

Fermenters: The soil in the primary fermenter is primarily proteinacous in nature, so the best cleaning approach is going to be on the alkaline side to remove the kraeusen and hop resins. Here again, noncaustic alkaline cleaners work exceptionally well for this type of soil and leave glass carboys looking great. For best results, rinse out as much of the yeast and kraeusen as quickly as possible after the fermenter is emptied. If the soil is allowed to dry, it is much more difficult to clean than cleaning right away. Immediate cleaning requires less time, chemical and scrubbing than letting the soil dry. Should the soil dry on, soaking over-night with the noncaustic cleaner (1/2-1 oz per gallon of water) works well to loosen soil. The fermenter then will typically just need a good, high-pressure hot water spray to remove any remaining attached soil.

For 5 gallon glass carboys with narrow mouths, it is a good idea to have a good, long handled, stiff bristle brush (available at homebrew supply shops) to scrub the krausen layer off of the dome of the carboy. This is the most difficult part of the fermenter to clean. The yeast sediment in the bottom of the fermenter normally rinses out quite easily. After rinsing the soil and cleaner out, sanitizing the fermenter is not necessary if it is not going to be used right away again. Simply drain as much of the rinse water out as possible and store until next time. To optimize the bacterial killing properties of the sanitizer, the sanitizing step should be done just prior to filling with beer. (More on sanitizers later).

Kegs, bottles: Proper cleaning of kegs and bottles is critical to the shelf-life of the beer. If the keg or bottle is not clean, the beer will pick-up organisms deleterious to both flavor and shelf-life. Kegs can develop beerstone (calcium oxalate) if not properly cleaned after each use. The scale precipitates like layers of paint inside of the keg. If not remedied in time, beerstone forms a sand paper like feeling to the touch.

Beerstone removal can be one of the most difficult cleaning problems encountered in brewing. In addition to containing calcium hardness, beerstone also contains amino

acids (protein). The amino acids enable beerstone to bind to surfaces, making it a tenacious scale. Because beerstone is not a straight inorganic scale, the acids mentioned earlier that work on removing hard water scale may not be up to the task of removing beerstone. Oxidizing chemistry helps break-up the amino acid groups in beerstone. Phosphoric acid with nitric acid is used in the brewing and dairy industry to aid in the removal and prevention of beerstone and milkstone deposits. Hydrogen peroxide is also being incorporated in some acid cleaners for this purpose as well. Sulfamic acid cleaners also work well on removing beerstone deposits.

The same cleaning procedure detailed for removing the soil in the kettle also works for removing beerstone, with one exception. Soaking with acid alone may not be enough to remove beerstone, especially if the deposit is severe. Brushing or scrubbing is usually required. Try this:

- Wet a rag, sponge or green pad with warm water. Pour the concentrated acid cleaner on it and lightly scrub the beerstone deposit. Don't use too much force, you don't want to scratch the surface, just wet the stone with the acid/surfactant mixture.
- Let the acid work for 10-15 minutes or so. DO NOT RINSE!
- Follow the acid step with a 1-2 oz. noncaustic cleaner per gallon of hot water. Don't get discouraged if this doesn't work on the first pass. Depending on the severity of the beerstone formation, it may take a couple of times to completely remove the deposit.

A question often asked is, "Why skip rinsing between the acid and alkaline step?" Skipping the rinse creates a pH swing that works well to get beerstone to come off the surface. A cold rinse after the acid step can "reset" the protein in the beerstone. Protein is insoluble at a pH of 4.5, so that's why you want to avoid the rinse. Try it! The noncaustic cleaners do a good job of leaving the stainless steel surface with an electrically neutral charge so beerstone will not be able to attach as easily as with an acidic finish. Once clean, the sanitizer will be to do its job much more effectively.

Conclusion

Cleaning and sanitizing equipment is the least glamorous part of the homebrewing experience. The best cleaning regime is one that is safe and requires the least amount of time, money and effort to accomplish the goal at hand without sacrificing the quality of the final product. Many brewers tend to get in a rut once an acceptable cleaning and sanitizing method is achieved. It sometimes takes a leap of faith to try something new, especially if you are not having any problems. If you want to make professional, fantastic tasting beer, you also have to clean and sanitize like a pro. The main thing is to remember to keep Charlie's timeless advice in mind: Relax, don't worry, have a homebrew!