BOILING WORT

Wort must have a full, rolling boil in order to fully utilize hops, and complete the purposes below. Water boils at 212F (100C) at sea level, and lower temperatures at higher elevations.

Always brew in a location where the sweet smell of boiling sugar and hops will not be a problem. The smell often lingers for some time after brewing. It is not a bad smell, but some people simply don't like it.

Boiling serves these purposes:

1. Sanitize wort and kills bacteria
2. Evaporate water, concentrating the sugars
3. Isomerize hops, making the bittering and aroma oils bond to the grain proteins (for both malt extract and all grain)
4. Coagulate grain proteins, causing them to clump together, fall to the bottom, and clarify beer
5. Remove off flavors and precursor grain compounds, such as DMS (Dimethyl Sulfide)

Tip #1: Do not cover the kettle during boil

Expertise: Beginner
Importance: High

It is acceptable to leave the kettle fully covered while the temperature is rising to a boil, but once boiling, it must be removed. A rolling boil is necessary to properly utilize hops. If the kettle will not boil uncovered, leave it partially covered.

Sometimes even with the lid on, a burner (stove top or propane) is not powerful enough to cause a boil, or the kettle is simply too big. Leave the lid mostly covering the kettle to get a small, bubbling boil. If there is absolutely no boil with the burner on high and the kettle partially covered, do not continue. Use a smaller kettle or another heat source.

During the boil, a byproduct from the grain malting process called DMS (Dimethyl Sulfide) is created, which can give flavors of cooked vegetables. This is bad in beer. By leaving the kettle uncovered, the DMS will evaporate. If the cover is left on, DMS will collect in stream on the lid, and drip back into the kettle.

Always test a burner with a kettle full of water to make sure it will produce a full boil. Do not wait until brew day to find out.

Tip #2: Keep a spray bottle near boil kettle

Expertise: Beginner
Importance: Medium

Have a spray bottle full of clean water, or a garden hose, near the kettle. As the boil begins, the wort will foam significantly, and if not sprayed down, it can will boil over, creating a big, sticky mess.

If using a stove top, a boil over will cause wort to overflow onto the stove surface, and once cooled, it is very hard to clean.

Tip #3: Hot break

Expertise: Intermediate
Importance: Medium

When the kettle begins to boil, the wort often creates foam. Five things are happening here:

1. Grain proteins are coagulating (clumping together) and settling to the bottom of the kettle, clarifying beer.
2. It is being sanitized. Most bacteria is killed.
3. Hops are isomerized by the boil, which opens the lupulin glands that contain alpha acids for bittering. A rolling boil is necessary for this.
4. Wort is condensed by evaporating water and leaving more fermentable sugars. This continues the entire boil.
5. Removes DMS (Dimethyl Sulfide) and other compounds which can lead to off flavors.

The proteins of the wort become foam on the surface. As bubbles rise to the surface at the start of the boil, they are trapped under the foam. Once the foam breaks naturally or is sprayed with water, the bubbles rise and pop. Use a spray bottle or hose to remove foam.

Foaming usually stops once hot break is complete. This can last anywhere from just a few minutes to over 15 minutes. Sometimes the kettle will foam after adding hops.

A homebrew store manager and former headbrewer stated to add about 10% of the bittering hops before boil starts, and once boiling, turn the heat off, add the remaining 90% bittering hops, then turn the heat on. He mentioned he has been using this method for over 10 years and had no problems with foam.

Tip #4: Cold break

Expertise: Intermediate
Importance: Medium

Once the wort has cooled to ambient temperature, suspended hops and grain proteins will settle to the bottom of the kettle. This is called cold break.

Several methods for chilling[226] can be used. The faster this is done, the sooner yeast can be pitched, and chill haze[227] can be avoided.

[226] : Refer to Chilling Wort chapter, page 439
[227] : Tip #21, page 413

Tip #5: How long to boil

Expertise: Intermediate
Importance: Medium

Most boil times are 60 minutes, some last 90, and a few last 120. The longer wort boils, the more it becomes caramelized, which makes it darker, and gives a sweeter taste. This is not necessarily bad, but the results might not be as expected.

There are multiple reasons why the boil is 60 minutes. Not all hop additions can be done if the boil is shorter. For example, if adding bittering hops at 60 minutes and aroma hops at 5 minutes, if the boil is only 30 minutes total, both hop additions are not possible because of the short boil time. Understand the boil timeline and when to add hops for desired effect.[228]

Some problems that may occur with a short boil time include hops not fully utilized, beer stability, clarity, evaporation of negative hop oils, DMS not fully removed, and more.

A longer boil also utilizes slightly more of the hops. From articles that have been published on the subject, a longer boil only gives about 5% more utilization.

[228] : Refer to Hops chapter, Tip #1, page 238

Tip #6: Boil time when using pilsner malt

Expertise: Intermediate
Importance: High

When using pilsner malt, always boil for 90 minutes. Pilsner contains more DMS than pale and other malts, so a longer boil is necessary to remove it all.

This does not apply when using pilsner LME or DME.

Tip #7: Raising gravity by adding sugar

Expertise: Intermediate
Importance: Medium

To increase the original gravity for more potential alcohol, add fermentable sugars to the boil or fermenter.

Any fermentable sugar will work, but each will have a unique flavor. Corn sugar (glucose, also called dextrose), cane sugar (table sugar, sucrose), brown sugar (cane sugar before molasses is removed), DME, LME, honey, molasses syrup, fruit without preservatives, additional grain during the mash, or virtually any other fermentable sugar that does not contain preservatives.

Do not use high fructose corn syrup. It is heavily processed and will not give good results.

A simple reference for common brewing sugars is below. This assumes adding 5 pounds (2.2 kg) to 5 gallons (19 L) of water. Adjust quantity as necessary.

Fermentable sugar	Points per gallon
Liquid Malt Extract (LME)	1.036
Light Dry Malt Extract (DME)	1.044
Corn sugar (dextrose)	1.046
Sugar (sucrose, cane, etc.)	1.046
Molasses	1.036
2 row pale malt	1.027

Tip #8: Lowering gravity by adding water

Expertise: Intermediate
Importance: Medium

It is rare that anybody complains of having too many potential fermentable sugars, with the possible exception of trying to clone a recipe and needing to lower the original gravity.

Gravity is lowered by simply adding water to the wort, whether in the kettle or fermenter, before fermentation begins. Exactly how much to add depends on how much lower the gravity needs to be.

Start by adding 1 quart (32 ounces, 946 ml) of water, then take a sanitized spoon and stir well to mix with sugars. Take a gravity reading. Continue adding water and checking the gravity until reaching desired original gravity.

Tip #9: Make a fruit beer hazy

Expertise: Beginner
Importance: Low

A simple effect is to make a fruit beer hazy. It is strictly for appearance, not flavor.

Boil any real fruit in wort or plain water for 5-15 minutes. The amount of fruit depends on how much flavor is desired. Most recipes use 1 pound (453 g) for each 1 gallon (3.8 L) of beer. The longer boiled, the hazier it will be.

After boiling, the fruit can either be added to the primary after fermentation is complete, or preferably the secondary. If fruit is added before fermentation starts, the aroma will be lost when the yeast CO2 escapes through the airlock.

Alternatively, for no hazy appearance, wash fruit first, then simply add to fermenter as explained above.

When kegging fruit beer,[229] be sure to filter the beer thoroughly before carbonating, otherwise it may clog the output post.

[229] : Refer to Kegging chapter, Tip #18, page 585

Tip #10: Boiling hops loose, in nylons, or mesh grain bag

Expertise: Beginner
Importance: Medium

Hops can be added to the boil in multiple ways. Each method has both good and bad points.

No bag, straight in the kettle: Maximum utilization, hops will float free, and must be cleaned out after brewing. May stick to side of kettle. Hops can either be filtered from wort, or use a siphon to remove wort and leave hops behind.

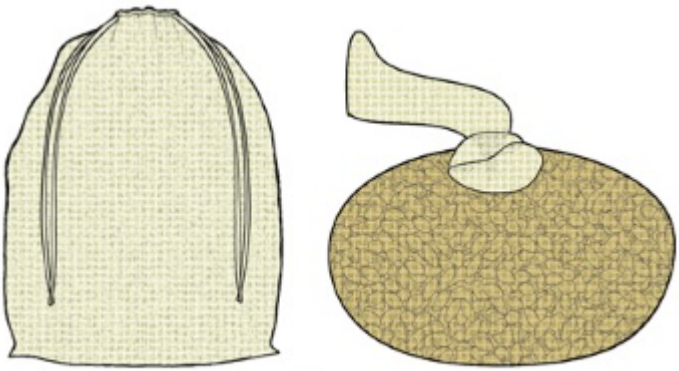
Nylon panty hose: Cheap, disposable, and give no off flavors. Throw away after using. Panty hose are tight fitting, so it is possible they will compact the hops, which may limit full exposure to boiling wort, and their effectiveness.

Mesh grain bag: Easy to use and clean. Simply place all hops inside any size grain bag and add in kettle. Hops will get maximum utilization. When boil is done, simply remove the grain bag, dispose of hops in garbage or compost, clean, and reuse. Grain bags are available in multiple sizes, in both coarse and fine mesh.

Tip #11: Coarse and fine mesh bags for grain and hops

Expertise: Beginner
Importance: Medium

Muslin grain and hop bags come in many sizes. Many are available in coarse and fine woven mesh. Some are single use for hops, others are reusable.



Left: Empty muslin grain bag with draw string
Right: Muslin grain bag full of crushed grain used in a partial mash

These bags are used for steeping grain, boiling hops in the kettle, and dry hopping.

Large coarse is best for grain, any size coarse for leaf hops, and any size is fine for pellet hops.

Tie the bag shut with the string or make a loose knot in the bag so contents do not spill out. Knots are easier to get out after boiling.

Clean muslin bags well and dry out before storing.[230]

Tip #12: Using paint strainer bag for hops

Expertise: Beginner
Importance: Low

Paint strainer bags come in a variety of sizes, and work great for boiling hops as an alternative to muslin bags. They are usually somewhat cheaper as well.

Due to their very large size compared to muslin bags, it may be best to tie in the middle to make removing hops easier.

These bags withstand boiling temperatures, and there have been no reports of any off flavors produced.

Use string or twine to tie it shut because these bags are designed to fit over a bucket and do not come with strings. Another option is to add hops to the bottom, then tie it in the middle.

[230] : Refer to Cleaning and Sanitizing chapter, Tip #15, page 147

Tip #13: Multiple hop varieties in boil

Expertise: Beginner
Importance: Low

Any number of hop varieties can be added to the boil. Be aware of different characteristics, alpha acids, and flavors. Not all varieties work well together.

Multiple varieties can be used for both bittering and aroma stages. Some complex recipes use 2 bittering hops at 60 and 45 minutes, and 3 aroma hops at 10, 5, and 0 minutes.

Example 1:

Hop	Ounces (grams)	Minutes in boil	Notes
Amarillo	1 (28 grams)	60	Lightly bitter
Cascade	1	5	Good floral and citrus aroma

Example 2:

Hop	Ounces (grams)	Minutes in boil	Notes
Cascade	1	60	Light bitter
Chinook	½ (14 grams)	45	Spicy, fruity, little or no bitterness
Sterling	1	10	Some floral and citrus aroma
Fuggle	1	10	Some fruity aroma
Willamette	2 (57 grams)	0 (heat off)	Good spicy, floral aroma

Example 3:

Hop	Ounces (grams)	Minutes in boil	Notes
Columbus	1	60	Somewhat bitter
Crystal	1	15	Slight floral aroma
Crystal	2	5	Strong floral aroma

Example 4:

Hop	Ounces (grams)	Minutes in boil	Notes
Nugget	1	45	Spicy, herbal flavor, little to no bitterness
Summit	1	5	Good tangerine aroma
Summit	2	Dry hop (no boil, added to fermenter or keg)	Strong tangerine aroma

Tip #14: Grant

Expertise: Advanced
Importance: Low

A grant is a small container (cut open keg, large pot) which holds a few gallons (several liters) of hot wort. It is placed between a lauter tun[231] and boil kettle.

A pump transfers wort from the lauter tun to the boil kettle. Without a grant, if the mash water runoff slows down, the pump would siphon the lauter tun directly, effectively compacting the grain bed, decreasing flow.

Grants are mostly used in commercial breweries, although not common, and not necessary for home use.

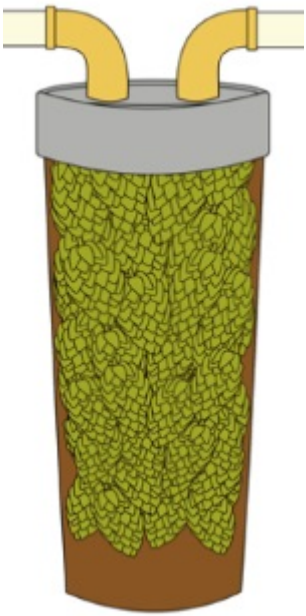
The vast majority of microbreweries and homebrewers use a combination mash/lauter tun, instead of separate vessels.

[231] : Refer to Equipment chapter, Tip #35, page 115

Tip #15: Hopback

Expertise: Advanced
Importance: Low

A hopback is a vessel that goes between the boil kettle and wort chiller. It can be made from virtually anything that is food grade, and can be sealed. A bucket, kettle, glass jar, and many other containers can be used. It has openings for hot wort from the kettle, out to the chiller, and a lid to put hops inside.



Hops are placed into the hopback. 1 to 2 ounces (14 to 28 g) is common. As hot wort is drained from the kettle, it will go through the hops, absorbing the oils, adding extra aroma, then goes to the wort chiller.

Plastic can melt or glass can shatter because hot wort coming from the kettle will be near boiling temperatures (212F, 100C). Although those will work, a metal container is recommended.

This technique is not the same as dry hopping because the wort coming straight from the kettle is very hot, and will extract more oils, giving additional aroma. The aroma will be chemically bonded to the wort proteins by heat, therefore, any aroma should not be lost during fermentation. Dry hopping would only lose aroma if the hops are added before fermentation is complete.

The hopback is mostly used in commercial breweries, but can be bought or made for home use as well.

Tip #16: Cover the stove top with foil for boil overs

Expertise: Beginner
Importance: Medium

Brewing kettle boil overs happen to everybody at some point. It is worse when it happens on the stove top. Cleaning up the sticky mess once it is dried on is very hard, and can take several hours, depending on the severity.

A simple, easy, and cheap method to prevent this is to cover the stove with aluminum foil, leaving only the burners uncovered. Putting down multiple layers is a good idea.

After covering, if any boil overs happen, simply remove the bad foil and replace it.

The stove top doesn't look pretty with foil covering it, but once a brewer has cleaned up one boil over disaster, using this remedy will prevent it from happening again.

Tip #17: Brewing low alcohol beer

Expertise: Intermediate
Importance: Low

Making a low alcohol beer requires additional steps beyond regular brewing. There are two basic ways to make it. Some breweries take a regular beer and heat (not boil) it, evaporating the alcohol. This can be done at home as well. Another method is to simply brew a beer with less fermentable sugars.

Details are below for both methods. Fermenting a beer with less sugars is easier and faster.

Using heat to evaporate alcohol:

When fermentation is complete, heating will evaporate most of the alcohol, but will kill remaining yeast, hop flavor, and aroma. Bitterness will remain. Dry hopping can be used to give additional aroma if desired. More yeast is needed for natural carbonation, unless kegging and force carbonating will be used.

1. Once fermentation is complete, pre-heat oven to 180F (82C). Wait for oven to heat.
2. Clean brewing kettle that is large enough to hold 5 gallons (19 L), or use 2 kettles. Cover with aluminum foil. Make a small opening in foil just large enough for racking tube, or empty using drain valve.
3. Remove airlock.
4. Siphon beer from fermenter into kettle.
5. Clean and sanitize fermenter.

6. Place kettle inside hot oven. Fold over at least half of the foil, or preferably all. Alcohol must evaporate. The yeast and hop flavor and aroma will be removed during this process.
7. Keep kettle in hot oven for 30 to 45 minutes.
8. Once done, turn off oven, replace foil over entire kettle. Outside air touching beer should be minimized. This could allow airborne bacteria to contaminate it.
9. Open oven door and allow kettle to cool enough that it can be racked into the fermenter. Do not rack hot beer. A bucket will warp or melt and a carboy can crack.
10. When cooled, remove from oven.
11. Make a small opening in the foil just large enough for the siphoning end of the racking cane, or empty using drain valve.
12. Siphon beer back into fermenter.
13. If desired, add dry hops for aroma.[232]
14. After dry hopping is complete, additional yeast must be added for carbonation, or keg and force carbonate. The beer will retain bitterness. One package of dry yeast is adequate.
15. If bottling, add ¾ cup of corn sugar, mix well, then bottle.

[232] : Refer to Hops chapter, Tip #15, page 257

Using less fermentable sugars:

Most malt extract recipes use 7 pounds (3.2 kg) of LME. Use up to half of this amount.

Most all grain recipes use between 8 to 12 pounds (3.6 to 5.4 kg) of base malt. Use up to half of the total amount.

Use approximately half amount of specialty malt specified in the recipe for both LME and all grain.

The same or half the amount of yeast can be pitched. There are significantly less fermentable sugars, so the fermentation time will be shorter.

Evaporating the alcohol by heat and adding dry yeast at the end is not necessary with this method. Corn sugar will still be needed for natural carbonation if not kegging.

Tip #18: Straining hops from wort in boil kettle

Expertise: Beginner
Importance: High

When hops are added to the boil, the leaves must be strained before the wort is racked to the fermenter. The easiest way to remedy this is to place the hops in a grain bag, but some brewers simply add loose hops to the boil.

A few different methods of straining are below:

Method #1:

If the kettle does not have a drain valve, place a sanitized grain bag over the suction end of a siphon, and a funnel with a strainer into the fermenter airlock opening. Coarse mesh grain bags and strainers work best. Fine mesh will clog easily. Rack wort through funnel. This should be done after the kettle has chilled in an ice bath or tub. The boiling temperature will melt a siphon.

Method #2:

If the kettle has a drain valve and dip tube, place a bag over the tube. With no dip tube, a bag may be able to be tied onto the inside drain pipe. Without a bag, there is a good chance the hop leaves will clog the valve, so use a spoon or paddle to keep leaves out of the pipe. This must be all done before filling kettle and boiling.

Method #3:

Put a funnel with a coarse screen strainer into the fermenter opening where the airlock will go. Do not use a fine screen strainer as it will easily clog. Slowly pour the wort from the kettle through the funnel or open drain valve. Try to avoid letting clumps of hops fall into funnel because it will clog and overflow. Should this happen, remove funnel, pour the hops out, and continue the process.

It is acceptable if a few hop leaves or pellet residue is racked into the fermenter, as long as there are no large amounts.

Tip #19: Clarifying beer

Expertise: Beginner
Importance: Medium

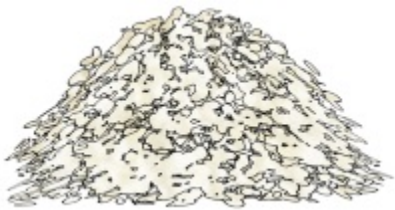
Multiple additives can be used to clarify beer. These products are known as kettle finings.

The most commonly used and cheapest product is Irish moss. It is processed seaweed, but does not smell or have any taste. Use 1 teaspoon per 5 gallons (19 L) in the last 15 minutes of boil.

Irish moss is negatively charged, and grain proteins are positively charged. These bond together, and fall to the bottom of the kettle. Very widely used in breweries.

Whirlfloc tablets are a blend of Irish moss and Kappa carrageenan. Use half of one tablet for 5 gallons, or one full tablet for 10 to 15 gallons (38 to 57 L), during the last 5 minutes of boil.

Gelatin can be used during bottling or kegging. Use ½ to 1 teaspoon per 5 gallons.



Isinglass is made from dried fish bladder. The smell is not pleasant, but it does not contribute any flavors to beer. This may be a powder, liquid, or resemble small glass shards. Add during bottling or kegging.

Generally only light or medium colored beers (pilsner, pale, amber) should be clarified if desired. Porter and stout beers are dark beers, so there is no benefit.

None of these products should contribute any flavors. The only purpose is to clarify. Also remember that when wort is boiled, the proteins coagulate, which also helps clarify beer.

Tip #20: Kettle head space during boil

Expertise: Beginner
Importance: Medium

Leave adequate head space between the wort and top of the kettle during the boil. A minimum of 2 inches (5 cm) is recommended, but several inches (cm) is best to avoid boil overs.

If wort is at the top of the kettle when hot break and foaming occurs, it must be sprayed down with water very quickly. If there is little or no head space, there may not be enough time to spray, and a boil over will likely result.

Tip #21: Chill haze

Expertise: Beginner
Importance: Medium

Grain proteins and tannins from malt remain suspended in beer. When chilled, these react and clump into large particles, and become visible in the light. These make beer appear milky or hazy.

There are multiple ways to resolve this. Chill beer to 30F (1C), then filter to remove haze and yeast. However, this will not work if naturally carbonating, because yeast is required.

Another method is to use a protein rest when mashing. Allow the mash to remain between 113F to 140F (45C to 60C) for 20 to 30 minutes. The proteins causing haze will be removed by the natural enzymes during the mash.

The easiest method is a full rolling boil, followed by rapid cooling. A rolling boil will cause the grain proteins and tannins to create foam, known as hot break, and fast cooling cause these to fall to the bottom of the kettle, known as cold break.

Once chilling is complete, rack to fermenter, then pitch yeast. If the wort naturally cools overnight, the beer will have chill haze because the haze forming compounds have remained in the wort.

Another option is to use kettle or keg finings.[233]

[233] : Refer to Tip #19, page 410

Haze is measured in Formazin Turbidity Units (FTU) as follows:

200 or less is clean
300 to 400 is slightly hazy
450 and above is hazy

A haze of 250 FTU or higher is noticeable. While the haze is not necessarily bad, it may affect the flavor, and give others the impression the beer is faulty.

Tip #22: Whirlpool

Expertise: Advanced
Importance: Low

The whirlpool is largely used in commercial breweries. It is used to separate hop matter from wort. In some breweries, it is built into the boil kettle, and in others, it is a separate tank that hot wort is pumped into and allowed to rest. Only pellet hops are used. Whole leaf hops can plug the drain valve due to the larger size.

Kettle with whirlpool arm

After the boil is finished, wort is pumped out the drain valve and back inside slightly below the wort surface, at an angle. This creates a whirlpool.

It usually runs 15 minutes, which moves all the hop matter to the center of the kettle, then the pump is shut off. The brewer waits another 15 minutes for the hop matter to settle to the bottom, and collect in a pile. Wort is then pumped out to the chiller, leaving a hop cone behind.

A simple method at home to create a whirlpool is to take a long handle spoon or paddle, and stir the wort repeatedly in one direction for several minutes. This will cause the hops to collect in the center, and eventually settle.

A whirlpool arm can also be added to any existing kettle.[234]

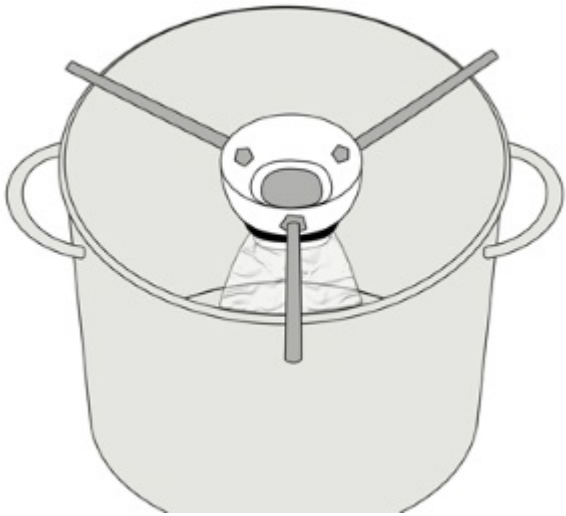
Pellet hops can be added to a fine mesh muslin bag instead of installing a whirlpool.

[234] : Refer to Building A Home Brewery chapter, Tip #11, page 642

Tip #23: Hop spider

Expertise: Beginner
Importance: Low

The two most common methods for adding hops to a boil kettle are either loose, or in a muslin bag.



Another method that is rising in popularity is called a hop spider. This is a device that has 3 or 4 legs that sit on the edge of the kettle, suspended above the boiling wort. It has a center container with an open bottom, and a hop bag is fastened to it. The hop bag is the only part that goes in the boiling wort.

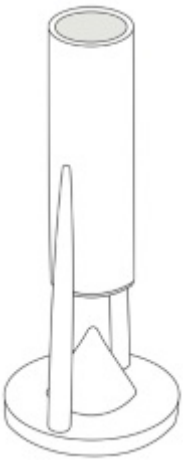
Hops are added into the container during the boil. When the boil is done, the hop spider is removed and contents dumped out.

There is only one bag to clean, no whirlpool is necessary, and no worrying about hops getting into the drain or wort chiller.

Tip #24: Siphon spray wort aerator

Expertise: Intermediate
Importance: Low

Once wort is done boiling, it must be aerated to add oxygen so yeast can breathe, and be pumped or slowly poured into the fermenter.



When using gravity to drain the kettle, using a plastic device called a siphon spray wort aerator will both aerate using surrounding air, while slowly draining into the fermenter.

The piece fits onto the end of tubing, has an opening at the top for water or wort, a cone shaped bottom, and causes liquid to form a shower.

This can also be used with strike and sparge water during the mashing process.

Be sure to wear gloves or use a rag to hold the tubing because it will be very hot.

Tip #25: Anti-foam agent

Expertise: Intermediate
Importance: Low

For those experiencing common boil over problems, there is a product on the market called Fermcap-S, which some retailers carry, or can be bought online.

This can be used in the boil kettle and in the fermenter. It is not water soluble, so it will remain behind when beer is racked out, and does not affected flavor or appearance.

Add a few drops during boil, or two drops per 1 gallon (3.78 L) during fermentation.

QUIZ

Q1. How long is a common full volume wort boil?

A. 50 minutes.
B. 45 minutes.
C. 80 minutes.
D. 60 minutes.

Q2. What is the minimum kettle temperature required for wort to fully utilize hops?

A. 212F (100C).
B. 180F (82C).
C. No minimum.
D. 200F (93C).

Q3. Describe what happens during hot break.

A. Grain proteins fall apart from heat, sugars crystalize, and hop oils bond to wort.
B. Hop oils isomerize, wort is sanitized.
C. Wort begins to foam, grain proteins coagulate and slowly fall to bottom of the kettle.
D. Brewing adjuncts create foam, wort begins to clarify.

Q4. Identify which are all clarifying agents.

A. Irish moss, whirlfloc, gelatin.
B. Rose hips, gelatin, isinglass.
C. Whirlfloc, dandelion, gelatin.
D. Isinglass, Irish moss, lavender.

Q5. Which muslin grain bags are recommended for malt, leaf, and pellet hops?

A. Coarse for malt, fine for leaf, coarse for pellet.
B. Coarse for malt, coarse for leaf, fine for pellet.
C. Fine for malt, coarse for leaf, fine for pellet.
D. Fine for malt, coarse for leaf, coarse for pellet.

Q6: How much head space should the kettle have during the boil?

A. Any amount is acceptable.
B. 6 inches (15 cm) is minimum.
C. At least 2 inches (5 cm).
D. As little as possible to maintain a rolling boil.

Q7. How can a low starting gravity be raised?

A. Add water.
B. Add lactose.
C. Add hops.
D. Add fermentable sugar.

Q8. Describe what happens during cold break.

A. Wort cools and clarifying agents get added.
B. Hops and grain proteins settle to bottom of the kettle.
C. Wort is chilled.
D. Hops and adjuncts settle to the bottom of kettle.

Q9. How long is wort boiled when pilsner made is used?

A. 90 minutes.
B. 120 minutes.
C. 60 minutes.
D. 180 minutes.

Q10. How is DMS removed when brewing all grain?

A. By sparging.
B. By using brewing adjuncts.
C. By mashing in at a higher temperature.
D. By keeping the lid off the kettle while boiling.

Q11. What happens to wort boiled over 60 minutes?

A. Nothing.
B. More water is evaporated.
C. Water evaporates leaving more sugars, wort caramelizes and darkens.
D. The potential alcohol from the sugars doubles.

Q12. What are the purposes of boiling wort?

A. Sanitize wort, condense sugars by evaporating water, isomerize hop oils, coagulate the proteins, removes DMS.
B. Kills most bacteria, coagulates proteins, caramelizes wort, isomerizes hop oils, prohibits yeast ester compound formation.
C. Caramelize wort, isomerize hop oils, sanitize the wort, increase aroma, removes protein haze.
D. Coagulate the proteins, condense sugars by evaporating water, removes fusel alcohols, lower carbohydrates, increase fatty acid production.

Q13. What is a whirlpool used for?

A. Chilling wort faster.
B. Moves all hop matter to center of kettle, separating it from the wort.
C. Assists to fully dissolve any remaining hop matter.
D. Removes any remaining grain husks.

Q14. Give an easy, effective method to reduce chill haze.

A. By using a clarifying agent, such as irish moss.
B. A 90 minute boil to remove hazy forming compounds.
C. Filtering beer.
D. A full, rolling boil, then chilling quickly.

ANSWERS

A1. D – 60 minutes.[235] (A), (B), and (C) are not true boil times. Some are 90 and 120 minutes, but the most common is 60.

A2. A – 212F (100C).[236] (B), (C), (D) Temperatures are all too low. A full foil is required.

A3. C – Wort begins to foam, grain proteins coagulate and slowly fall to bottom of the kettle.[237] (A) Sugars only crystalize from a long boil, hop oils isomerize during the full boil, (B) these are part of the purposes of boiling, (D) adjuncts do not create foam, wort does begin to clarify as proteins coagulate and settle.

A4. A – Irish moss, whirlfloc, gelatin.[238] (B), (C), (D), Rose hips, dandelion, and lavender are all herbs used for flavor and aroma instead of hops.

A5. B – Coarse for malt, coarse for leaf, fine for pellet.[239] (A) Coarse will work for pellet, but hops will not remain inside the bag and will form a pile on the bottom of the fermenter, (C) fine will work for malt, but will be harder to rinse the sugars and flavors, (D) this is the reverse of the answer.

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235 : Refer to Tip #5, page 390
236 : Refer to Chapter Introduction, page 385
237 : Refer to Tip #3, page 388
238 : Refer to Tip #19, page 410
239 : Refer to Tip #11, page 396

A6. C – At least 2 inches (5 cm).[240] (A) The amount does matter. Less than 1 inch (2.5 cm) is not adequate, several inches is best. (B) 6 inches (15 cm) is very good, but not considered the minimum, (D) Adequate head space is absolutely necessary, but has no effect on maintaining the boil.

A7. D – Add fermentable sugar.[241] (A) Water will only lower gravity, (B) lactose is not fermentable, (C) hops only add bitterness and aroma.

A8. B – Hops and grain proteins settle to bottom of the kettle.[242] (A) Clarifying agents are usually added during the boil, not at the end, (C) wort is usually done with a wort chiller, not a part of the cold break, (D) adjuncts are kettle flavoring additions.

A9. A – 90 minutes.[243] (B) and (D) 120 and 180 will work, but are not necessary, and will result in a caramelized, sweeter wort, (C) 60 minutes is not sufficient.

A10. D – By keeping the lid off the kettle while boiling.[244] (A) Sparging only rinses grain, (B) mashing at a higher temperature will give a full body beer or release tannins, depending on how high the temperature is, (C) brewing adjuncts flavor beer.

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240 : Refer to Tip #20, page 412
241 : Refer to Tip #7, page 392
242 : Refer to Tip #4, page 389
243 : Refer to Tip #6, page 391
244 : Refer to Tip #1, page 386

A11. C – Water evaporates leaving more sugars, wort caramelizes and darkens.[245] (A) While not immediately noticeable, wort is affected. (B) This is true, but not the only effect of a longer boil, (D) Significant sugars and yeast pitched would be required.

A12. A – Sanitize wort, condense sugars by evaporating water, isomerize hop oils, coagulate the proteins.[246] (B) Wort will get caramelized in a long boil, but that is not the purpose, yeast is not added at this point, (C) boiling does not increase aroma, protein hazy is affected during chilling, (D) fusel alcohols are created by yeast fermenting at a high temperature, boiling does not lower carbohydrates, or increase fatty acid production.

A13. B - Moves all hop matter to center of kettle, separating it from the wort.[247] (A) Does not chill wort, (C) pellet hops are long dissolved at this point, and whole flower do not dissolve, (D) any grain husks should be removed during vorlauf.

A14. D – A full, rolling boil, then chilling quickly.[248] (A) Clarifying agents may help remove hazy forming proteins, but it is not the most effective, (B) a longer boil does not remove chill haze, (C) filtering will remove it, but it is not the easiest method.

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245 : Refer to Tip #5, page 390
246 : Refer to Chapter Introduction, page 385
247 : Refer to Tip #22, page 415
248 : Refer to Tip #21, page 413