November 2018

Brew Kettle Boiling

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In the Brew kettle the wort is boiled with the addition of hops.
The misconception is that water boils at 100C and that it freezes at 0C. The truth is these are affected by the concentration of other chemicals in the water as well as altitude (air pressure). So the actual boiling temperature may vary from day to day and from brew to brew depending on the wort concentrations.
At this point you might think so what. You might not even have the ability to adjust the temperature of the Wort kettle boiling. However like every other step there are a lot of temperature dependant steps going on here. Acids are extracted from the hops , enzyme activity is terminated, Maillard reactions take place, and proteins that determine foam stability are affected.

The addition of hops to beer adds various bitter flavors and foam stability.
The actual temperature as well as for how long the hops are boiled will have significant effects upon the flavor. Boiling of the hops extracts the acids and oils. By adding hops early in the boil, will add to the bitterness of beer. The increased hop acids will also increase the shelf life (act as preservatives). Hops added in the middle of the boil (boil for 15-30 min) give the beer a “hoppy” flavor. The hops added near the end of the boil will give “hoppy” flavors and aromas due to the short heating the aromatic hop oils and will not volatilize. Your choice of hops and knowing the actual boiling temperature will allow you to make relative adjustments to what hops and when to add them and for how long.

This is my favorite part of the process. I love caramel, nutty toffee notes to my beers. This is due to a process called the Maillard reaction. Maillard reactions occur between free amino acids and carbohydrates in the wort and cause browning (darkening) and can add nutty, bread-like, caramel, and toffee notes to the beer. These reactions are dependent on the amino acids present, the pH and the temperature of the boil. If any of these factors change, unexpected flavors can result. With these factors at play it’s hard to replicate this reaction. Yet brewers do it all the time. So once again in order to achieve the most consistent product, temperature, pH and all the other preceding steps must be controlled precisely.

Now we get to the actual mechanics of your Wort kettle. In any kettle there is a variation in temperature from top to bottom with areas closest to the heating elements being warmer.
As with any process temperature uniformity is ideal and it is ideal to invest in a kettle that heats from the sides as well as the bottom.
As this temperature difference increases both the flavor of the beer and the foam stability suffer due to denaturation of foam stabilizing proteins.
Therefore in order to achieve the greatest foam stability, flavor balance, and the best body, the temperature during boiling should be kept as low as possible. This is almost an oxymoron since it will boil dependent upon the ingredients and the air pressure. But uniform heating will decrease high

temperature at the bottom and lower at the top. Also if the kettle is sealed the pressure can increase and therefore increase boiling temperatures. Ideally boiling temperature should not exceed 102°C .

It is also important to control the temperature of the wort post-boil. The wort should be cooled as quickly as possible. At temperatures above 60°C (140°F), bacterial growth is inhibited. Below that, bacterial will flourish in the nutrient rich wort. The wort should be cooled as quickly as possible, ideally 30 minutes or less, to a point below 27°C. Any of you familiar with HACCP regulations for cooked foods will know this as an absolute requirement. If the wort takes too long to cool bacteria can begin to grow. By using a cooling bath or wort chiller with cold water or glycol coolant, wort can be cooled quickly enough to avoid bacterial growth. Another advantage of rapid chilling is that it induces cold break where proteins are precipitated out due to the temperature change.
Chillers using any of these systems may perform better if the water is colder or if the chiller is performing better (variable depending on the hydro load!). Therefore it is again critical to monitor the performance of the chiller. If it does not chill fast enough spoilage bacteria could grow and the cold break might not occur.

pH

Trub formation is when haze-causing proteins stop being soluble and precipitate out of the wort,
This is also known as "hot break" and is optimized at a pH below 5.6 but below protein coagulation is inhibited again, so it is again critical to manage the pH properly using a precise instrument.
This precipitation of protein not only deters haze in the beer it also promotes foam stability.
Again since you will be measuring warm fluids a meter with ATC (automatic temperature compensation) is critical here.
The pH of the wort will affect the solubility of your hops – so the body, taste and clarity of your finished beers are at stake. Boiling result in Hops components creating the bitter flavours humulones to iso humulones) which in turn can be precipitated out by higher pH's.
A good pH meter can act as your assistant when adding any acids or other ingredients to control the pH level in the Brew Kettle.

At the start of a boil the pH should be somewhere between 5.2 and 5.6. As the wort boils, the pH will drop by about 0.25. This is not much but as before get ready to adjust the pH by adding acids to lower it or CaCO3 to raise it.

Oxygenation (O_2)

Prior to fermentation (after the wort is chilled), the amount of dissolved oxygen in your wort should be measured to make certain that it's an optimum environment for yeast activity. Our portable dissolved oxygen meters with automatic calibration and temperature compensation, are specifically designed for testing samples. The measurements can be displayed in our Portable Dissolved Oxygen Meter in ppm or in % saturation. The oxygen levels during boiling are relatively unimportant. Oxygen levels are only appreciable during the very first part of the boiling process because as the temperature of the water is increased the solubility of oxygen decreases. By the time the wort reaches boiling temperatures the amount of dissolved oxygen is negligible.

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