Electrical Conductivity (EC)

Electrical conductivity (EC), often simply referred to as conductivity, is a measure of the ability of an aqueous solution to carry an electric current. Pure water has no conductivity (reading is not zero but very low) because there are no dissolved ions in it. The more ions in solution, the higher the conductivity value. Conductivity measurement of water source in beer brewing gives an indication of the water purity and the baseline measurement before brewer can make any adjustments, like addition of minerals.

Dissolved Oxygen (DO)

After boiling in the kettle, the hopped wort is devoid of oxygen. It is cooled down rapidly to below 80 °F (27 °C) before oxygenation for better oxygen uptake. The amount of dissolved oxygen required depends on the yeast strain and the original gravity of the wort. Traditional ale and lager worts were usually not collected higher than 1045 (12°P) and required 6 to 8 ppm dissolved oxygen. With high gravity brewing original gravities have increased up to 1080 (20°P) and require dissolved wort oxygen levels of 16 ppm or higher. Modern strains of yeast can require as high as 20ppm DO. After oxygenation, yeast is pitched into the wort. Yeast utilizes oxygen to become healthy and to reproduce before fermenting the wort to beer. Oxygen is necessary to produce unsaturated fatty acids and stearic acid for yeast’s cell wall. A strong cell wall enhances the yeast’s alcohol tolerance. Healthy yeast metabolizes wort into alcohol and carbon dioxide without giving off-flavors or off-odors. Once fermentation is complete, the beer is free from oxygen and must be protected from oxygen exposure to prevent oxidation and staling. It is almost impossible to introduce oxygen during transfers and packaging (settling and capping), but the amount should be insufficient for healthy yeast to grow. Brewers should be capable of achieving less than 50 ppb (0.05ppm) total in package oxygen.

Potassium

Malt contains between 4.6-4.8 g/kg of potassium, the major part of which is solubilized during mashing; in beer the concentration of potassium lies between 300 – 500 ppm (mg/L). Above 500 ppm, beer can be salty. Potassium has a purely salin effect. The potassium/calcium ratio affects yeasts flocculation.9

References and Suggested Readings

Calcium concentrations must be balanced with low carbonate-bicarbonate levels as they have counteracting effect on calcium. These ions should be kept to less than 50ppm. Bicarbonates, being strong alkaline buffers, may raise the pH of the mash to unacceptable levels if available in large amounts.2

As sparging progresses, the pH of wort being run off from the mash increases. The pH of the run off wort should be below 6 because higher pH will extract tannins, silicates, and other compounds from the grain leading to astringent-off flavors and cloudy, hazy beer.8

The collected wort is transferred to a kettle for boiling. During the boil, calcium carbonate is precipitated (as long as calcium is still present) and the pH decreases, just like during mashing. To achieve this, bicarbonate ion must be removed to keep the pH below 5.6. This pH range will help extract the best character from hops, maximize the amount of hop break formed, and keep color pick-up to a minimum. Another important function of boiling is coagulating the hot break. The optimal pH for hot break formation is 5.2. If big, fluffy bits of break material in wort are present in early boiling, it is a confirmation that pH is in the right range.4 Hot break must be removed so that the hot wort can be clear.

When yeast is added to the wort, the fermentation begins—sugar turns into alcohol, carbon dioxide and other components. To check the contamination of the equipment after cleaning process / CIP can be checked using an ion selective sensor and meter.

Sodium

Sodium is a desirable ion in beer for final product flavor complexity. The range is 0-150 ppm Na+. Professional brewers use simple cleaning process or clean-in-place (CIP) techniques to make regular cleaning efficient and effective. Cleaning process / CIP involves circulating cleanser or sanitizer through a spray ball in enclosed equipment. Brewers will clean each time the wort or beer is transferred from a vessel. For example, kettle must be cleaned after the wort is boiled and sent off through the heat exchanger and into the fermentor. Cleansers with sodium hydroxide (commonly known as caustic soda) as active ingredient are by far the most widely used in breweries.10 Any residual sodium in the equipment after cleaning process / CIP can be checked using an ion selective sensor and meter.