



MASTER BREWERS ASSOCIATION OF THE AMERICAS

Brew Water Treatment - Chemical Reduced Process

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Theory

Every water is different! – It is possible to change every water to the requested one!

- ⇒ *Different beer styles request different water!*
- ⇒ *Contact with beer requests high microbiological quality*

Pre-treatment of Raw Water - Dechlorination

- Typical 1st step with city water
- Granular activated carbon (GAC) filter
- Adsorbs organic also for trihalomethanes (THMs, chlorine by products), typically once / week
- Backwash! Flush out residuals, loosening carbon – just necessary flow, not excessive high
- Thermal sanitization: best with hot water, by steam some carbon particle structure gets destroyed
- Long lasting quality filter material
- Chlorine content: < 50 ppm
 - Corrosion, especially at higher temperatures (chlorides Cl⁻)
 - Off flavors possible by formed combinations (e.g. chlorophenols)

Hardness

Carbonate Hardness	Non Carbonate Hardness
HCO ₃ ⁻ : annihilating acidity (bonds acids during mashing which raises pH)	All CA2+ and Mg2+ salts – promoting acidity sulfates and chlorids do not change pH but add CA2+ or Mg2+

Not the main hardness but the residual alkalinity is important!

- Influence of the water regarding the mash pH
- Acidity annihilating effect of carbonates residues if hardness components react in mash
- Rate carbonate – non carbonate

$$\text{Residual Alkalinity} = \text{Total hardness} - (\text{Ca}^{2+} + (\text{Mg}^{2+}/2)) / 3.5 \text{ [in ppm]}$$

RA: 0 = no influence only from malt
change of 60 ppm = equals pH change of 0.1

Influence of Ions to Beer:

Ca ²⁺	lowers mash pH which supports starch splitting enzymes, supports enzymatic activity as co-factor for α-amylase, promotes protein precipitation during wort boiling, supports oxalates removal by forming combinations for fall out (gushing) bitter (higher content)
Mg ²⁺	as NaCl in higher content salty, sour, NaHNO ₃ strong acidity lowering, >25 ppm slower yeast activity (cell toxin)
Na ⁺	dry, adstringent taste
Sulfates	< 10 ppm fermentation (introduction from malt too)
No ₃ ⁻	turbidity, 25 – 40 ppm
SiO ₂	No oxidizing chlorine! negative influence on shelf life
ClO ₂ , O ₃	medical off-taste
Chlorophenols	<10 ppb carcinogenic
Trihalomethanes	

Technology

Demands on Water Treatment Technologies

- Flexible
- Resource consumption
- Sustainability
- Low costs
- Easy to handle, safe and reliable operation
- Minimized by products
- No chemicals, no high concentrate dangerous chemicals
- Slightly / non polluted waste water
- Automation, low handling / labor costs, documentation
- Less energy consumption

Mineral Adding

- Easy, cheap and most commonly used
- Water quality and beer style to respect, not always sufficient
- CaCO₃ (gypsum) – poor solubility, hard to control
- CaCl₂ – chloride content may cause corrosion
- Residual alkalinity gets changed (increase non-carbonate hardness) and the total ion content

Lime softening Ca(OH)₂

- Simple, High real estate (setting time), High investment costs
- No high concentrated chemicals; Sludge as residual, CaCO₃
- Lowers carbonate hardness but non carbonate hardness keeps unchanged, blending with raw water to requested hardness or CaCl₂ or CaSO₄ (noncarbonated hardness, Ca-content)
- Higher pH of water and especially high of waste water during desludging

Ion exchanger

- Small, Expensive
- Small water consumption,
- High Salt load in waste water (collected salt and regeneration chemicals)
- Corrosion of stainless steel
- Regeneration with high concentrated chemicals, handling with high concentrated chemicals (HCl or H₂SO₄)
- Extensive work

Reverse Osmosis

- Small, High tech, costly
- No (less) chemicals
- Relatively low water consumption; Waste water – higher salt contents – yield 85 – 90%
- All ions taken out, cations and anions - Demineralized to large extend
- Driven by opposite osmotic pressure between raw and treated water,
- H₂O molecules through membrane = permeate; others like salts, organic materials, micro organisms – stay concentrated in retentate because of membrane
- No chlorines – harm membrane

Chemical Reduced Process

What does CHEMICAL REDUCED PROCESS mean?

- No formation of THM no introduction of chlorate, bromate
- No disinfection of raw water
- No bactericidal and bacteriostatic protection of water network
- No microbiological stabilization of stored water



How to work chemical reduced process?

- Reduction or elimination of the initial bacterial count
- Avoiding reinfection through biofilm growth in pipelines
- Minimize storage of water to the essential
- Use of alternative disinfection and sterilization methods

How to implement a chemical reduced process?

- Use of membrane filtration systems like ultra filtration
- Process equipment hot sanitizable in hygienic design
- The process shall be as closed as possible

Hygienic Process Design

- All components including piping, pumps, valves, connections, welding
- Hygienic construction of the complete treatment path
- For sanitizing the construction and materials have to fit without excessive stress on the membranes or the material
- Automatic CIP - concept of the whole water treatment process

Water Treatment – Basic Mechanical Separation

Media Filtration, Multilayer Filter, GAC:

- Elimination of unwanted substances with different media
- Activated carbon: taste, color, chlorine
- Gravel: undissolved solids, oxide, ...
- Special media: manganese, arsenic, uranium, fluorides, radon ...

Ultra Filtration:

- Filtration of undissolved solids bigger than 0.02µm
- Almost a 100% guarantee of eliminating all bacteria and viruses
- No change of salt content of the water!

Reverse Osmosis:

- Pressurized filtration by the reverse osmosis principle
- Change of water salt content

Equipment Solutions

Mediafiltration

- Hygienic vessel design with no stagnation zones, dead zones or short-circuit flows
- Optimal design of flow rate / space ratio; service-friendly, sustainable materials
- Integrated Metrology for backwash according to quality optimizes the water consumption
- Hot water sanitization to ensures microbiology and long life of filter media
- Automation for safety, less labor



Ultrafiltration

- Hollow fiber modules with in-out operation with low operating pressure (max. 87 PSI), no "dead legs"
- Efficiency usually above 95%
- Backwash at continuously full plant performance without additional filtrate tank
- Minimizing contamination risk during back wash by directly filtrate use without storage
- Integrated measuring and controlling for rinsing according to quality for best rinse water consumption
- Hot water sanitizable membranes that allow sanitization up to 185°F
- CIP process of UF plant in operation direction: never unfiltrate on filtrate side!



Reverse Osmosis

- With spiral wound modules
- Low pressure range with max. 232 PSI operating pressure
- Secure separation of solved salt, solved organic material and micro sized particles
- Flexible Flow rate, controlled product water (max. + / - 20 %) minimizing stress to the membranes by stop and go situations
- Low waste water, Minimum energy consumption
- Constant high quality and yield of product water regardless of raw water fluctuations with measurements and controls automatic adaption to different raw water temperatures & qualities (e.g. summer - winter)
- Automatically prevention of the membrane damage by redox measurement for all oxidants
- Prevention of scaling and fouling to prevent membrane blocking despite the possibly high recovery rates of up to 90 %
- Automatic permeate flushing recommended
- Sanitizable stainless steel tubes and membranes recommended which allow sanitization up to 185°F

