Water Hardness | Technical Bulletin

RAW water contains many impurities which are of concern in the food processing industry. Untreated water contains calcium and magnesium bicarbonates and carbonates, typically referred to as hardness. Also to be found are iron and aluminum salts, as well as sulfates, chlorides, and silicates. Raw water may also contain organic matter, microorganisms, and many other trace impurities. All of these are important to us in our role in the food processing industry.

When talking about detergent cleaners however, the picture is somewhat clearer. We primarily need to be interested in the hardness salts of calcium and magnesium which effect the performance of our cleaners and the quality as a result.

Our most basic requirement is to clean and remove the soil. We also do not want to leave or cause a residual film. This is often easier said than done because we commonly employ heat and alkali, the two things most likely to cause scales and deposits of calcium and magnesium. We use heat and alkali to remove fatty, protein, and organic soils. Unfortunately, the chemistry of calcium and magnesium make them less soluble in water under these conditions. The tendency then is for precipitation of hardness salts while we clean.

Scale and Soap Scum

In the past when using soaps, the hardness in the water would react with soap to form a scum which would kill the detergency and leave a film. Today's sophisticated detergents are essentially immune to this effect so the emphasis has shifted to reacting the hardness, keeping it in solution or suspension, and preventing crystalline adherent scales.

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We employ a number of chemical techniques to achieve this goal. We add chelating agents such as EDTA, gluconates, glucoheptonates. We also add multifunctional ingredients, such as phosphonates, polymers, and complex phosphate that act as chelants, dispersants, and suspending aids. This entire arsenal, in many cases the majority of a products raw material cost, is brought to bear on the water hardness problem; to prevent deposits on and in the equipment we clean. In some situations, it is less trouble and less costly to simply rinse with an acid to remove these deposits.

Some raw waters are so hard that other aspects of cleaning and sanitizing are affected. When raw water contains large amounts of calcium carbonate hardness the alkalinity and pH of the water are increased. This can lead to other problems in addition to scale deposits. When sanitizing with a pH sensitive sanitizer such as an acid anionic sanitizer, an iodophor, or a peracetic acid sanitizer, the alkaline nature of the water can result in a high pH where the sanitizer is ineffective.

Care must be taken even when rinsing with hard water. If the equipment or rinse water is hot, evaporation will likely result in a film of hardness salts and silicates. Silicate films are exceedingly difficult to remove requiring physical abrasion or hydrofluoric acid.

The best way to overcome these problems is to use a well formulated cleaner with the above mentioned qualities and softened water. Using softened water will help prevent deposits during rinsing. Remember, the last thing you do after cleaning is to rinse the system just cleaned with hot water. During this phase there are no chelants or dispersing agents to aid in prevention of deposits.

The following information will make it easy to determine the capacity of soft water requirements.

In order to size a water softener properly you must know the following:

1. Maximum flow rate required in gallons per minute.
2. Hardness of the water to be softened.
3. Average flow rate in gallons per minute
4. Hours per day of operation or total gallons per day required.

NOTE : If the total hardness of the water is expressed in parts per million then you must convert it to grains per gallon by dividing your total hardness by 17.1.

Assume the average flow rate is 20 GPM
Assume the total hardness is 11.7 GPG (200 PPM)
Assume the hours per day is 10

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The following calculations would be:
20 GPM times 60 = 1200 Gallons per hour times 10 hours = 12,000 Gallons per Day.
12,000 gallons times 11.7 = 140,400 Grains per day required.

Now that we know the grains per day required we can determine the cubic feet of softener resin required by the following formula:

One cubic foot of high capacity exchange resin regenerated using 12 pounds of salt has an exchange capacity of 25,000 grains. If we divide the grains per day by the capacity per cubic foot, we will arrive at 5.6 cubic feet required.

This, of course, does not allow for any reserve and assumes no change in water quality. In actuality, you would need to add for fluctuations in water usage and quality.

Sizing of the softener must also consider maximum flow rate to determine both the control head and tank size to eliminate the possibility of high back pressure and only partial softening of the water.

It must also consider the time the tank will be off line while being regenerated. Unless a twin alternating unit is used, this will allow hard water to bypass during regeneration. If a twin is used the capacity must allow for re-saturation of the brine solution between regeneration times to assure full regeneration of the next tank.

A typical commercial twin alternating water softener

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