As Published in Water Technology, March 2003

The art of zeolite application

A complete guide to zeolite use for a host of water treatment problems.

By Kurt Gruett, Vice President

Zeolite media is a versatile product used for the removal of hardness, iron, and manganese; ammonia reduction; and pH correction in water. In zeolite's sodium alumino-silicate bond, the silica provides strength to the structure while the aluminum gives the material its ability to soften water. In comparison to round resin beads, zeolite is a heavier media that provides better filtration, and cleans faster with only slightly greater backwashing rates – without the loss of media. When applied correctly, zeolites can reduce the customer's initial purchase cost as well as operational costs of the equipment. The old adage that water treatment is an art and not a science still holds true. Water treatment methods often cannot be expressed by numbers, or supported by facts; it is more a "feel" of how and when to apply the right medias. The most important part of applying zeolite is identifying what minerals are present.

Effect of water quality

Because zeolite is used on problem waters, the water quality (or lack of it) is very important in determining which zeolite media to apply. Testing is always the starting point. Since water will change from its original composition in transit to a laboratory, testing should always be done on the job site. Color, odor and turbidity should also be noted at the time of testing.

Pumping systems and plumbing must also be examined since they can adversely affect the water, especially if high iron, manganese, and H_2S are present. In certain situations, pumping systems can precipitate iron or other materials in the water, diminishing the ability of the zeolite to remove these contaminants by ion exchange. Use of a demonstration mini-softener on the job site can forewarn of this potential problem.

Once the water has been tested for minerals that may be present, apply the following rules to ensure that the zeolite is used to its maximum potential:

1) Hardness

Zeolite works the same way as any cat-ion exchanger - calcium, magnesium, and ferrous iron ions are replaced with sodium (or potassium) through the ion-exchange process. However, zeolite requires a minimum hardness of 50 ppm. At and above this level of hardness, the pores in the media will expand during the service cycle, allowing materials such as CO_2 and mineral acids to enter the media and become trapped, like a molecular sieve. This process allows the zeolite to raise the pH of the water.

However, during the brine cycle of the regeneration, the opposite occurs. Zeolite contracts and shrinks, thus "squeezing" the gases and acids from the media and rinsing them to drain. If the hardness is below the minimum (50 ppm), these materials may block exchange sites, resulting in loss of capacity.

High hardness (30-80 gpg) is not a problem with the exception of higher flow rates. Just as with resins, the system must be of adequate size to prevent hardness leakage.

2) Iron

Iron removal by zeolite is primarily accomplished by ion exchange in the softening process. For clear water iron (Fe^2), the amount is limited to 15 ppm in residential applications and 10 ppm in a commercial/industrial setting. If precipitated iron (Fe^3) is present, most will be filtered by the sand structure of the media. However, some ferric iron may be too small to be filtered, resulting in a "bleed" of a small amount of iron from the media.

When sizing a zeolite conditioner under heavy iron conditions (>5 ppm), size the equipment using the capacity of each media. When using metered initiated regeneration systems, size so that the unit regenerates a minimum of every six days. If the consumption varies and the unit could be idle for longer than six days, use the days over-ride feature of the electronic timers to ensure proper cleaning of the media.

3) Manganese

Manganese is not as common in water as iron, but its removal is much the same. When applying zeolite, manganese is to be considered just as iron. Simply add the iron and manganese content together and choose the appropriate size unit. Just as iron, there is no need to compensate the hardness for manganese. However, the same cautions should be observed.

4) pH

Applying zeolite to a lower than specified pH (6 or 7, dependent on the specific media used) can result in degeneration of the media. The pH correction works on the principle of absorption. The CO_2 and mineral acids are absorbed into the crystal structure of the media.

Unusually high levels of CO_2 (>40 ppm) can, however, cause problems with the zeolite, which can result in loss of capacity. Usually CO_2 is an isolated issue that water treatment dealers in the area are aware of. If CO_2 levels are not known, testing should be completed at the job site to rule it out. Tests can be conducted with a CO_2 test kit or calculated by alkalinity, pH and temperature readings. (See Figure 1, next page).

If high CO_2 is found, treatment with technical grade soda ash ($NaCO^3$) releases some CO_2 from the media and re-captures lost capacity. Always use extreme care when working with any chemicals and follow the manufacturer's recommended handling procedure. Never allow unsafe water to enter the plumbing system.

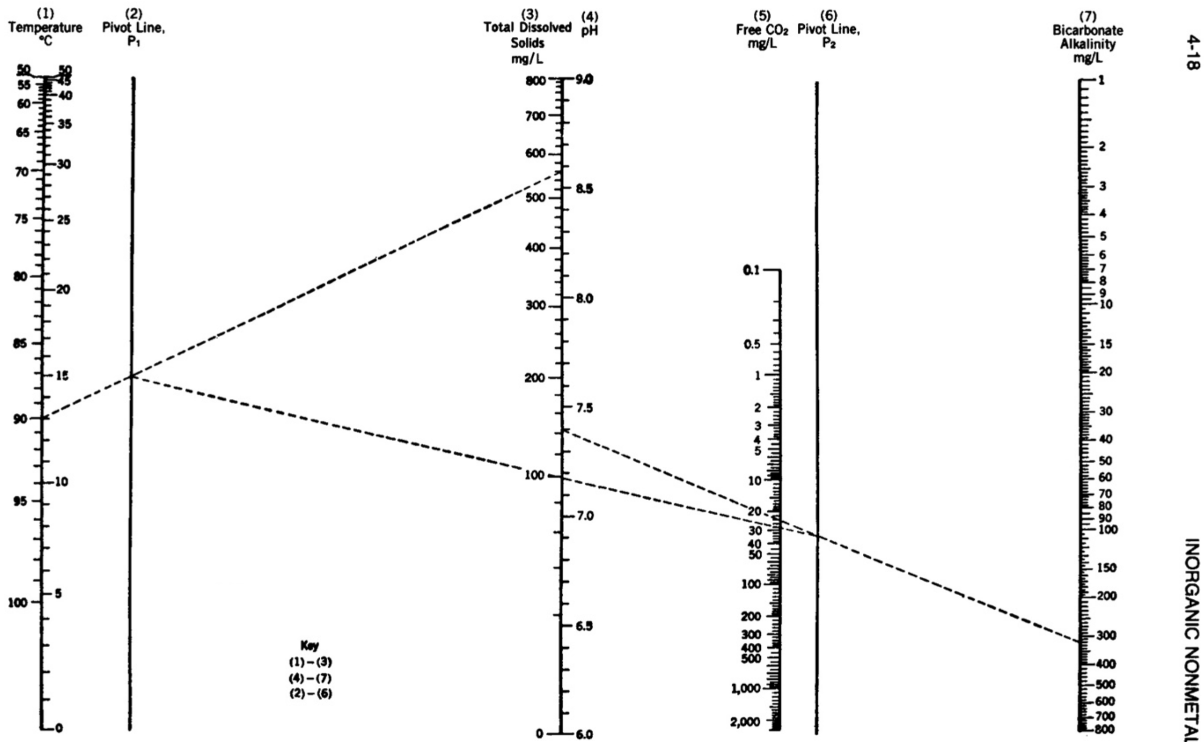


Figure 4500-CO_2:4. Nomograph for evaluation of free carbon dioxide content. To use: Align temperature (Scale 1) and total dissolved solids (Scale 3), which determines Point P_1 on Line 2; align pH (Scale 4) and bicarbonate alkalinity (Scale 7), which determines Points P_2 on Line 6; align P_1 and P_2 and read free carbon dioxide on Scale 5. (Example: For 13°C temperature, 560 mg total dissolved solids/L, pH 7.4, and 320 mg alkalinity/L, the free carbon dioxide content is found to be 28 mg/L.)

Using the soda ash as "preventative maintenance" can also help to keep the media clean of CO_2. Adding 8 oz. with every 50 lbs. of salt can alleviate some of the problem by raising the pH of the brine, although some reduction in capacity can be expected. Using these procedures, zeolite conditioners can recover up to 90% of their original capacity.

5) Organics (Tannins)

Organics such as tannins will turn the water a "tea-like" color. Tannins are nothing more than a dye in the water caused by local vegetation. When combined with iron, however, tannins create a complex molecule that can slip through cat-ion exchange water softeners.

Under high iron conditions, the most accurate way to test for tannins is to first eliminate as much iron from the water as possible. Use a mini-softener to eliminate any clean water iron (Fe^2), and then filter the water through a .45-micron filter pad to filter out the ferric iron (Fe^{+3}). Test for iron again to ensure that it has been removed. If the water is still a tea-like color after this process, it is likely that a tannin condition exists. Perform a tannin test to confirm.

Iron in combination with tannins is often best removed through a trial-and-error process - again the art of water treatment. Once the right combination of equipment and media is found, it can usually be duplicated in the same area with great success. Tannin medias (anion exchange media) or chlorination has proven to be effective in removing these types of organics.

6) TDS (Total Dissolved Solids)

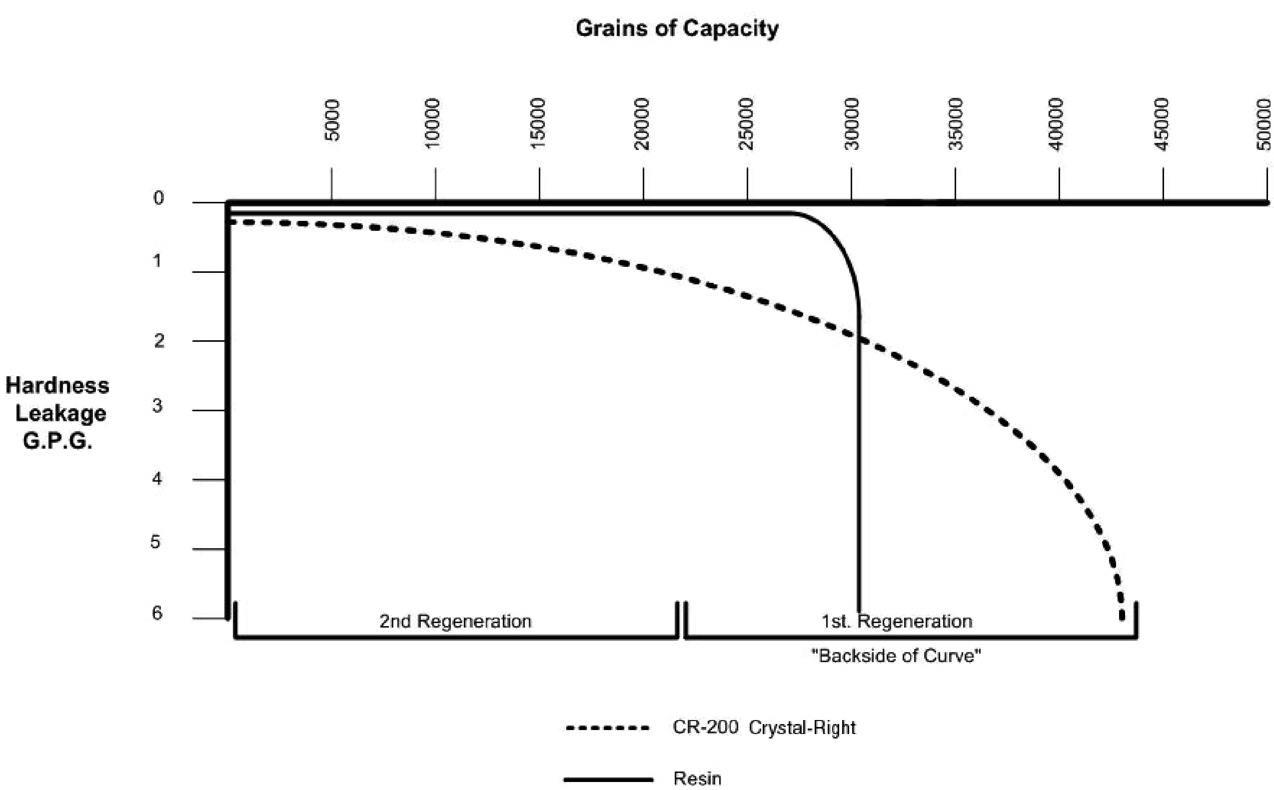
A TDS level below 80 is known to harm zeolite media. At this level, water has a natural tendency to dissolve things, including the silica from the mineral (the basic structure of the media). These waters are often low in hardness as well. In these cases, an acid neutralizer containing Calcite or Corsex can be installed as pre-treatment to the zeolite. This will raise the TDS of the water to a safe level for the media, and add enough hardness to use the zeolite safely.

Helpful Application Tips

When applying Crystal-Right to a particular water condition, all minerals in the water must be taken into consideration. If an extreme iron condition exists, do not size the unit based solely on the hardness of the water. In these cases, think of the zeolite as an iron filtration media, rather than a softening media. Apply regular regenerations (a minimum of every six days) to ensure proper cleaning.

The hardness capacity of zeolite is based upon the ability to soften water to 1 gpg at a given flow rate. When applying this rule, zeolite will “bleed” 1 gpg sooner than resins, which is why zeolite has a lower rated capacity. However, if the service run continues past 1 gpg of hardness, Crystal-Right will continue to soften longer than resin and the hardness will gradually increase until the original hardness is reached. In some cases, this could be double the rated capacity of the zeolite. Resins will deplete their full capacity much faster than zeolite .

If the zeolite capacity is severely exceeded, two or three regenerations may be needed to bring the media back to full capacity. (See Figure 2, below).



Flow Rates

Flow rates can also affect zeolite to a greater degree than resins due to the slower kinetics (speed of reaction) of the material. Continuous flow rates will yield lower capacities and diminished water qualities, especially in commercial settings with extreme problem water. Higher flow rates are achievable, but a loss in capacity should be expected.

Sizing a unit containing zeolite under all the different circumstances and extreme water conditions can be difficult. Unfortunately, there isn't one formula or equation that can be offered as a guide. Most dealers, however, are familiar with local water conditions and have a good idea where zeolite will perform and where alternative methods may be needed.