Operator Quiz Corner

Don't Confuse Magnesium with Manganese!

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Both magnesium and manganese are naturally occurring minerals often found in groundwater. Both are a natural component of most foods and are necessary for proper nutrition and health. And both can cause aesthetic issues in drinking water when exceeding EPA's Secondary Standards. But that is where the similarities between magnesium and manganese end.

Magnesium contributes to what is commonly referred to as the water's '*hardness*'. Magnesium, in combination with calcium, constitutes the majority of hardness. Hardness is measured in units of mg/L of Calcium Carbonate equivalents (CaCO3) and concentrations above 300 mg/L as CaCO3 are considered too hard for domestic water usage. High levels of hardness will cause a scale to build up on the interior walls of pipes and prevent the lathering of soap. Water treatment ('*softening'*) may be necessary if water is too hard. The ion exchange treatment process is practical for very small systems. Large systems usually employ what is known as 'lime softening' to remove hardness. Lime softening consists of adding lime to supersaturate the water with calcium which will then promote the formation of a calcium/magnesium precipitate large enough to settle out in a clarification basin. Fortunately, the majority of waters in New England are considered 'soft' and do not require hardness removal treatment.

Manganese is often found in groundwater along with iron. At certain levels (iron > 0.3 mg/L, manganese > 0.05 mg/L) discoloration of water and brown and/or black staining of fixtures and laundry can be a problem. Under certain conditions the iron and manganese particles will settle in sections of the distribution system piping and lead to problems when the sediments are resuspended causing dirty water complaints. Short term fixes can include frequent flushing to prevent sediment buildup, or the addition of a sequestering chemicals. Sequestering chemicals (typically polyphosphates) do not remove iron or manganese but chemically bind the elements to minimize discoloration. Sequestering is only effective when the iron concentration is below 1.0 mg/L and the manganese level is below 0.3 mg/L. The most effective way to minimize problems with manganese is removal. Small systems can remove manganese with ion exchange, but most municipalities will employ some combination of oxidation and filtration. Oxidation, often using air, chlorine, ozone or potassium permanganate, causes the manganese to form tiny particles that can then be filtered out. Filters can be multimedia sand filters, proprietary 'greensand' filters or more recently membrane filters. Many groundwater systems in Massachusetts have elevated levels of manganese. The Massachusetts Office of Research and Standards has determined that there is sufficient evidence to show that there are health risks associated with manganese at levels above 0.3 mg/L – especially for infants. For this reason, MassDEP has established 0.3 mg/L as the Health Advisory Level (HAL). Exceeding the HAL will trigger certain follow-up actions by the water system. This may include the installation of a manganese removal treatment system.

1) What are the atomic symbols for Magnesium and Manganese respectively?
   a) Mn, Ms
   b) Mg, Ms
   c) Mn, Mg
   d) Mg, Mn

2) What is a common problem associated with water that is considered to be 'hard'?

a) Brown or black staining of white porcelain fixtures and staining of laundry.
b) Scaling on the inside of pipe walls that can lead to plugging of building plumbing – especially hot water pipes.
c) Elevated levels of lead and copper at the consumers tap resulting in violations of the Lead and Copper Rule.
d) Exceeding the Maximum Contaminant Limit (MCL) for Magnesium.

3) In most groundwater supplies Magnesium is often found together with ______ and Manganese is often found together with _______ ?
   a) Iron, calcium
   b) Calcium, iron
   c) Lead, calcium
   d) Copper, iron

4) Which of the following is currently regulated by EPA as a Secondary Standard with a Secondary Maximum Contaminant Level (SMCL) of 0.05 mg/L, but is regulated by MassDEP with an enforceable health standard of 0.3 mg/L?
   a) Iron
   b) Manganese
   c) Calcium
   d) Magnesium

5) Well Nos. 1 & 2 are manifolded together before entering the distribution system. Well No. 1 has a manganese concentration of 0.1 mg/L and has an average pumping rate of 650 gpm. Well No. 2 has a manganese concentration of 0.03 mg/l and an average pumping rate of 1025 gpm? When both wells are pumping simultaneously what is the resultant downstream manganese concentration
   a) 0.057
   b) 0.95
   c) 0.57
   d) 19.98

Solution:

Use the Three Normal Equation from the ABC Formula Sheet: $(C_1xV_1) + (C_2xV_2) = (C_3xV_3)$

Where: $C_1 = 0.1$ mg/L, $V_1 = 650$ gpm, $C_2 = 0.03$ mg/L, $V_2 = 1025$ gpm, C_3 = unknown, $V_3 = V_1 + V_2 =$ 1,675 gpm

Rearrange formula to solve for C_3: $C_3 = [(C_1xV_1) + (C_2xV_2)] / V_3$

$C_3 = [(0.1x650)+(0.03x1025)] / 1,675 = [65 + 30.75] / 1,675 = 95.75 / 1,675$

= **0.057 mg/L**