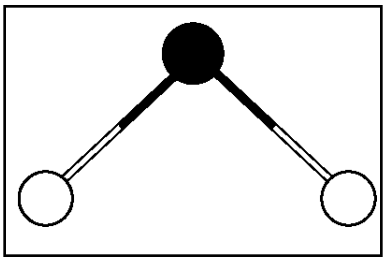
TRIANGULAR WAVE
Fact Sheet

Triangular Wave Deposit Control Mechanisms

When the Triangular Wave System treats water or other fluids, several things happen.

1. The hydrogen bonds between water molecules are broken and more water molecules are freed to hydrate scale ions and colloidal particles.
2. The scale ions dissolved in the water are agitated, they collide, and form scale molecules that join together to form crystals.
3. The colloidal particles in the water receive an enhanced surface charge, possibly from the freed water molecules. The enhanced surface charge is great enough for the colloidal particles to repel each other and the sides of the equipment, and stay suspended in the fluid.

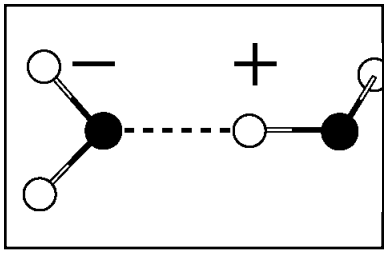
Water Is a Polar Molecule



A water molecule, because of its shape, is a polar molecule. That is, it has one side that is positively charged and one side that is negatively charged. The molecule is made up of two hydrogen atoms and one oxygen atom. The bonds between the atoms are called covalent bonds, because the atoms share electrons.

The hydrogen atoms have one electron each. Because they share those electrons with the oxygen atom, the electrons tend to stay close to the oxygen atom and the outside of the hydrogen atom tends to be positively charged.

The oxygen atom has eight electrons. Most of those tend to stay away from the hydrogen atoms, and cause the outside of the oxygen atom to have a negative charge.

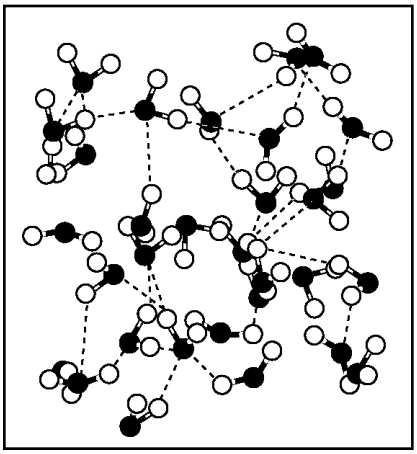


When two water molecules get close together, the polar forces work to draw the molecules together. The oxygen atom of one water molecule will bond with several hydrogen atoms of other water molecules. These bonds are called hydrogen bonds. Hydrogen bonds are not as strong as covalent bonds, but they are strong enough to bind water molecules together and give water its unique characteristics. (An analogy concerning the bonds is that the covalent bonds are like a strong glue bond; while the hydrogen bonds are like the bond between two toy magnets.) Two of those characteristics are: water's great ability to dissolve materials, and water's lower density when it is frozen. At any time about 20% of the water molecules in liquid water are freed of their hydrogen bonds and able to "hydrate" other materials in the water.

The Triangular Wave treatment technology takes advantage of this unique characteristic of water, a polar molecule.

Hydrogen Bonds in Water

The hydrogen bonds are shown by white dashed lines.



Note how many of the oxygen atoms are bonded to more than one hydrogen atom. If there are more free or separate water molecules then the water will be more reactive as a solvent.

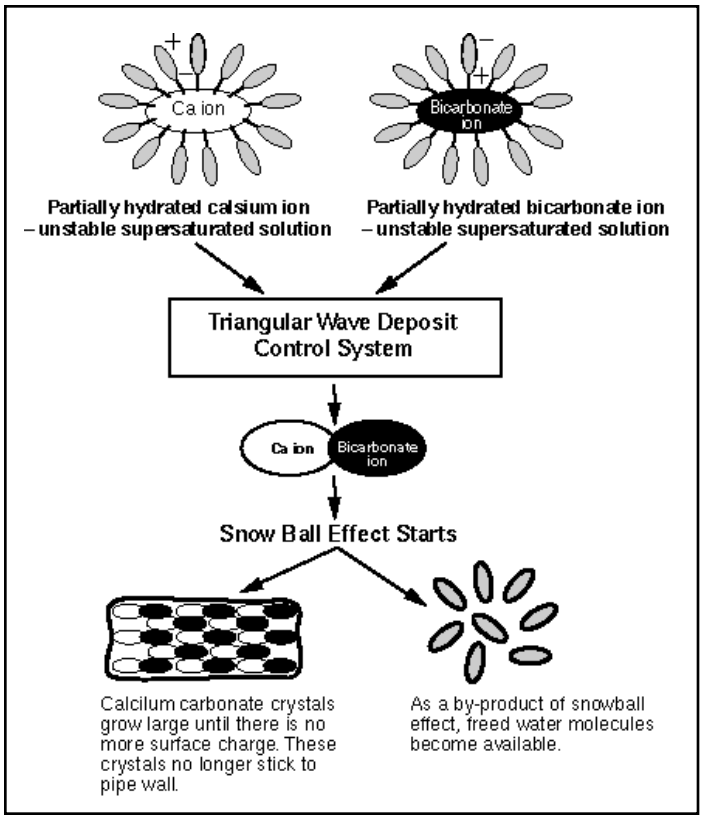
The Triangular Wave deposit control technology provides a means to break down the hydrogen bond of water without increasing the temperature; therefore the water molecules become free.

Triangular Wave Technologies,Inc.• 85 Chestnut Ridge Road • Montvale, NJ 07645 USA • 800-728-3420 Fax 201-573-8710 • Email: info@triangularwave.com

TRIANGULAR WAVE
Fact Sheet

The electric coil in the deposit control system induces a time varying magnetic field within the pipe. This change of magnetic field with time causes an induced voltage. Since water is a charged particle, this energy will be transferred to the water molecules, and will increase their molecular kinetic energy. This increased internal energy will break some of the hydrogen bonds; resulting in more separate water molecules.

Scale Control Mechanism



Calcium carbonate (CaCo3) is the primary constituent of scale in water systems. Calcium and carbonate ions enter the water as parts of other molecules that dissolved in the water. The ions join to form calcium carbonate when they precipitate out of solution at the surfaces of the equipment. The calcium and carbonate ions are “hydrated” when they are dissolved in the water. This means the ions are surrounded by water molecules that are attracted to the ions by the electrical charge.

When a ionic compounds such as salt (sodium chloride) or calcium carbonate enter water, the polar water molecules seek to hydrate the ions from the molecules, because the electrostatic attraction potential of the water molecules is very high.The water molecules greatly reduce the attraction of the ions in the ionic compound molecules; so that the ions only interact weakly with each other and do not aggregate into crystals.

A substance will only dissolve if the attractions between its ionic charge centers and the water molecules are sufficient to overcome the attractions between its own ionic charge centers. As water dissolves a substance, water molecules will surround and form electrostatic bonds with the dissolving ion. As these bonds between water molecules and dissolving ions form, energy is released (known as the heat of hydration). When this hydration heat becomes larger than the bonding energy between the ions on the dissolving substance, the ion will dissolve into the water solution.

Heats of hydration are typically much smaller than the bonding energy between the positive and negative ions of an ionic compound. Therefore each ion of a solid unit must be surrounded by many water molecules before it can be solvated. In other words, large aggregates of water cannot effectively dissolve solutes, whereas separate water molecules can.

The main culprit in most scale problems is the super-saturated solution. There is so much scale causing mineral in the solution that ions are only partially hydrated. The scale causing minerals such as calcium and magnesium ions are unstable and “barely hanging in water” in a super saturated solution. If the scale causing minerals are left untreated and conditions such as pH, temperature, and pressure change in a flow system, the solubility of scale causing minerals may decrease. (In cooling towers, con-densers, boilers, and other equipment changes in temperature are integral parts of their operation.) The electrostatic attraction between the dissolved mineral ions and metal services makes these minerals stick to the surfaces.

Triangular Wave Technologies, Inc.• 85 Chestnut Ridge Road • Montvale, NJ 07645 USA • 800-728-3420 Fax 201-573-8710 • Email:info@triangularwave.com

TRIANGULAR WAVE
Fact Sheet

This is why the scales are unavoidable without some active scale prevention measures. The induced molecular agitation in the Triangular Wave electronic deposit control system causes the unstable mineral ions to collide with each other and precipitate. Impurities in the water such as alumina or silica provide initial nucleation sites for further precipitation of adjacent mineral ions. A snow ball effect starts, resulting in the growth of many crystals, each consisting of numerous mineral ions.

This enables crystal salts to become large in size and float with water; thus they do not stick to the metal services, because the crystals do not have the charges at the surface anymore. As the byproduct of the above mentioned precipitation and snowball effect of mineral particles, freed water molecules become available to dissolve existing scales. When this hydration heat becomes larger than the bonding energy between the ions on the dissolving substance, the ion will dissolve into the water solution.

Heats of hydration are typically much smaller than the bonding energy between the positive and negative ions of an ionic compound. Therefore each ion of a solid unit must be surrounded by many water molecules before it can be solvated. In other words, large aggregates of water cannot effectively dissolve solutes, whereas separate water molecules can.

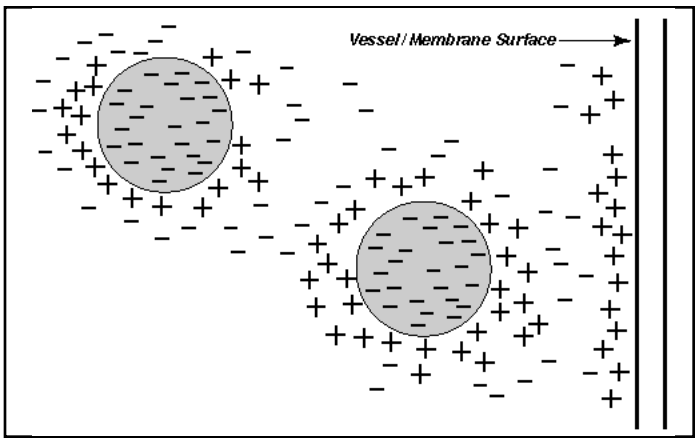
The main culprit in most scale problems is the supersaturated solution. There is so much scale causing mineral in the solution that ions are only partially hydrated. The scale causing minerals such as calcium and magnesium ions are unstable and ***"barely hanging in water"*** in a super saturated solution.

If the scale causing minerals are left untreated and conditions such as pH, temperature, and pressure change in a flow system, the solubility of scale causing minerals may decrease. (In cooling towers, condensers, boilers, and other equipment changes in temperature are integral parts of their operation.) The electrostatic attraction between the dissolved mineral ions and metal services makes these minerals stick to the surfaces. This is why the scales are unavoidable without some active scale prevention measures.

The induced molecular agitation in the Triangular Wave electronic deposit control system causes the unstable mineral ions to collide with each other and precipitate. Impurities in the water such as alumina or silica provide initial nucleation sites for further precipitation of adjacent mineral ions. A snow ball effect starts, resulting in the growth of many crystals, each consisting of numerous mineral ions.

This enables crystal salts to become large in size and float with water; thus they do not stick to the metal services, because the crystals do not have the charges at the surface anymore. As the byproduct of the above mentioned precipitation and snowball effect of mineral particles, freed water molecules become available to dissolve existing scales.

Enhanced Surface Charge on Colloidal Particles



Very often water in cooling systems will have colloid sized particles. These include alumina, silica, bacteria, and algae. The colloidal particles have a surface charge that is relatively weak. As the colloids move around in the water, they collide and aggregate.

When the colloids pass through the Triangular Wave field the surface charges on the colloids are enhanced. Some researchers theorize that this effect may be caused by an ordering of water molecules adsorbed on the surface of the colloids. The net result is that the colloids repel each other and the sides of the equipment, and do not form deposits on the surfaces of the equipment.

In the case of bacteria, slime forming bacteria attach to the walls of the equipment and form biofilm. Biofilm is the habitat for other bacteria such as legionella. The Triangular Wave System enhances the surface charges of the slime forming bacteria; preventing them from attaching to the equipment. This deprives the other bacteria of a habitat they need to feed and propagate. Over a few days time, most of the bacteria die.

Triangular Wave Technologies,Inc. • 85 Chestnut Ridge Road • Montvale, NJ 07645 USA • 800-728-3420 Fax 201-573-8710 • Email: info@triangularwave.com