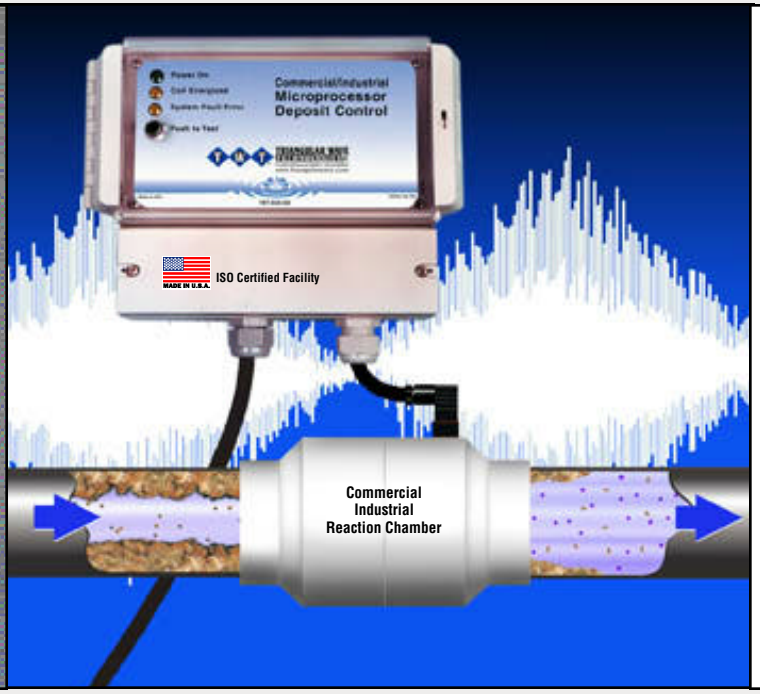
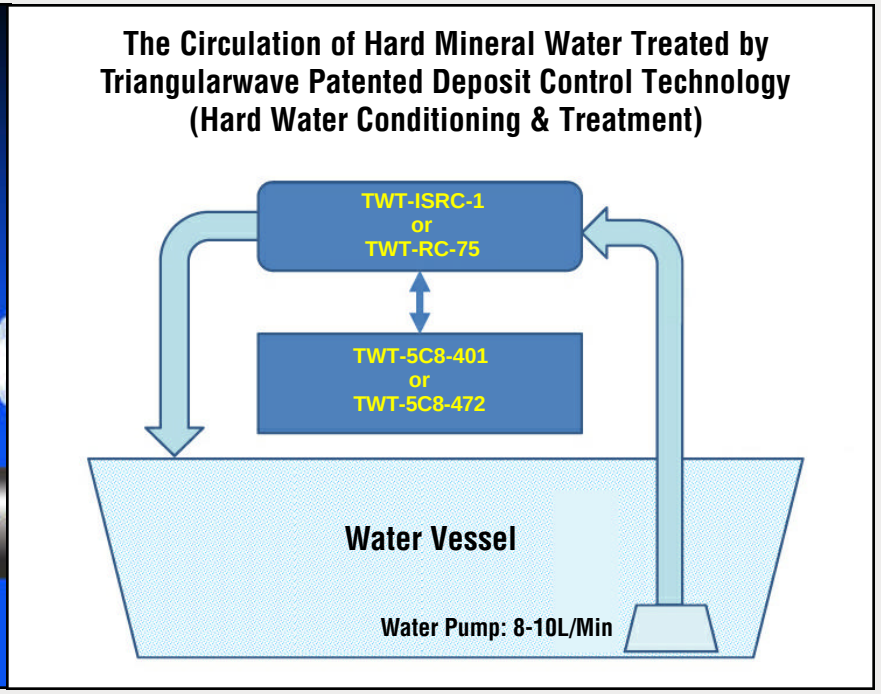
Scale Deposition Tests Using Mineral Water

Test fabricated and performed in Japan by Makoto Nagashima Ph.D.

Addendum to File# TS100A (illustrated tests): Patented Triangularwave Deposit Control Technology Features & Benefits (Tubes • Pipes • Heat Exchangers)

- Contrex Mineral Water (made in France)
- Major Constituent (100 ml)
- Ca=46.8mg, Mg=7.45mg, Na=0.94mg, K=0.28mg
- Hardness 27.3 grains





Hard mineral water was selected to provide the ability to illustrate the scale depositing and then, more to the point, how to inhibit, remove scale deposits and return the fluid based system to it's optimum operation.

Hard Water Minerals

Inhibits and Removal

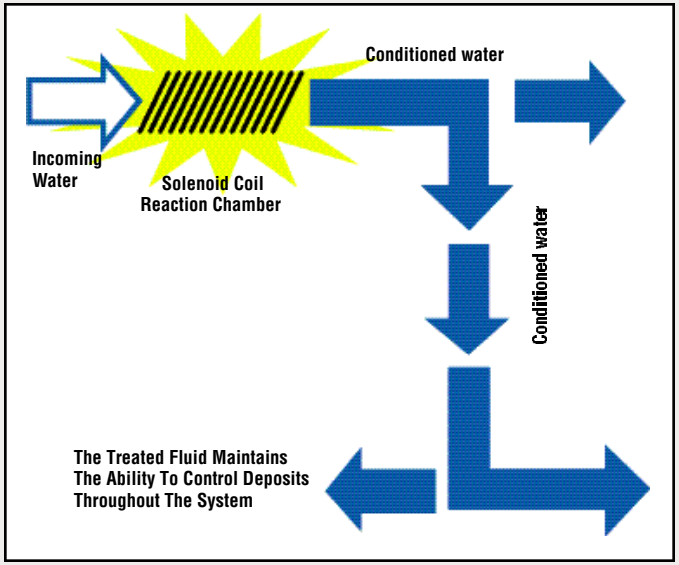
Tests Features & Benefits

Hard Water Problems Solved Easily (Chemical-Free)

FIELD TESTED AND PROVEN EFFECTIVE

Removal of Scale by Triangularwave Technologies treated & conditioned water. Tests conclusively demonstrates the ability of TWT® deposit control technology (hard water conditioning & treatment) to inhibit & remove scale deposits in pipes, tubes and heat exchangers

TWT systems work to consistently deliver high quality water, reduce scale and bio-fouling in plumbing systems and to increase efficiency of both once through and recirculating HVAC, process cooling, agriculture, industrial processing, waste water and other fluid based systems.



SATISFACTION TWT GUARANTEED

When the TWT system is properly installed the effects of the Triangularwave form technology treatment last downstream

Fluid based system applications, may require some or all of these technologies for optimal end-to-end water conditioning, treatment, disinfection & purification.

The First Step in achieving clean water is a filtration system that effectively removes particulate matter and similar debris

The Second Step in achieving clean water is the TWT Chemical-Free Deposit Control Technology (hard water conditioning & treatment)

The Third Step in achieving clean water is the Ultra Violet, Ionization and/or Ozone Disinfection & Purification Technology. The output water is thus disinfected and offers exceptionally high quality for processing, human consumption and use.

The Fourth Step in achieving clean water is a post filtration system if necessary and/or required.

Calcium

(white metallic chemical elements)

Ions (an electrical charged atom or group of atoms) **(CA^{2+})**

Aragonite Crystals

(mineral made up of calcium carbonate in orthorhombic crystals)

The drastic change of CA^{2+} ions was:

- The start-up of TWT scale controller
- The water vessel was standing over night

During the operation of the TWT scale controller, CA^{2+} concentration almost constant in value.

Coagulation

(the act of changing from a fluid to a soft semisolid state)

Relative coagulating power:

CA^{2+} has similar power of Mg^{2+} and less coagulating power than Al^{3+} and Fe^{3+} which are well known coagulates.

- After 8 hours of treatment through TWT system and overnight still standing of water vessel, a lot of coagulates of $CaCO_3$ crystalline were observed on the surface of mineral water.
- The scale deposition was not observed inside the double pipe (tube & heat exhanger)

  The generated $CaCO_3$ particles are considered as the colloidal particles and get the negative charges in the water solution flow. The $CaCO_3$ particles repel each other and form the negatively charged inner surface of the water pipe and devices.

Colloid Stability

(gelatinous substance made up of very small, insoluble, non-diffusible particles larger than molecules, small enough so that they remain suspended in a fluid medium)

Colloid Stability:

Fundamental colloidal chemistry.

- The generated $CaCO_3$ particles through TWT reaction chamber (or solenoid coils) pretend as colloidal particles.
- The $CaCO_3$ particles have a net negative surface charge and repel each other by coulomb force.
- The surface of inner pipe and devices has the negative charge under water solution condition.
- The repulsive coulomb force between $CaCO_3$ particles and the surface of pipe or device prevents the formation of scale (**Suspension:** suspending or being suspended).

Colloid Destabilization in Mineral Water:

- The positively charge ions (Ca^{2+} in mineral water) neutralize the colloidal negative charges. Colloids ($CaCO_3$ particles) aggregate in size and settle if the water flow stops.

pH Level/Percentage Hydrogen

(measure of acidity or alkalinity of water)
(recommended pH value for water treatment industry -7.5 to 8.5)

- The pH value increased in the first 5 hours of testing. This phenomenon, once pH value reached to around 8, pH remained at almost constant value.

  The calcium carbonate generated will tend to increase the pH of the solution, since most make up water is low in pH this increase is helpful as it moves the pH toward a neutral level.

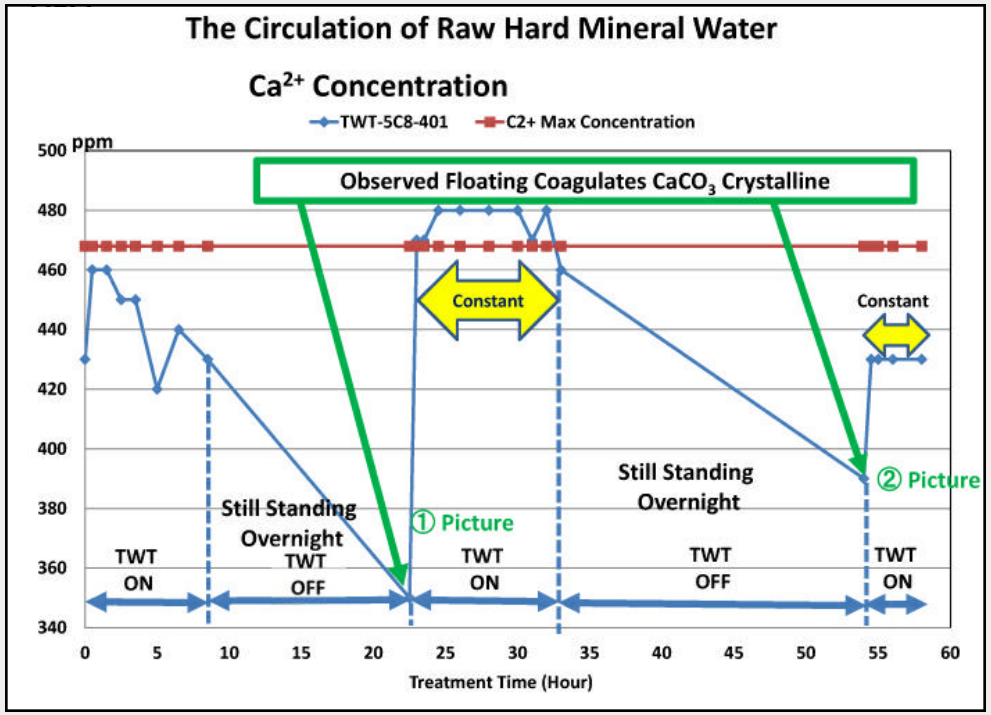
Electrical Conductivity

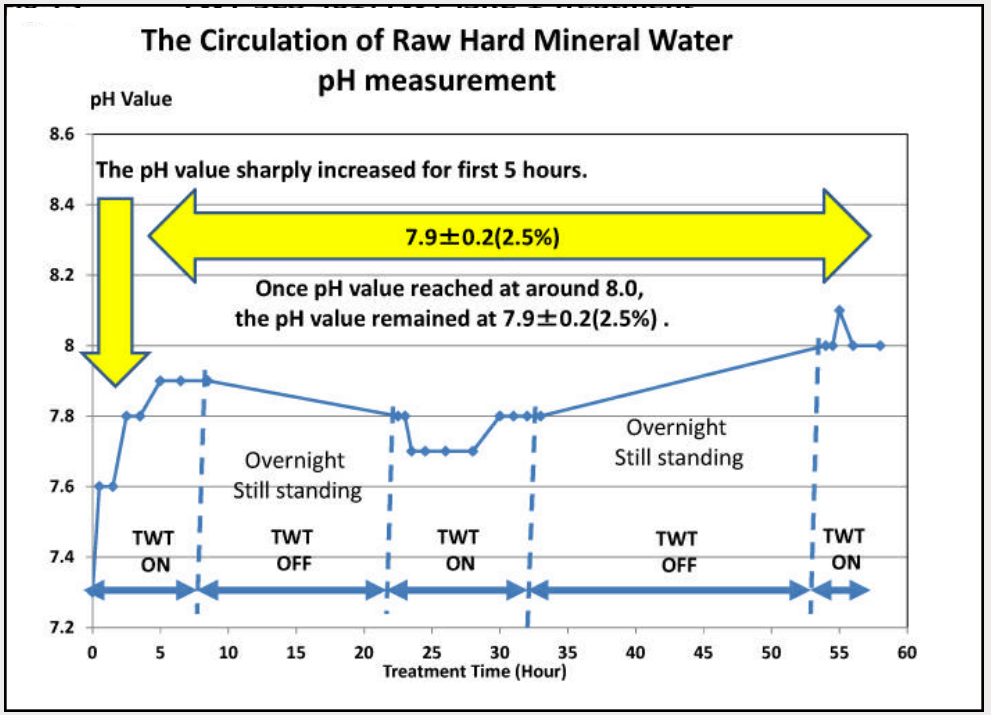
(the power of conducting, electricity, etc.)

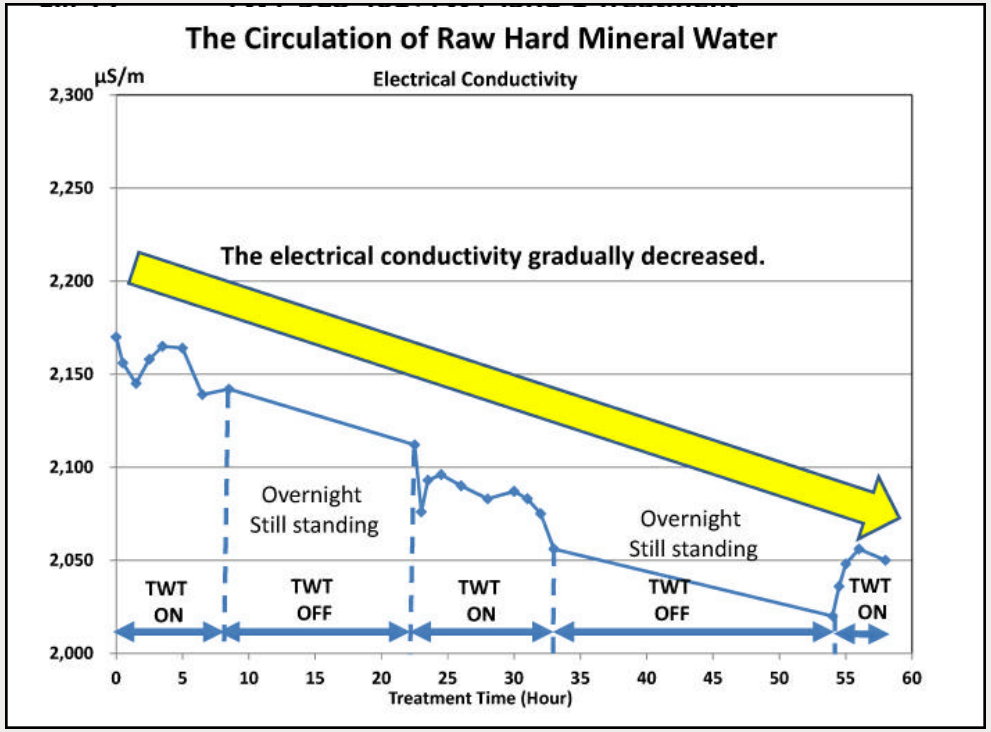
- The evidence shows the higher reduction rate of electrical conductivity may indicate higher generation rate of $CaCO_3$ crystalline particles

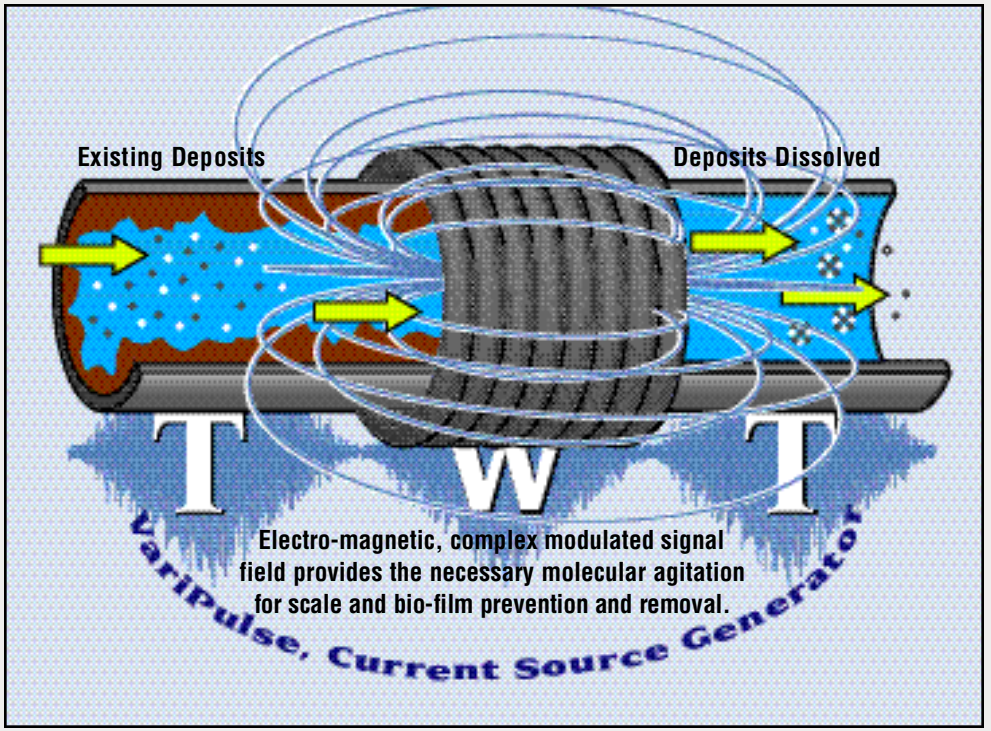
  The TWT® electromagnetic technology causes calcium ions to be generated in the solution. These ions when combined with carbonate, results in the calcium carbonate (scale) with a negative charge. This is then repelled by the negative charge on the pipe walls.

OVERVIEW OF TESTS









Conclusion: Test Results

Triangularwave patented deposit control technology: (Scale and bio-film, control, prevention & removal)

- Under flowing water solution with mineral ions, the scale formation is prevented by using TWT scale controllers (deposit control technology).
- The coagulates of $CaCO_3$ crystalline particles generated at the point where the water flow was stagnated. The coagulates of $CaCO_3$ particles never occurred under the water flow conditions.
- Once the water flow stagnates, the coagulation of $CaCO_3$ particles will take place.
- The best way to reject the coagulates of $CaCO_3$ is the electrocoagulation method.
- The TWT® systems performance is great in controlling & preventing scale.

Additional technical support materials and tests results available upon request

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Triangularwave Technologies Patented Deposit Control Technology has other potential applications in a wide range of industrial processes including transport, mixing and blending, size separation, dewatering, flotation, leaching, solvent extraction, ion exchange, electrolytic processes, chemical synthesis (compounds/structures), water reclamation and extraction of oil or sulfur from geological formations.

When installed in a process pipeline the Triangularwave Deposit Controller will:

- ***Reduce viscosity***
- ***Control fine particles (slime)***
- ***Enhance mixing/blending***
- ***Keep reactants or products in solution or suspension; reduce agglomeration and clogging of pipes, valves, fittings etc.***
- ***Enhance transport limited liquid-solid reactions***
- ***Provide a new chemical synthesis regime***
- ***Enhance water reclamation processes***
- ***Enhance performance of filtration equipment***
- ***Enhance performance of size separation equipment***
- ***Enhance dewatering process***

The Return On Investment of a TWT System is Undeniably Significant From Operational, Economical, and Safety Points-Of-View.

HARD DOLLARS SAVINGS- Chemicals, Salts Water & Energy

- Usage reductions of around 90% or more are typical.

- Water In - typically the HVAC industry concentration ratio can be increased from 2-3 to 6-8 (while still reducing the chemical consumption), indicating an annual make-up water savings of 70% or more. Savings would include conservation incentives.

- Water Out - volume of discharged water is reduced proportionately, along with the fees. Depending on actual chemical, salt use reduction and local laws, further savings may be possible if blow down water can be recycled and/or sent directly to the sewer system.

- Energy - systems have been found to deliver between 5 and 15 % energy savings when compared to a well functioning chemical system because the controller adapts to changes in water conditions without operator intervention. Energy savings can be much higher (up to 40 %) vs. a poorly performing chemical system or no chemical system at all.

SOFT DOLLARS - Materials, Labor, Time, Safety

- Chemical, salt handling and storage costs - reduced material and labor costs, freed-up storage space and cost allowance for increased safety (risk reduction). Reduction comparable to chemical cost reduction (up to 90 %).

- Maintenance, repair, replacement and downtime costs (chemical & salt delivery systems) - due to reduced usage rate. Reduction comparable to chemical and salt cost reduction (up to 90 %).

- Maintenance, repair, replacement and downtime costs (plumbing system, tower and cooling systems) - due in part to the adaptability described above under “Energy”. Cleaning of the system and/or during shut down is also generally easier with TWT technology, as any film on any surface can be easily removed with a soft cloth. Additionally, the lower level of chemicals in the system will make it safer for workers doing the cleaning (75 - 90 %).

LIFECYCLE SAVINGS

- Savings continue typically for 10 years or more from date of installation. Savings accelerate after the payback period and continue for the life of the system. Lifecycle savings are thus typically many times the cost of the TWT System.

HARD DOLLARS

- Can be estimated from purchase records or water volume and prices from the previous year.

SOFT DOLLARS

- Costs should be estimated based on the average of 10 years of data, or the age of the system if less than 10 years old, to smooth out the effect of infrequent repairs and replacements.

LIFECYCLE SAVINGS

- Are calculated as the net present value of the sum of the annual savings over 10 years using a reasonable interest rate (e.g. prime plus 2 %).

TYPICAL PAYBACK

- Payback is less than 2 years when considering ***HARD DOLLARS ONLY***.

Versatile Triangularwave Deposit Control Products & Systems To Effectively Meet The Needs Of Any Industry and Application

- ***Residential • Commercial***
- ***Industrial Control Scale Deposits/ Bacteria/ Corrosion/Algae/ Colloids In All Fluid Based Systems***
- ***Efficient, Cost Effective & Reliable***

The Green Market Answer!

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