# PREVENTING FORMATION OF WATER HARDNESS SCALE USING MAGNETIC WATER TREATMENT DEVICE IN SEMI-STATIC CONTAINER.

*Mark Queenan1, Steve Berenson 1,2,* 1.Queenan Chemical Corporation, Crystal River, FL, 2. Berenson Partners, (Krazy Klean Labs, LLC.) Miami, FL

*Keywords: Polarized; Calcium Carbonate; Ion, Crystal form; Calcite; Aragonite; Scaling; Water; Magnetic treatment*

***Abstract***

The purpose of this paper is to investigate the ability of the Krazy Klean Magnetic Water treatment device to prevent formation of hardness scale mineral in a semi-static hard water container. Magnetic water treatment is an important alternative to chemical treatment in preventing scale formation in industrial and home water systems. The Krazy Klean Magnetic Water Treatment Device testing and results were done at an ISO/IEC 17025:2017 accredited third-party laboratory utilizing X-Ray diffraction analysis. X-ray diffraction provides an easy way to distinguish between the two polymorphs of Calcium Carbonate aragonite and calcite.(1) Calcite causes surface scale build-up and staining while aragonite does not. This paper will explain how Krazy Klean strong applied magnetic field accelerates crystallization of calcium carbonate into aragonite preventing toilet tank and bowl surface scale and staining.

*Keywords: Polarized; Calcium Carbonate; Ion, Crystal form; Calcite; Aragonite; Scaling; Water; Magnetic treatment*

## I. INTRODUCTION

Water we use in our homes to drink, brush our teeth with, shower, wash our clothes and flush the toilet contain minerals. High levels of these minerals cause hard water. So, what is hard water? The term "hardness" was originally applied to waters that were "hard" to wash in because it prevents soap from lathering.

Hard water contains a high mineral count. Ground water often percolates through limestone where it picks up minerals like calcium, magnesium and also trace minerals like iron, gets picked up from the soil, lakes, rivers and from corroded plumbing. If your home gets water from a well, you most likely have hard water; however, it is not just a rural issue. The U.S. Geological Survey says 85% of homes in the nation have hard water. (2)

Minerals like calcium, magnesium and iron are not fundamentally harmful to your health. In fact, they are beneficial nutrients. The concern with high levels of minerals such as calcium is that they can leave hard water deposits or "scale" on the internal surfaces of your homes water pipes and cause numerous problems with your laundry, kitchen, bath, and toilet. Water hardness minerals typically causes the buildup of hardness scale and stain (as seen in this toilet bowl).

Hard water scale build-up can directly cause bacterial growth in residential plumbing systems including toilet tanks and bowls. This growth can cause foul odors and when the toilet is flushed a "toilet plume" of aerosolized water droplets can travel through the air up to 15 feet away, contaminating surfaces in the bathroom such as handwash sink handles, toiletries, etc. (3)

We know hard water is bad. How can it be prevented? A well established and proven method of removing hardness minerals is water softening. Water softener systems are proven to work. As hard water passes through a softener, hard water ions calcium and magnesium trade places with sodium ions. Sodium ions are replaced or "exchanged" by calcium and magnesium ions. During this process, "free" sodium ions are released into your homes drinking, cooking, washing, and bathing water. Water softener systems are expensive to buy and install with never-ending electricity, salt bag and system maintenance costs. Additionally, water used in recharging the system can overload or reduce the effectiveness of small septic or sewer systems. There may also be associated health risks from sodium intake. Compared to a water softener system, the PermaFlush Magnet Water Treatment Device is a fraction of the cost, requires no electricity, purchasing of salt and no maintenance.

Water is a polar liquid, which means that in each molecule, the atoms with their electrons and nuclei are arranged so that one part of the molecule has a positive+ electrical charge while the other part is negatively- charged. The Krazy Klean Magnet device brings a single positive (+) charge to the water. The change of the magnetic field causes the water molecules to rotate, in one direction or the other. In the presence of the Krazy Klean magnetic field, the positive charge physically configures the fluid so that the negative poles of the molecules are attracted to the magnetic source which creates a polarized (the positive and negative charge has been separated from each other) and linear structural reorganization of the molecules. (4)(5)
Figure 2 explains this phenomenon.

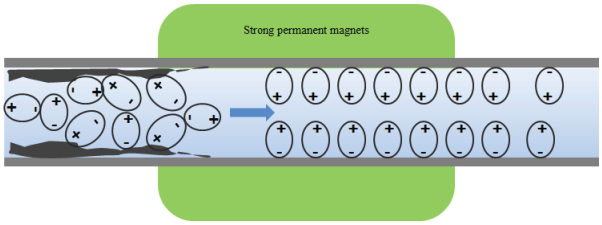



*Figure 2: Applied magnetic field effect on hard waters. As Hardness Minerals enter the Magnetic Field, because of their electric charge they are pushed in opposite directions.* (4).

The activated molecules now react like small magnets due to the Lorentz force which generates a magneto-hydrodynamics effect. (4)(5). The magnetic field increases the surface energy of the hardness minerals and keeps them small and highly soluble. Because they have become more soluble, they will increase their water content. In the case of hardness mineral calcium carbonate, the magnetic effect makes the crystals completely hydrated (saturated water) and changes them into a calcium carbonate polymorph called Aragonite. The increased water content causes the Aragonite to flock together forming larger needle shaped crystals which remain suspended in the water and do not stick to toilet tank or bowl surfaces. The electron micrographs in **Figure 3**. show carbonate deposits on the left (not magnetically treated water) and Aragonite deposits on the right.

(magnetically treated water). Notice how full and hydrated the polymorph Aragonite has become.

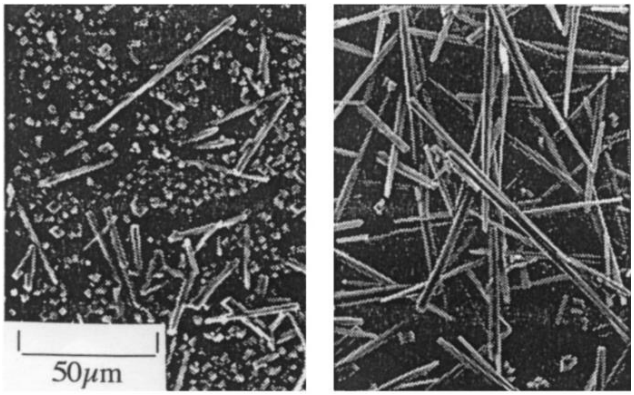



*Fig. 3. Electron micrographs of carbonate deposits from untreated (left) and magnetically treated (right) mineral water*(6).

In addition to preventing scale build-up the Krazy Klean Magnet Water Treatment Device has the ability over time to remove existing hard water scale and staining from surfaces by increasing the water content of the old limestone scale. The magnetic field weakens the build-up, dissolving into the polymorph Aragonite form, which can now be removed by flushing or rinsing. (7)(8)(9). Previous studies show that the polymorph Aragonite can persist in its form for up to 200 hours.

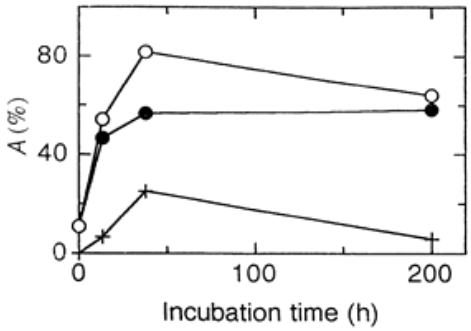



*Fig. 1. A set of data showing evolution of the aragonite ratio A with incubation time t* in untreated water (#), treated water (L) and the difference (d).(7).*

The magnetic treatment is reported to last up to hundreds of hours (7)

## II. MATERIALS AND METHODS

### MATERIALS

**a.** Siemens X-ray Diffractometer / Model 500 / Cu radiation.

**b. Chiller**

**c.** JADE Operating and analytical XRD application software.

**d.** Sample Slides – pre-cleaned microscope clear glass retrofitted.
**e. Fisher AR 20 pH meter**
**f.** Analytical Scale – Mettler AG 204
**g. 2L Beaker**
**h. Stir Plate and magnetic stir bars**
**i. Disposable pipette**
**j. 50mL plastic centrifuge tube**
**k.** Certified A.C.S Calcium Carbonate
**l. Tap Water**

**METHODS**

**a.** To access center of magnet device for sampling, the back of the device was widened and opened up to accommodate this as the 'As Received'.
**b**. Sample slides were cut to 1"x2" to fit into XRD sample holder dimensions.
**c.** 2 – 2L (0.5 gallons) beakers were filled with 1800mL tap water. The size of the beakers were chosen to replicate the size of 2021 dual toilet half flush that releases only 0.5 gallons of water to handle liquid waste.
i. One beaker was used as control with no magnet device and the other beaker contained the magnetic device.
**d.** Initial pH water taken and recorded to ensure pH was 7.0 – 8.0 range.
**e.** 27.0mg of Calcium Carbonate was weighed and added into each beaker and stirred until soluble in water. Hardness was measured to ensure that the samples would be strong enough to show results with both the control without the device and the sample with th device. Hardness was measured at 40 mg/L which is slightly hard. The goal was to ensure that the device would work even with slightly hard water.
**f.** Both beakers were left overnight with a very minimal calcium carbonate precipitating out after a 12-hour resting period.
**g.** Both control and sample water was kept stagnant during experiment with a 20 second agitation occurring right before samples were pulled. Agitation was done to mix water so a full beaker representation could be sampled. This mixing also simulates the flushing of a low volume toilet flush tank.
**h.** The magnetic device was placed into one of the beakers and the initial START (0 hours) samples were grabbed.
i. A disposable pipette was used to pull sample from in-between magnets for the beaker containing magnet device. All samples were pulled from between the magnets for duration of testing.
ii. For the control without the magnet device, all the samples were all pulled from center of beaker.
**i.** Pulled water samples were added dropwise to coordinating labeled glass slides and left overnight to dry.
i. Excess sample stored in 50mL plastic centrifuge tubes – useful if any issue with pulled samples occurred (i.e., broken slide, scan validation needed) without repeating the experimental process.
ii. The pH was taken and measured each time sampling occurred.
**j.** Sampling was conducted on both the control and the device within the beakers:
i. Start (0 hours), 1 hour, 2 hours, 4 hours, 6 hours, 6.5 hours, 24 hours & 72 hours.
**k. Dried samples were then tested on the XRD.**
i. Operating parameters: 40 kV and 30 mA // 0.02° step // 1.2° second per step
ii. Samples were scanned from 25° to 50° 2Θ
**1.** Shortened range used to narrow in and focus on Calcite 113 peak and Aragonite 221 peaks typically in the 40° - 46° 2Θ portion.
**m**. Scans were saved and analyzed with JADE Operating and analytical XRD application software.

**III. RESULTS**

As previously stated, magnetic water treatment increases the surface energy of the hardness mineral calcium carbonate, keeping them small and highly soluble. The increased solubility hydrates the calcium carbonate forming the polymorph Aragonite. Non-magnetically treated water from the calcium carbonate polymorph calcite, which is not soluble, does not become completely hydrated and will adhere to surfaces causing scale. To test the efficacy of the Krazy Klean water treatment device for Calcite and Aragonite formation, our third-party analytical chemistry lab used XRD (X-Ray Diffractometer) testing for the presence of Aragonite and the absence of calcite.(1).
The following XRD slides show at the Start (0 hours) the WITH and WITHOUT Krazy Klean device samples had no Calcite or Aragonite peaks present. **See Figures 5 and 6 below.**

**Figure 5.**

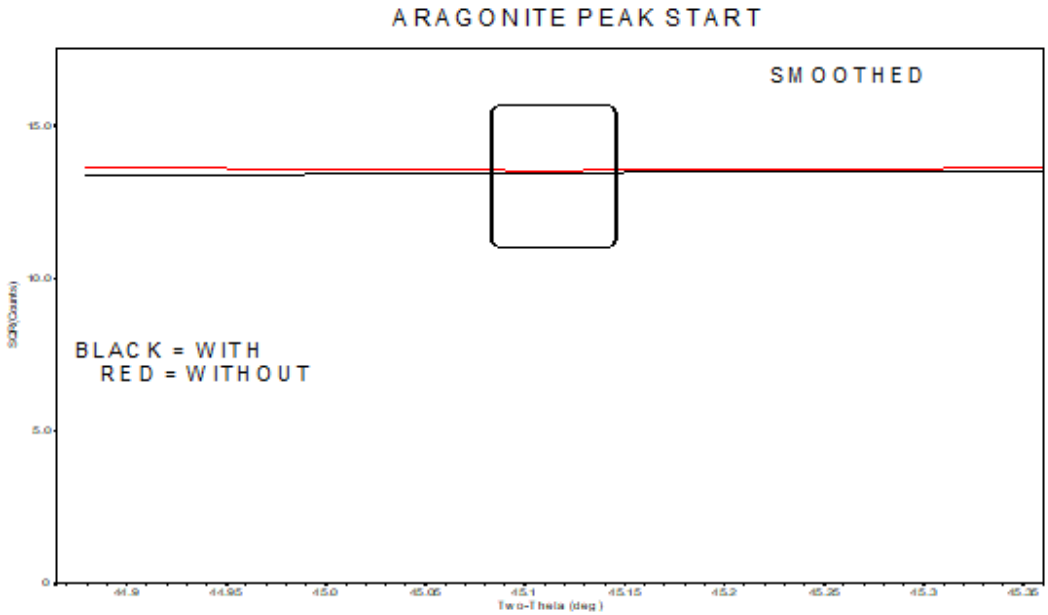
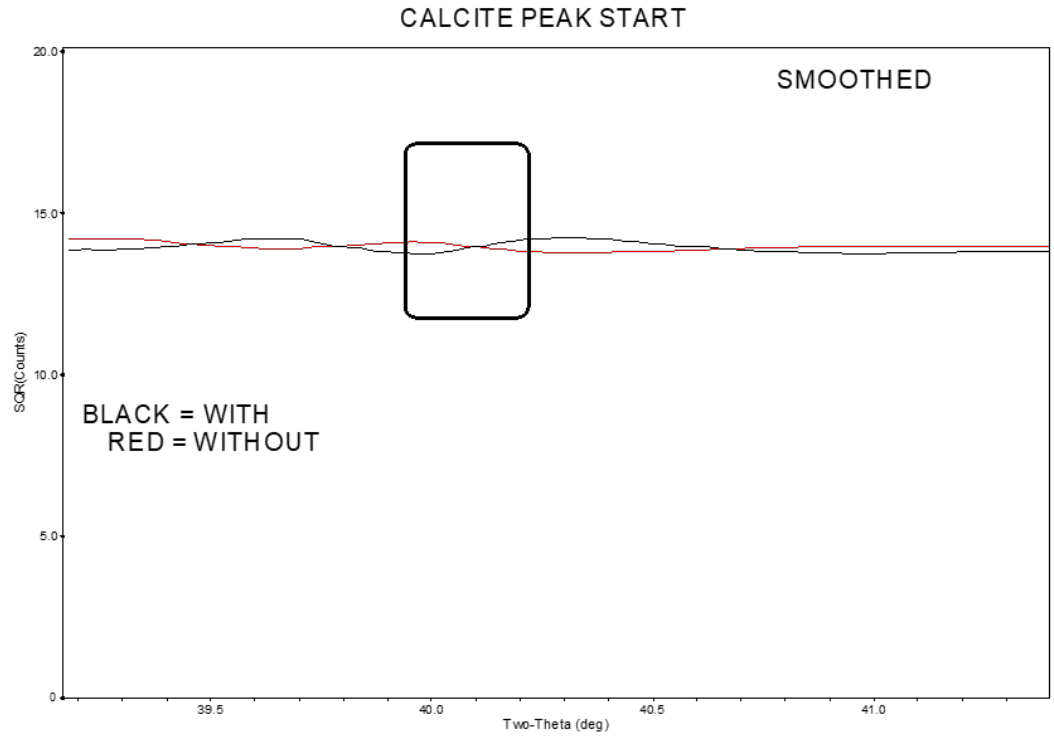



**Figure 6.**




The 5.5 hours scan WITHOUT sample slide clearly

shows the Calcite 113 peak while containing no Aragonite 221 peak **as seen in Figure 7 below.**

The 5.5 hours scan WITH the Krazy Klean device scan shows no Calcite 113 peak while the Aragonite 221 peak is clearly present **as seen in Figure 8 below.**

**Figure 7.**

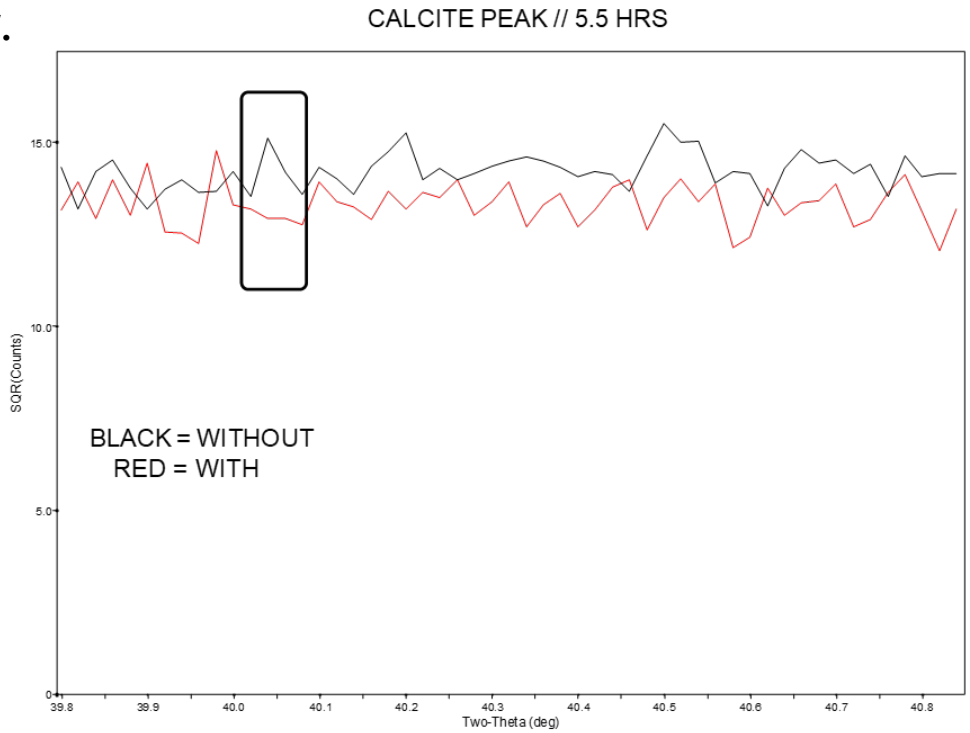
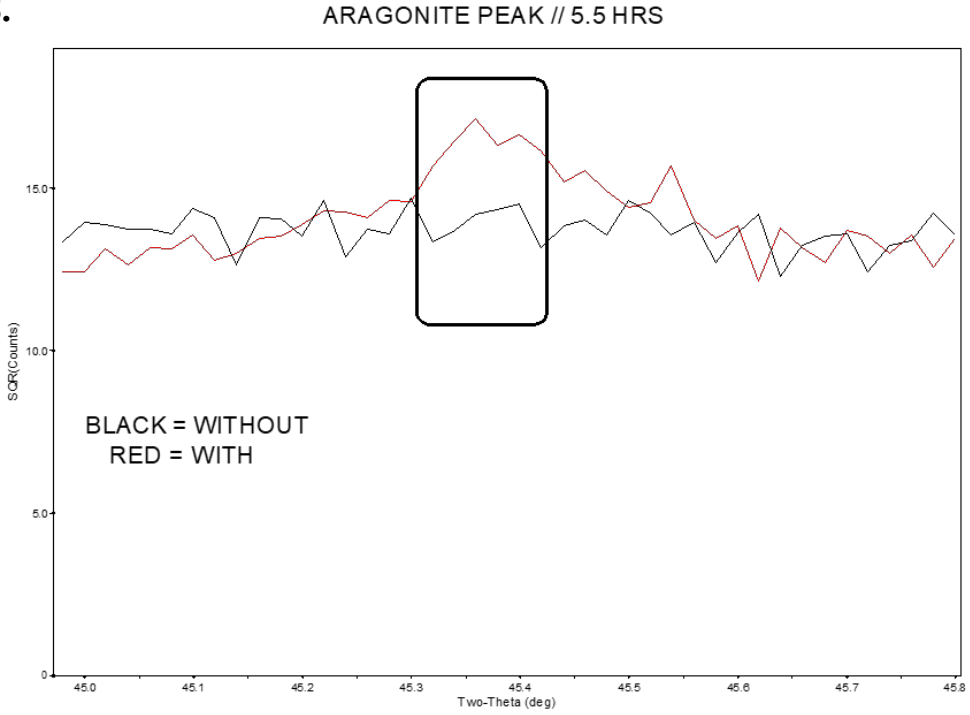



**Figure 8.**



## V. CONCLUSIONS

Duplicate testing was conducted. First testing was concluded on January 4th, 2021, and the second testing was concluded on March 21st, 2021. Both test dates clearly show how the strong influence of Krazy Klean Magnet Water Treatment Device's magnetic field increases the surface energy of the hardness minerals and keeps them small and highly soluble, leading to a completely hydrated (saturated water) calcium carbonate polymorph called Aragonite. The increased water content causes the Aragonite to form hydrated needle shaped crystals which remain suspended in the water. The Aragonite crystals stay suspended in water and do not adhere to toilet bowl and toilet bowl surfaces. The suspended Aragonite crystals are now easily flushed or rinsed away. The benefit of using the Krazy Klean Magnet Water Treatment Device is prevention of hard water scale build-up and staining, prolong life of toilet, time and money savings by eliminating hazardous cleaning chemicals, conserves water, safe for adults, children, and pets.

## V. ACKNOWLEDGMENT

The authors would like to acknowledge Clark Testing Laboratories located in Jefferson Hills, PA for giving us the opportunity to work with your highly skilled and professional team.

## VI. REFERENCES

1. X-ray diffraction (XRD) of aragonite and calcite. Railsback's Some Fundamentals of Mineralogy and Geochemistry. http://railsback.org/Fundamentals/A&CmixturesXRD01.pdf

2. https://www.usgs.gov/special-topic/water-science-school/science/hardness-water?qt-science_center_objects=0#qt-science_center_objects

3. https://www.wqpmag.com/scaling-back-bacteria; https://www.businessinsider.com/flushing-toilet-seat-up-sprays-water-germs-2016-3

4. Existing Scale Deposits Removal by Magnetic Water Treatment: Theoretical Study and Experiment M.Y. El Hafidi* and M. El Hafidi. International Journal of Water and Wastewater Treatment. Research Article Volume: 3.3

5. Explaining the Lorentz Force Using Magnetic Lines of Force. Maxwell's Fluid-Mechanical Approach D. Marett (2013). http://www.conspiracyoflight.com/Lorentz/Lorentzforce.html

6. Magnetic water treatment J.M.D. Coey*, Stephen Cass Physics Department, Trinity College, Dublin 2, Ireland. Journal of Magnetism and Magnetic Materials 209 (2000) 71}74.

7. Sohaili J, Shi HS, Lavania-Baloo, Zardari NH (2016) Removal of scale deposition on pipe walls by using magnetic field treatment. J Cleaner Produc 139: 1393-1399.

8. C. Jack Quinn 1997, Magnetic treatment of water prevents mineral build-up, Iron and Steel Engineer, 47-53.

9. Magnetic water treatment J.M.D. Coey*, Stephen Cass, Physics 11. Department, Trinity College, Dublin 2, Ireland. Journal of Magnetism and Magnetic Materials 209 (2000) 71}74

10. Kotb A, Abd El Aziz A. M, 2013. Scientific investigations on the claims of the magnetic water conditioners, Annals of Faculty of Engineering, Hunedoara-International Journal of Engineering, 147-157.