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THE SCIENCE BEHIND MAGNETIC WATER CONDITIONING

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Water is the most necessary substance for life. In fact, living creatures — like spas and pools are basically vessels for liquid water. Because we work in an industry that relies so heavily on sanitized water, it is imperative that we strive to understand how water reacts under various conditions. This is not always an easy task, as liquid water refuses to follow some of the most fundamental laws of nature. It is the one substance that turns into something lighter when it crystallizes-which is why ice floats. And even when liquid water cools down to near freezing it violates one of the basic rules that heat rises and expands things. As water cools down below 39 degrees Fahrenheit, it does not shrink, it expands! It expands so much that the coldest water moves to the top, above warmer water! That's why freezing starts on the top of the water. We should be happy it does that. Because of this solid layer of water on top, the rest of the water is insulated.

Another weird water fact is that it accepts more heat energy than its normal share-a great benefit to life. Indeed no other substance can transport as much heat energy. That's how liquid water normalizes the temperature extremes in out living zones-it absorbs heat when there is too much, and it releases heat if there is not enough.

HARD WATER FACTS

The list of the anomalies in the behavior of liquid water could be continued on and on. But we have to consider one more: Although water, chemically neutral, it is one of the best solvents known to man. Water has the capability to entrap other substances. In other words, it tends to cluster around every non-water particle, forming conglomerations or complexes, as they are called scientifically.

Water's capacity to entrap substances results in its high mineral content. The amount of these dissolved minerals being carried by the water determines its hardness. One of the most common minerals in water is calcium carbonate, a substance that forms mountain ranges such as the Alps. When liquid water evaporated the dissolved minerals become over concentrated and must crystallize. This also happens when the temperature of the water increases, or when the solubility of the carbonates in the water decreases. The consequence is a sediment of those minerals on the walls of the container — in our case spas and pools.

These sediments of minerals that grown on the container walls are actually limestone, which is hard and difficult to remove. Very hard water can produce these hard sediments with bad consequences. Unfortunately, this process is a slow one and cannot be recognized immediately. Nevertheless, the effects of hard water are quite noticeable if left to build up over time. Today the water lines that the Romans had used for hundreds of years show accumulations of hard lime scale many inches thick, as in the beautiful Pont du Gard in southern France, for instance.

But it only takes a few years for hard lime scale to take its toll on water pipes and equipment. Such sediment layers in heaters hinder the transfer of heat.

For swimming pools, the removal of existing hard lime scale is usually accomplished by an acid wash, which interrupts the operation of the system. Furthermore, the acid can attack pool walls and open up leaks.

Most water supplied by water districts in the United States is well cared for, analyzed chemically and rendered clean enough for drinking. Most of it contains a good amount of calcium content. This is important for proper taste and a healthy mineral balance. However, it tends to create deposits of scale over the years if no preventative measures are taken.

ROOT OF THE PROBLEM

Preventing scale can also be accomplished via water softeners, which work as ion exchangers. They take the calcium carbonate and replace it with sodium. The resulting water is not recommended for drinking because of the sodium content. And used in larger amounts, it also adds salt to the groundwater. Other chemical additives may rid the water of calcium carbonate, but only by risking contamination.
If one is serious about finding a cure for an undesired condition, it is essential that he or she find out what the source of the problem is. In the case of hard lime scale, the reason for it's formation is easy to understand with a few basic laws of crystallography.

The change from the dissolved calcium carbonate to lime scale is a phase change from liquid to crystalline. Any phase change needs a starting point. Most of the time a piece of a different material may serve as such a starting point. Such a piece can be extremely small, like a speck of dust, a super molecule or tiny solid particle. If such starting points are not available in the water, the crystallization can start only at the materials that make up the container walls. The crystallization grows in layers until it becomes lime scale.

Fig. 1, Microscopic photograph of unconditioned hard water showing "dendritic" crystal scale formation.

Fig. 2, The same water as in Fig. 1 after having moved through magnetic fields with nearly 100% effectivity.

Once we know what causes lime scale, the means of prevention seem obvious. We have to provide the necessary crystallization points for the minerals in the water so that the minerals do not wander to the container walls to find crystallization points.

How can we do that? By creating a disturbance in the water that produces crystallization centers for the minerals.

Actually, most water contains huge amounts of such centers. Almost all of these potential centers however are entrapped by the water-molecule complexes and cannot act as crystallization centers. Therefore, we have to break a few of these complexes so that their internal captive particles become free. Once free, they act as centers for mineral molecules and form microcrystals. That leaves less calcium carbonate to form hard scale on the walls.

MAGNETIC CONNECTION

Fortunately, an entire arsenal of complex-busting techniques is available. The disturbance can be mechanical whirling, sonic disturbance, electrical frequencies and magnetic disturbances. They all reduce the formation of hard lime scale to some extent. Lately, magnetic devices have become more and more popular for a number of reasons.
Permanent magnet materials have been developed in recent decades to be 100 times as strong and much more durable then the old-fashioned magnets made out of steel. In contrast to steel magnets, which weaken with age, modern ceramic magnets do not show any changes with age. They keep their forces so precisely stable that nuclear submarines base their subpolar, under-ice navigation on instruments depending on the accuracy of the permanent magnets. So, once they are magnetized, permanent magnets never need recharging or an energy source, which makes their use most convenient and unfailing.

The effects of magnetic fields on running water have been observed long before these better magnets were developed. Patents on treatment of water with magnets appeared as early as the 1950s. Though these magnets were not very strong, their effects were described as making the water appear to behave as if it was soft, as if its mineral content was lowered. Noticeably less scale was produced after prolonged use.

EASTERN INFLUENCE

This technology was used mainly in eastern countries, which were lacking a competent and reliable chemical industry. Hundreds of reports have popped up in Russia, China, Poland and Bulgaria detailing the successful use of mag-

nets to treat water.
Lacking any chemical means of softening the water, these countries used magnets to treat water for irrigation and industrial uses, as well as for personal use, where improvements of taste and faster drying were reported. Many attempts to explain the reasons for the observed effects were made without much success. Also methods of measuring the effects remained unsatisfactory.

In western countries the use of magnetic water treatment methods developed much more slowly. Water softening by chemical means was in general use and the difficulties of explaining and measuring magnetic effect on flowing water kept it suspect in western minds. In addition the chemical industry tried to discourage its utilization for obvious reasons.

However, the practical effects of magnetic water treatment were undeniable after prolonged use. A number of companies took advantage of the situation in western countries to market magnetic devices for water treatment, often equating magnets with magic or mysticism.

But there is no mystique in how magnets work to treat water problems. For example, the agriculturally oriented California State Polytechnic University in Pomona, Calif., Pioneered the reuse of irrigation water by using magnetic water treatment devices. The positive effects of magnets on water was confirmed in the 1980s through systematic research. With the scientifically sound knowledge of the processes involved, it was then possible to develop treatment devices with the newest permanent magnets. Also a quantitative method evolved for evaluating the effectiveness of the devices.

NEW TECHNOLOGIES

The new devices had a great effect on water treatment. Not only was the formation of scale totally eliminated, the removal of scale deposits in old water pipes could be accomplished in relatively short times. This had taken years with the older devices.

How can magnets do that? How can they provide nucleation centers in the water? The shortage of nucleation centers in the water is known to inhibit the capability of the water molecules to cluster around each foreign particle, rendering it unavailable as a nucleation center. The forces of the magnetic fields on those water molecule clusters is very weak. However the clusters vibrate in a number of ways. When they pass a number of magnetic poles at a certain velocity the periodic changes of the magnetic fields may coincide with one of the internal vibration frequencies of the water cluster. Resonance may occur and result in cracking open such a cluster. The formerly entrapped particle is set free, and the nearby mineral molecules rush from all sides to their nucleation center, where they form platelets.

The minerals that form the circular platelets do not have to crystallize on a

container wall. In turn, the number of hard crystals is reduced accordingly. This percentage reduction is the magnetic treatments effectiveness rating.

Since a method of quantitatively determining the effectiveness of the magnetic devices was developed, manufactures have been able to maximize their efficiency for industrial and residential use. Today, there are basically two types of magnetic water treatment devices: One is built into the pools circulation system, while the other simply attaches to any pipe within the pools circulation system. In-line devices are usually more effective than the clamp-on variety. But naturally, the clamp-on units are easier to install and are the most desirable for water systems that circulate, like a pool, thus giving the water repeated treatment over time.

Dr. Klaus J. Kronenberg is a world-renowned physicist specializing in the study of permanent magnets.

The science behind magnetic water conditioning
By Dr. Klaus Kronenberg, Ph.D., from an article reprinted from Aqua Magazine, August 1993

Hard lime and scale forms where ever tap water evaporates or is heated. While it may not be noticeable for a long time, there are commercial appliances that show a white deposit after only a few days of use. Steam cleaners, for instance, may become inoperable after two weeks due to heavy scale deposits. They have to be washed often with acid in order to avoid filter clogs. Also, dishwashers in restaurants need to be freed from the white scale deposits regularly. In the average residential home, it may take a couple of years until a layer of hard scale reduces the cross section of water pipes significantly. And in swimming pools a rough band of sediment often develops along the waterline, which may require mechanical grinding to be removed.

In many cases where the water has a high iron content, the scale deposits develop brownish tint. They may even acquire a deep brown color, as is often evident in toilet tanks. In dairy operations, fatty substances often mix with the sediment and create “butter stone.” In regards to cooling towers, circulating water may mix with algaecides, and the ensuing deposits may be toxic. These examples indicate that lime scale may contain more then calcium carbonate. Other minerals dissolved in the water solidify, as well, and can produce unsightly or even dangerous substances.

USING MAGNETS

Fortunately, a well designed magnetic treatment device will prevent such deposits from developing, as long as it is sized for the maximum water flow capability of the particular plumbing system. Safety inspections may be required, but in most cases inspection reveals nothing more than and accumulation of sludge, which can be removed easily.

Recently, a pool builder inspected my 30 -year-old pool, which has been fitted with simple magnetic water treatment device that is clamped on one of the lines between the pump and the filter. He was astonished to feel not a trace of roughness on the waterline tiles, and he could hardly believe that we did nothing to clean the tiles since last summer.

During the resurfacing of my driveway, a small bulldozer happened to rip one of the feed lines for the lawn sprinklers out of the ground. A young plumber replaced the old galvanized iron piping with new PVC tubing. The next day he returned and asked my permission to saw off a little piece of the old pipe. The reason: He wanted to show his father, a long time plumber, that it was possible for the outside of a water pipe to accumulate a thick crust of rust deposits while the inside of the 30-year-old pipe was without any substantial deposits.

But how could the old water tubes of my sprinkler systems be free of the interior deposits? After all, these tubes had been in the ground for 18 years before I had magnetic water treatment device attached to the house's water supply line. At that time lumpy hard deposits of reddish brown stones had already reduced the inner diameter of the 1-inch piping to less than 3/4 inch.

The removal of these hard deposits was rather dramatic. On Feb. 28 1982, when the magnetic device was installed on my house, I had opened all the faucets, toilet flushers, drains and garden hose outlets. Soon I found it necessary to remove all faucet strainer heads because the brown water emerging carried lumps of brown matter with it. It took about 4 hours until the emerging water had become colorless and ran steadily.

This event can be explained using the same facts about crystallization in water that were detailed in part one of this column. The only difference between magnetically treated water and untreated water is that magnetically treated water enables minerals to crystallize in the water instead of on the surface of some pipe or container. As a result we have converted the water formerly saturated with dissolved minerals into a mixture of solid microcrystals and clean water. When this purified water flows past other minerals it is capable of dissolving a new load of minerals.

Fig. 1, Microscopic photograph of unconditioned hard water showing "dendritic" crystal scale formation.

Fig. 2, The same water as in Fig. 1 after having moved through magnetic fields with nearly 100% effectivity.

In large industrial installations, like cooling towers, this process is evident as large chunks of old lime scale break off the walls. The treated water does not dissolve the old scale only from the outer surface: it penetrates between the scale and the wall. This area is the weakest part of the scale, so the water can

split the crystalline matter from the container wall. The dramatic speed of this process made some precautions necessary. In order to avoid clogs, filters and strainers should be temporarily taken out of the circulation system.
Clamp-on magnetic units typically have an efficiency rating off 20 to 40 percent although they are capable of removing old lime scale, this may take several weeks. But because they also prevent the formation of new scale, the units are always producing some benefit.

Corrosion prevention is another benefit of magnetic water treatment. Periodic acid washing of a pool is one of the reasons for the metal corrosion. In some cases, after long periods between acid washings, the hard deposits may cover up some weak spots, which turn into leaks when the deposits are dissolved by the next acid wash. Because magnetic water treatment makes acid washes unnecessary, a major cause of corrosive damage is eliminated.

Also after a long period of magnetic water treatment, the interior of pipes becomes covered with a thin continuous coating. This layer does not change over the years. Analyzed by a number of scientific institutes, it has been determined to be a corrosion preventing inert substance. In one case, it was found to be aluminum silicate.

The Steinbeis Institute in Reutlingen, Germany, has devoted years of research to the study of corrosion and has published numerous articles outlining the corrosion reduction experienced with water systems treated with magnetic devices.

IMPROVING WATER'S IMAGE

Effectively treated water looks sparkling clear, even if the water supply is murky. Some water experts claim they can recognize a specific silky appearance of magnetically treated water. This might be due to the multitude of microcrystals, which can reflect sunlight. The developing microcrystals, however are so small that they are visible only with high magnification.

In regards to smell, water that comes with a slight sulfur odor loses this smell after being treated with magnetic devices. Of significant interest to this industry, the chlorine odor of chlorinated water is greatly reduced by effective magnetic treatment. In fact, slight chlorination may become unnoticeable to the average user.

For aromatic brews such as teas or coffees, the desired aromas can be achieved with fewer ingredients if the water is effectively treated. The ensuing aromas appear cleaner to perceptive noses. It is said that in some eastern countries — China for instance — many people heat their tea water in a pot containing a magnet.

OTHER EFFECTS

One of the most obvious effects of magnetic water treatment is the enhanced ability of most cleaning chemicals and detergents. Magnetically treated water increases their effectiveness to the point where just one-third or even one-fourth of the cleaning agent is needed. In the cases of naturally contaminated water from lakes, an intense magnetic treatment has made the lake water fit for human consumption.

Magnetically treated water runs off a cleaned surface faster and in thinner sheets because surface tension is reduced. As a result one sees fewer water spots from drying. This has been applied successfully for the watering of decorative plants by sprinklers.

Surface tension in water is critical to biological life. Surface tension makes water rise in the fibers of the plants. It fills the capillaries in your body and it determines water's ability to penetrate soil and other materials. Therefore it is not surprising that wherever magnetic water treatment has been practiced, growth patterns have changed. Experiments with groups of growing farm animals and agricultural plants have been conducted at universities and federal institutions with stunning results. Some were hard to believe, so the scientists were reluctant to publish them immediately, pending confirmation.

Following are some of the results of scientific research:

At a California university, two control groups of piglets of 24 piglets each with normal feeding were compared with two groups of 24 piglets that were getting their water from a magnetic treatment device. The latter groups consumed twice as much water and grew an average 12.5 percent faster.

Cotton plantings with various irrigation were compared in California. The cotton plants irrigated with magnetically treated water grew to larger sizes with larger and denser foliage. However, they produced one-third less cotton than the control plantings.

A Washington navel orange tree watered with the magnetically treated water carried less fruit, but each orange became unusually thick and juicy, weighing 20 ounces on average. Similarly, a Eureka lemon tree fed magnetically treated water carries lemons that grow up to one pound each.

One biologist suggests that the slightly reduced surface tension of the magnetically treated water may facilitate its penetration of cell walls. This could accelerate the normal dividing of the cells in growing parts of living individuals. This would account for the faster vegetative growth and the reduced reproductive cell division responsible for the number of flowers and fruit.

The accelerated growth of plants by the use of magnetically treated water is possible because the root tips secrete enzymes that dissolve crystals in the ground, enabling the roots to ingest the dissolved minerals. This is not the case for one-cell organisms that pollute pool water. Algae and bacteria have

to ingest their food directly through their cell wall. They get plenty of water through it, but they cannot receive any nourishment in the form of crystallized minerals, which cannot penetrate the cell walls. Thus, bacteria in magnetically treated water starve.

Observations on swimming pools confirm this effect. The normal chlorine content of treated of swimming pools can be reduced by at least half if the water is efficiently magnetically treated. Even without any chlorination , no algae growth can be detected for about 36 hours. This is the normal duration of the affectivity of the magnetic treatment. After one to two days, the microcrystals formed by the treatment start to redissolve. After this time, a vigorous growth of algae occurs in the non-chlorinated pool if it is not replenished with treated water.

In short a swimming pool benefits by the application of magnetic water treatment for a number of reasons: Because the pool already has a circulation system, installing a magnetic clamp-on device is simple.

Chlorine content can be reduced by at least half, and chlorine odor is further reduced because much of the chlorine is incorporated into the microcrystals,which we cannot smell.

The treated water does not produce sediments on the pool's waterline.

No hard lime scale develops in the circulation system — neither in the filter nor in the heater.

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