Magnetic Water “Treatment”

According to some magnet vendors, magnets can be used to improve blood circulation, cure and prevent diseases, increase automobile mileage, improve plant growth, soften water, prevent tooth decay, and even increase the strength of concrete. This article focuses specifically on the claimed benefits of magnetically treated water and fuel.

Most magnetic water treatment systems are marketed through independent distributors who sell out of their homes. An Internet search using the keywords *magnetic treatment* reveals dozens of independent distributor home pages. Very few such devices are offered by national chain stores or advertised in mail-order catalogs. Possibly, the magnetic-device manufacturers sell through independent distributors to insulate themselves from some of the more exotic claimed benefits of magnetic treatment, or perhaps consumer and wholesaler skepticism has kept magnetic treatment out of mainstream retail. Regardless of the reasons, magnetic water and fuel treatment devices are not usually available at the local hardware or automobile parts supply store. This lack of wide availability has given magnetic water and fuel treatment a sort of fringe-science status in the minds of many consumers.

Claimed Benefits and Effects

Magnetic water treatment devices consist of one or more magnets, which are clamped onto or installed inside the incoming residential water supply line. Typical costs are $100 to $600. The claimed benefits of magnetic water treatment vary depending on the manufacturer. Some claim only that magnetic treatment will prevent and eliminate lime scale in pipe and heating elements; others make additional, more extravagant claims. Some of the additional claims include water softening, improved plant growth, and the prevention of some diseases in people who consume magnetically treated water. The distributors of these devices rarely cite any documented test results that validate these claims. Instead, they rely on numerous testimonials, lists of corporations and municipalities that purportedly use the devices, and scientific-sounding explanations of magnetic water and fuel treatment.

Magnets and Magnetism

To many people, magnets are a complete mystery. Vendors of magnet-based scams often use this ignorance to their own advantage, so a familiarity with the basics of magnetism can aid in the detection of dubious claims.

Magnetic fields are produced by the motion of charged particles. For example, electrons flowing in a wire will produce a magnetic field surrounding the wire. The magnetic fields generated by moving electrons are used in many household appliances, automobiles, and industrial machines. One basic example is the electromagnet, which is constructed from many coils of wire wrapped around a central iron core. The magnetic field is present only when electrical current is passed through the wire coils. Permanent magnets do not use an applied electrical current. Instead, the magnetic field of a permanent magnet results from the mutual alignment of the very small magnetic fields produced by each of the atoms in the magnet. These atomic-level magnetic fields result mostly from the spin and orbital movements of electrons. While many substances undergo alignment of the atomic-level fields in response to an applied magnetic field, only ferromagnetic materials retain the atomic-level alignment when the applied field is removed. Thus, all permanent magnets are composed of ferromagnetic materials. The most commonly used ferromagnetic elements are iron, cobalt, and nickel.

The strength of a magnet is given by its magnetic flux density, which is measured in units of gauss. The earth's magnetic field is on the order of 0.5 gauss (Marshall and Skitek 1987). Typical household refrigerator magnets have field strengths of about 1,000 gauss. According to the distributors, the magnets sold for water and fuel treatment have magnetic flux densities in the 2,000 to 4,000 gauss range, which is not unusually strong. Permanent magnets with flux densities in the 8,000 gauss range are readily available. The magnets sold for magnetic fuel and water treatment are nothing special; they are just ordinary magnets.

Water Hardness

The phrase *hard water* originated when it was observed that water from some sources requires more laundry soap to produce suds than water from other sources. Waters that required more soap were considered "harder" to use for laundering.

Water "hardness" is a measure of dissolved mineral content. As water seeps through soil and aquifers, it often contacts minerals such as limestone and dolomite. Under the right conditions, small amounts of these minerals will dissolve in the ground water and the water becomes "hard." Water hardness is quantified by the concentration of dissolved hardness minerals. The most common hardness minerals are carbonates and sulfates of magnesium and calcium. Water with a total hardness mineral concentration of less than about 17 parts per million (ppm) is categorized as "soft" by the Water Quality Association (Harrison 1993). "Moderately hard" water has a concentration of 60 to 120 ppm. "Very hard" water exceeds 180 ppm.

Hard water is often undesirable because the dissolved minerals can form scale. Scale is simply the solid phase of the dissolved minerals. Some hardness minerals become less soluble in water as temperature is increased. These minerals form deposits on the surfaces of water heating elements, inside hot water pipes and around plumbing fixtures. Scale deposits can shorten the useful life of appliances such as dishwashers. Hard water also increases soap consumption and the amount of "soap scum" formed on dishes.

Many homeowners and businesses use water softeners to avoid the problems that result from hard water. Most water softeners remove problematic dissolved magnesium and calcium by passing water through a bed of "ion-exchange" beads. The beads are initially contacted with a concentrated salt (sodium chloride) solution to saturate the bead exchange sites with sodium ions. Rock salt is added to a reservoir in the softener for this purpose. Ion-exchange sites have a greater affinity for calcium and magnesium, so when hard water is passed through the beads, calcium and magnesium ions are captured and sodium is released. The end result is that calcium and magnesium ions in the hard water are replaced by sodium ions. Sodium salts do not form scale or soap scum, so the problems associated with hard water are avoided. Ion-exchange water softeners are capable of reducing the hardness of the incoming water supply to between 0 and 2 ppm, which is well below the levels where scale and soap precipitation are significant.

Magnetic Water Treatment

Magnets are placed inside or to the exterior surface of the incoming water pipe. The water is exposed to the magnetic field as it flows through the pipe between the magnets. An alternative approach is to use electrical current flowing through coils of wire wrapped around the water pipe to generate the magnetic field.

Purveyors of magnetic water treatment devices claim that exposing water to a magnetic field will decrease the water's "effective" hardness. Typical claims include the elimination of scale deposits, lower water-heating bills, extended life of water heaters and household appliances, and more efficient use of soaps and detergents. Thus, it is claimed, magnetic water treatment gives all the benefits of water softened by ion-exchange without the expense and hassle of rock-salt additions.

Note that only the "effective" or "subjective" hardness is claimed to be reduced through magnetic treatment. No magnesium or calcium is removed from the water by magnetic treatment. Instead, the claim is that the magnetic field decreases the tendency of the dissolved minerals to form scale. Even though the dissolved mineral concentration indicates the water is still hard, magnetically treated water supposedly behaves like soft water.

According to some vendors, magnetically softened water is healthier than water softened by ion exchange. Ion-exchange softeners increase the water's sodium concentration, and this, they claim, is unhealthy for people with high blood pressure. While it is true that ion-exchange softening increases the sodium concentration, the amount of sodium typically found even in softened water is too low to be of significance for the majority of people with high blood pressure. Only those who are on a severely sodium-restricted diet should be concerned about the amount of sodium in water, regardless of whether it is softened (Yarows et al. 1997). Such individuals are often advised to consume demineralized water along with low-salt foods.

There is apparently no consensus among magnet vendors regarding the mechanisms by which magnetic water treatment occurs. A variety of explanations is offered, most of which involve plenty of jargon but little substance. Few vendors, if any, offer reasonable technical explanations of how magnetic water treatment is supposed to work.

The important question here, though, is whether magnetic water treatment works. In an effort to find the answer, I conducted a search for relevant scientific and engineering journal articles. I describe the results of this search below.

More than one hundred relevant articles and reports are available in the open literature, so clearly magnetic water treatment has received attention from the scientific community (e.g., see reference list in Duffy 1977). In nearly all cases researchers report finding no significant magnetic treatment effect.

The most important question for consumers, is whether the magnetic water treatment devices perform as advertised. Some commercial devices have been subjected to tests under controlled conditions.

- Duffy (1977) tested a commercial device with an internal magnet and found that it had no significant effect on the precipitation of calcium carbonate scale in a heat exchanger.

- A study of a commercial magnetic water treatment device was conducted by Hasson and Bramson (1985). Under the technical supervision of the device supplier, very hard water (300 to 340 ppm) was pumped through a cast-iron pipe, and the rate of scale accumulation inside the pipe was determined by periodically inspecting the pipe's interior. Magnetic exposure was found to have no effect on either the rate of scale accumulation or on the adhesive nature of the scale deposits.

- *Consumer Reports* magazine (December 1996) tested a $535 magnetic water treatment device from Descal-A-Matic Corporation. Two electric water heaters were installed in the home of one of the *Consumer Reports* staffers. The hard water (200 ppm) entering one of the heaters was first passed through the magnetic treatment device. The second water heater received untreated water. The water heaters were cut open after more than two years and after more than 10,000 gallons of water were heated by each heater. The tanks were found to contain the same quantity and texture of scale. *Consumer Reports* concluded that the Descal-A-Matic unit was ineffective.

Does magnetic water treatment perform as well as ion-exchange treatment? Definitely not. At present, the conventional water softening technologies are clearly much more reliable and effective. Further, the initial cost of an ion-exchange water softener (around $500) is comparable to that of many magnetic treatment systems.

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