



## Junk science in the marketplace

Magnetic water treatment, as discussed in the MagScams page, has been around for some time. During the 1990s, a number of water treatment systems based on the purported catalytic properties of certain alloys of "precious and semi-precious metals" appeared on the market. These are supposed to work on the principle that certain metal catalysts are able to inject electrons into the water, thus neutralizing hardness ions such as  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ . Other sites on the catalyst supposedly remove electrons from the bicarbonate ions. From the standpoint of chemistry, the idea that "hardness" ions can be neutralized in this way is ludicrous; any metal that is sufficiently electropositive to do this would also decompose the water itself! Not surprisingly, I have been unable to find any evidence in the reputable technical literature that these devices can soften water. The number of companies offering catalytic water conditioners seems to have declined recently; some remaining ones are EWS, StWS and SaWS. One previously promoted their device for agricultural operations as well as for ordinary water treatment; what is presumably the same product is available and its "working principle" is illustrated. Another company hits both the water- and fuel-treatment markets:

The electronegativity of the core alloy is less than the overall electronegativity of the water solution. Therefore, the core loses (gives up) more electrons than it acquires to elements such as Hydrogen ( $\text{H}^+$ ) ions which have an electronegativity of 2.1 and ionic compounds (radicals) such as  $\text{SO}_4^{2-}$ , and  $\text{CO}_3^{2-}$  which have higher electronegativities than the core alloy.

As the fuel passes over the catalyst, the larger aggregates of hydrocarbon fuels are broken down into smaller colloidal units. .. The catalytic reaction caused by the patented alloy in the Panther Fuel Stabilizer prevents covalent bonding ( or sharing of valence fields) of the fuel molecules which keeps the hydrocarbon aggregates in fine colloidal suspensions.

Although this stuff may sound "scientific" to some, anyone who has passed first-year Chemistry should recognize the gross misuse of the term "electronegativity" in the first example. There is of course no scientific basis for any of these statements, and no credible performance data is offered. This site, which

Some of "catalytic filters" that utilize zinc-copper alloy are also supposed to remove **chlorine**. This is theoretically possible, but I have not been able to find any credible evidence that this actually works.. Activated carbon filters have been shown to be effective in this application, and, more importantly, they can remove organic byproducts of chlorine treatment.

Below you can see some of the crackpot chemistry that has been cited by various catalytic device vendors. The left column of the following table quotes paragraphs from the Web sites of various vendors of these products.

| The hype  | The science   |
|---|---|
| "The potable water supplied to us is basically electron-deficient and not in optimum states of equilibrium."  | Utter nonsense. Water and aqueous solutions are always electrically neutral. The term "optimum states of equilibrium" is a meaningless creation of this hypemeister!  |
| "The [product] (through a process which is patent pending) uses several different types of metals housed in a water canister to draw in extra electrons from a ground for water passing through the water housing. Through a process known as "ionic conversion", calcium and other hardness agents in their ionic form are neutralized into stable molecules."   | How a metal or other solid can "draw in electrons" is a mystery! Metals tend to lose electrons rather than gain them; this is the major source of metallic corrosion. As for "ionic conversion" (a term unknown to chemists), the ions are already the most stable forms; that's why they are in solution in the first place!   |
| "The conditioner core contains thousands of cathodes which supply electrons to positively charged ions in the water (such as $H^+$ ) but also contains thousands of anodes that remove electrons from negative ions such as $Cl^-$ , allowing them to gather together as neutral gases such as $Cl_2$ ."  | Any metal above hydrogen in the activity series can reduce $H^+$ as described, but at the cost of corroding the metal and introducing $M^{2+}$ ions into the solution. But what's the point of destroying hydrogen ions? This would raise the pH and enhance scale formation! Also, who wants to get gassed by poisonous $Cl_2$ ? But not to worry: no metal known to Chemistry is able to remove electrons from negative ions.   |
| "The catalytic alloy conditioner core contains elements which have higher oxidation potentials than ions in the water solution. As the water flows through the catalytic alloy conditioner, some of the electrons drawn into the solution displace some already captured by ions such as $CO_3^{2-}$ , $HCO_3^-$ , $SO_4^{2-}$ , and $OCl^-$ during the turbulent orbitings of the various electrons."  | 1) "Free electrons" cannot exist in aqueous solution.<br><br>2) None of the "hardness" ions such as $Ca^{2+}$ , $Mg^{2+}$ , $HCO_3^-$ , etc. is capable of being neutralized (reduced or oxidized) in aqueous solution. The reason is that $H_2O$ itself is more readily oxidized or reduced. Only a small number of metals, such as sodium, are able to reduce $Ca^{2+}$ and $Mg^{2+}$ anyway; anyone who knows what happens when you put Na in water can see why this cannot possibly work! |
| "This allows the "displaced" electrons to become "free electrons" in the solution and these "free electrons" can be captured by ions or colloids with lesser electronegativities such as $Ca^{2+}$ and $Mg^{2+}$ to free themselves of $CO_3^{2-}$ , $SO_4^{2-}$ , and $HCO_3^-$ , and assume their neutral atomic structures (Ca and Mg) and break away from their ionic bonds while in solution or from lattice scale bonds in cases where they are in solid precipitated or scale form." | 3) Even if these "neutral atomic structures" like $Ca^0$ and $Mg^0$ could be formed, they would react immediately with water, yielding the original ions $Ca^{2+}$ and $Mg^{2+}$ .  |
| "Increased egg production - chickens lay two eggs daily instead of one."  | This is a curious result in light of the fact that egg shells are made of $CaCO_3$ whose very components are supposedly being removed from the water! It would be interesting to know how many hens were studied, and how many sets of non-conforming results were thrown away.   |
| The increased electron count in the water also inhibits the breakdown of the bicarbonate ion into $H^+$ and $CO_3^{2-}$   | The conversion between these various carbonate species depends solely on the pH and does not involve gain or loss of electrons.   |

|   |   |
|---|---|
| <p>"The turbulence of water flowing through this non-ferrous core element strips away adhesive compounds clinging to the minerals and causes the molecular structure of the water to be rearranged, while natural minerals are retained. The ChemFree process of conditioning water uses three electromechanical scientific principles: epitaxial nucleation, controlled oxidation and reduction, and harmonics."</p>   | <p>1) "Adhesive compounds" cling to solid surfaces, not to dissolved minerals. And what prevents these mysterious adhesives from clogging up the filter?</p> <p>2) The water structure rearranges itself all the time through random thermal motions, and on a time scale far shorter than that required to pass through the alloy area.</p> <p>3) Harmonics? (A new scientific principle?)</p>   |
| <p>"The additional negative charges in the solution reduce the bonding of the oxygen atoms of H<sub>2</sub>O molecules and the hydrogen atoms of other H<sub>2</sub>O molecules (i.e., hydrogen atoms other than those in their own molecules) by supplying the negative charges (electrons) that the oxygen atoms attract. As a result, there are less hydrogen bonds between the individual H<sub>2</sub>O molecules. This results in "wetter water," which in turn results in better cleaning water and better soil-leaching water."</p> | <p>This is similar to the arguments given by the <a href="#">magnetic laundry ring shysters</a>, and like it is errant nonsense. Any electrons introduced into water would immediately decompose it; the remaining H<sub>2</sub>O molecules would be just as fully hydrogen-bonded as before.</p>   |
| <p>"The ... Water Conditioner decreases the dissociation of HOCl ... by providing additional electrons to the water solution which has the net effect of inhibiting the rise in the phi of swimming pool water."</p>  | <p>Dissociation of HOCl (used as a disinfectant in swimming pools) has nothing to do with electrons; the fraction dissociated depends solely on the pH of the water.</p>  |
| <p>"The ability of the ChemFree Water Conditioner to reduce the gaseous content of the water solution probably also contributes to inhibition of algae growth. Algae requires nitrogen as well as phosphorous and sunlight for growth. By reducing the nitrogen content of the water, the ChemFree Water Conditioner reduces the nutrient supply of algae."</p>   | <p>There is no known mechanism by which an alloy can reduce the concentration of nitrogen or other atmospheric gases in water. Further, few if any algae are able to utilize nitrogen gas; they derive their nitrogen from ammonium or nitrate ions which are commonly present in natural waters.</p>   |
| <p>"Corrosion is inhibited if the iron is made more negative compared to its surroundings, forcing the anode areas to act as cathodes. This is accomplished by the attraction of some of the extra electrons in the water solution (supplied by the ... Water Conditioner) onto the anodic areas, thereby preventing the ionization of the Fe atoms."</p>   | <p>The first sentence describes cathodic corrosion protection, a widely used technique. The metallic "anode" that supplies the electrons does so in the process of undergoing corrosion itself. And come to think of it, what prevents the electrons from traveling directly from the cathodic to the anodic regions of the catalytic alloy without even entering the solution, which they cannot do anyway?</p>  |
| <p>"The turbulence resulting from the water rushing through the ChemFree Water Conditioner core facilitates the removal of gases by increasing the probabilities of gaseous elements such as Cl and N contacting other like elements and forming Cl<sub>2</sub> gas and N<sub>2</sub> gas, respectively."</p>   | <p>Assuming that the symbols Cl and N denote atomic chlorine and nitrogen (which cannot have more than transient existence even if sufficient energy were present to produce them, which is certainly not the case under the conditions described), turbulence would likely increase the rate of contact. However, there is no known mechanism by which atomic N can form in water. Cl atoms can be formed by the action of sunlight on chlorinated water, but these extremely reactive species would have only a transient existence because they would react with water before encountering each other.</p> |

|   |   |
|---|---|
| <p>"All other things being equal, the decrease in surface tension due to the decrease in hydrogen bonding of the water molecules reduces the boiling point of water. However, microwave oven tests conducted on equal amounts of conditioned and unconditioned water sometimes show that the boiling point of the conditioned water sample is higher than that of the unconditioned water sample. This apparent paradox can be explained when it is remembered that the gaseous content of the conditioned water is reduced by the ChemFree Water Conditioner. This can result in an increase in the molecular weight of the water for the given volume."</p>   | <p>1) If hydrogen bonding could be reduced, the surface tension and boiling point would decrease, but there is no evidence that these devices have any effect on hydrogen bonding, nor is there any conceivable mechanism by which they could.</p> <p>2) Ordinary gases are so slightly soluble in water that they are unlikely to depress the boiling point by more than about 0.001°, which would likely be unobservable in a microwave oven for numerous reasons.</p> <p>3) The molecular weight of water is a constant that depends only on its elemental and isotopic composition.</p> |
| <p>"The ... System significantly reduces chlorine by converting it to a natural mineral known as Zinc Chloride. This conversion occurs through the process of "flash chlorination". Incoming water flows through the filtration bed of KDF and causes an ionic reaction to occur. This ionic effect causes the chlorine to convert to a harmless mineral (Zinc Chloride). This small ionic action also causes a process to occur known as redox shock". In this process, a very small electrical charge is created which serves as a bacteriostatic effect inside of the filter. This tiny electrical charge effectively serves to inhibit the growth of bacteria within the KDF filtration bed."</p> | <p>Supposedly, metallic zinc is the reducing agent here. In theory, almost any metal can reduce chlorine, but this is a slow reaction that I would not expect to have any significant effect in a flow-through system at ppm concentrations.</p> <p>Sterilization by electrocution is a new twist, but the only "redox shock" I have ever heard of is when my students find themselves unable to balance a redox equation on a midterm exam!</p>  |
| <p>In operation, scale particles tend to 'lattice' together due to their sharp, protruding crystalline structure. One of the operational principles of the [device] is a surface chemical reaction between the crystalline structures, which exist in the water, and the metal alloy within the Turbu-Flow. The sharp crystalline structures, after passing over the first element or 'fence' start to be broken down into a series of thread-like colloids</p>   | <p>There is no reason to believe that scale particles can be "broken down" by interacting with a metal surface, and I am not aware of any evidence for the existence of "thread-like colloids" of carbonate solids.</p>   |
| <p>"The ...cell acts as a catalyst on the water. The bonds of the H<sub>2</sub>O molecules are broken. Foreign particles entrapped by the water molecules become exposed to the open solution. Their surfaces become available as nucleation points for the nearby CaCO<sub>3</sub> molecules"</p>  | <p>There is no way that a catalyst (even one with a high-tech-sounding name ending in -tron) can break the very strong OH bonds in water in the absence of an abundant source of energy. And if this were possible, why peddle water softeners when the inventor could earn billions by using the same process to substitute water for gasoline as an automotive fuel?</p>  |

So, what to make of all this? These statements are reminiscent of what I often see on exams written by first-year Chemistry students who have devoted more time to partying than studying. (Now I think I know what some of these people do for a living after they drop out of college!) The fact that this is mostly nonsense does not in itself prove that the products don't work, but it should inspire a healthy degree of skepticism. **There is simply no credible mechanism known to science that can explain the claimed results, none of which have been scientifically validated anyway. *Caveat emptor!***