A Multi-Clean White Paper

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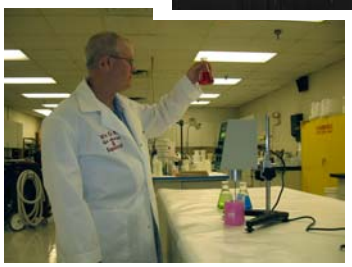
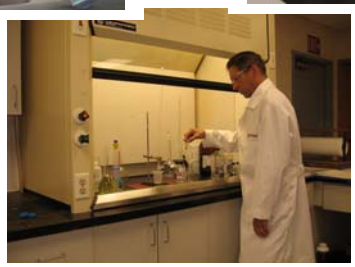
You Decide.....

"Magic Water?"

OR

"A Powerful Cleaner from Ordinary Tap Water?"





The Science of Cleaning

Can a powerful cleaner be produced by passing an electrical current through normal tap water? The authors of this white paper examine the concept that has been incorporated into devices being sold and marketed under the names ecH2O™ and Activeion™. They then apply some scientific principles to help people make their own decisions about this new technology.

Contents

Key Terms

- ✓ Surface Tension
- ✓ Electrolysis
- ✓ Surfactants
- ✓ Emulsification
- ✓ Ions: Acidic & Alkaline
- ✓ Sanitizer

Disclaimer

The authors of this white paper possess Bachelor of Science Degree's in Chemistry and have actively worked in the product development for Multi-Clean with a combined 32 years of experience.

The authors acknowledge that as employees of Multi-Clean, a certain bias will be implied. We also acknowledge that we do not have access to the scientific data used to substantiate the claims made by either Activeion™ LLC or the Tennant Company.

We hope that this White Paper will generate legitimate questions about this technology that will be answered with equally scientific explanations.

Introduction

Turning ordinary tap water into a powerful cleaner is a green marketer's dream come true. Or is it too good to be true? This paper looks at some of the chemistry behind the concept of passing an electrical current through tap water and the expectant results. We also look at the science of cleaning using traditional 'surface-active-agents' (surfactants). Then, we apply these concepts to discuss if or how this "electrified" water could be used to clean surfaces.

As you read this paper, there are three issues that are discussed in depth: **1)** The relationship between effective cleaning and a key chemical property of water referred to as '*Surface Tension'*. **2)** The potential variability in the claimed cleaning solution when tap water and electrical current are the only raw materials utilized. Using impurities in water as the means to making this system work needs to acknowledge the tremendous variability of impurities present in ordinary tap water. **3)** The role of acidic and alkaline ions in cleaning products.

With the emphasis in the cleaning industry about science based cleaning, we feel this white paper is timely. This paper was not written to draw conclusions, but simply to raise legitimate questions about the technology and allow potential purchasers to make informed decisions.

Electrolysis of Water

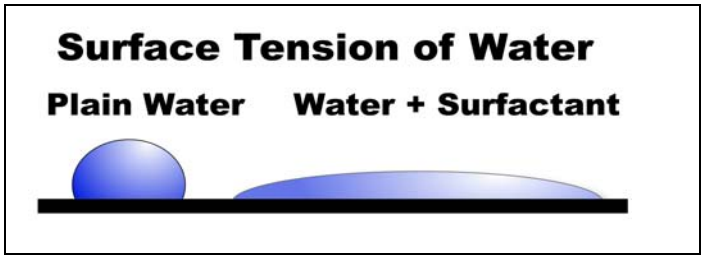
Pure water is a poor conductor of electricity. To create any meaningful reactions in water using a low electrical energy source, a carrier of the charge referred to as an "electrolyte" is needed. One of the simplest and best known

electrolytes is table salt (Sodium Chloride or NaCl to the chemist). In fact, "electrolyzed water" devices that use sodium chloride as an electrolyte to make claimed cleaning solutions are commercially available. These devices create two separable solutions, a mild alkaline pH solution, and an acidic bleach solution. Since the Activeion™ or the Tennant Ech2o™ do not claim to add anything to the water; it is presumed that natural impurities present in normal tap water are being used as the current carrier or **"**electrolyte". It is further presumed that these impurities enter into chemical reactions that produce the claimed cleaning solution.

It should be duly noted, that very little would happen if a low energy electrical current is passed through truly pure (distilled, deionized or reverse osmosis) water.

How Cleaners Work

Water alone is not an effective cleaner because it has a high surface tension and does not wet surfaces effectively.



A good example is the beading of rain water on the surface of a waxed automobile. Water adheres weakly to wax (low surface tension) and strongly to itself (high surface tension), so water clusters into drops. Surface tension gives them their near-spherical shape, because a sphere has the smallest possible surface area to volume ratio.

The difference in surface tension between the water and the waxed car surface causes the water to repel or bead up and does not get the surface wet.

This can be shown by moving the beaded water

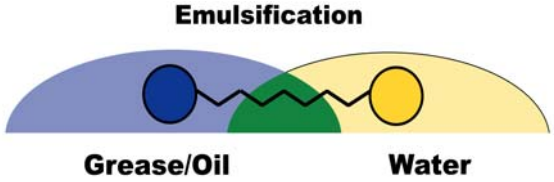
drops around a surface like a hockey puck. If the water is repelling from the surface, it can not go into pores, cracks or anywhere soils can hide.

By adding tiny amounts of a compound known as a surfactant (Surface-Active-Agent), the active ingredients in all cleaners, the surface tension of the water is dramatically reduced from 73 dynes/centimeter to 30 dynes /cm, allowing the water to spread over surfaces, penetrate dirt and lift it from surfaces. In laymen's terms…. "surfactants make water wetter".

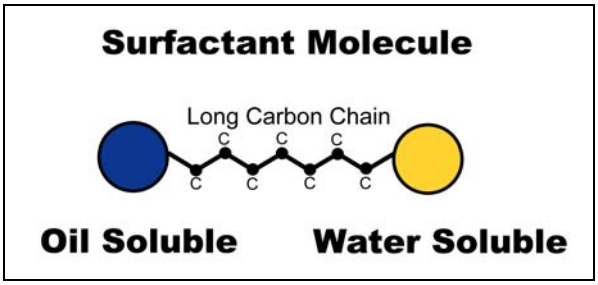
Surface Tension Table

Mixture	Surface Tension
Water	73 dynes / cm
Surfactant (.005%)	30 dynes / cm
ActiveIon™ Solution	Unable to measure

Cleaners are also effective at emulsifying oily soils to allow for removal from surfaces by rinsing, mopping, wiping etc. The ecH2O™ information acknowledges that for petroleum soils, a conventional degreaser is necessary.



Detergents or surfactants are made up of a long chain molecule. One end is water loving, while the other end is oil loving. Cleaners allow the greasy/oily soils to emulsify with water to allow the soils to be suspended until they are rinsed away.



We all know that if our hands get visibly dirty and we wash them with plain water, the dirt is not removed. Add a little soap (aka surfactant) and Voila! Dirt is quickly removed. Try washing your dishes, pots and pans with only water and see how clean they become. Now try it with the Activeion™ device… any better results? You decide.

Measuring surface tension is typically done with an instrument called a Surface Tensiometer. One such device is the du Nuoy surface tensiometer which reads static surface tension by measuring the force necessary to pull a platinum-iridium ring from a liquid-air interface (see photo). Unfortunately, because it is claimed the

solutions exiting the Activeion™ sprayer (as well as the ecH2O™ scrubber) returns to regular tap water in 45 seconds, this scientific method for measuring surface tension is not practical.

Surfactants (Surface-Active-Agents) are compounds that dramatically reduce the surface tension of water enabling cleaning products to work effectively.

Bill Nye, "The Science Guy™"actually explains the idea of how cleaners work through surface tension reduction in the Activeion™ video (about ½ way through) found on the Activeion™ website.

Our own visual observations seem to show that there is a little or no surface tension reduction to the "electrified water" immediately after the water exits the Activeion™ sprayer.

Tap Water as a Raw Material

Water is sometimes referred to as the "universal solvent". If you have ever cleaned hard water scale from fixtures or soap scum from showers, you know that water creates some unique cleaning challenges. Cleaning with just water doesn't work, and many times, it's the water residue that caused those problems in the first place.

Water quality throughout the United States varies widely. This suggests a wide variance of impurities present in normal tap water. The most common impurities found are Calcium and Magnesium ions, which are the primary ingredients of what is commonly referred to as "hard" water. It is presumed that the Activeion™ and the Ech2o™ systems depend on these ions to be the "electrolyte" in order for the tap water to carry a current.

But water chemistry not only varies by geographic location, it varies from building to building. Many commercial facilities use water softening equipment to remove the Calcium and Magnesium from water. Traditional softening systems use salt (sodium chloride-NaCl) as a way to exchange the Calcium and Magnesium ions for less harmful sodium ions.

Some buildings are now using reverse osmosis filtration systems to remove nearly all ions from the water. Many homes are also equipped with reverse osmosis filter systems in their kitchen tap water supply.

Without a water quality analysis, it is very hard to know the quality of the "tap" water in every faucet across the country. How will this affect the performance of the Activeion™ or ecH2O™ equipped scrubbers?

The water quality issue is mentioned in the ecH2O™ information that addresses this question: "***What if I use the machine in an area with hard water?***" The reply is "***ecH2O uses smart technology which detects mineral content in the water and adjusts the electrical current accordingly***". It further states that "***the result is a consistent output and cleaning performance regardless of water type***".

Acidic and Alkaline based Cleaners

Acidic or alkaline ions can help a cleaner be more effective. These ions by themselves are **NOT** cleaners however, but are commonly combined with surfactant solutions, to help buffer the cleaning solution and enhance cleaning power.

For greasy or oily soils, traditional cleaners and degreasers use "alkaline based builders (i.e. ions) and surfactants" to increase the emulsifying ability and allow these soils to be removed.

For soils like hard water deposits, soap scum or rust stains, acids are combined with surfactants to remove these soils.

Acidic and alkaline **ions** alone do NOT make an effective cleaner and have negligible impact on the surface tension of water.

Water, even though it's the "Universal Solvent", is not effective at removing these common soils found in homes, schools, daycares, offices, industry etc.

The Activeion™ and ecH2O™ appear to be claiming that the powerful micro (air bubbles) bubbles in the water will clean as effectively as traditional surfactant based acid and alkaline cleaners for a wide variety of soils.

Oxygenated Water

Activeion™ and ecH2O™ claim highly oxygenated micro (nano) bubbles (aka air bubbles) assist in loosening dirt. The assumption here is that all soils found in homes, hospitals, schools, etc are particulate soils, not greasy or oily soils.

Grease and oily soils create difficult cleaning problems because oil and water are incompatible. Other problem cleaning challenges include: hard water deposits, soap scum, body oils, rust stains, inks, food stains, etc. We expect that Activeion™ or ecH2O™ equipped scrubbers would have great difficulty cleaning non-particulate type soils.

Another issue with air (oxygen) bubbles in water is that it reduces contact between the cleaning solution and the soil to be removed. We are unable to explain how air bubbles in water will facilitate cleaning.

A Sanitizer?

Activeion™ has claimed the product is a sanitizer and has an EPA Establishment number. The Activeion™ is considered a "Pesticidal Device" by the EPA as defined by the requirements set forth in 40 CFR 152.500.

A "Pesticidal Device" defined by the EPA: "Is an instrument or contrivance that is intended to mitigate, repel, destroy, or trap a pest".

All EPA registered disinfectants and sanitizers are required to go through a thorough testing and review by the EPA.

All EPA registered disinfectants and sanitizers also have labels that list many items that are not found with the Activeion™.

Information found on all EPA labels includes:

- Product EPA Registration Number
- Active Ingredients
- Directions for Use
- Contact Time for each organism
- Organisms it has claims to be effective on.

- Whether it was tested in the presence of organic matter, and at what level.
- Is a pre-cleaning step required for gross filth.
- Water hardness in which testing was done
- Does it clean and sanitize in one step or is a pre-cleaning step required.

Since the Activeion™ is registered only as a Pesticidal Device, the above information is not available to the end user.

Measuring Cleaning Performance

How a cleaner performs depends on many things. Standard test methods have been developed that measure the effectiveness of a cleaner. Green Seal®, a non-profit organization which certifies products as being "Environmentally Preferable" as well as the EPA's Design for the Environment program have both embraced performance as part of the measurement on whether a hard surface cleaner can be certified as "green". This is simply recognition that the product must actually clean to be green certified. For example:

The Green Seal® Standard GS-37, General Purpose Cleaners requires that a hard surface cleaner must meet the following requirements to become certified.

> **"**Each product shall clean common soils and surfaces in its category effectively, at the most dilute/least concentrated manufacturer-recommended dilution level for routine cleaning, as measured by the following applicable standard test methods. Products shall be diluted, as required, just prior to testing using water from the cold tap at no more than 50ºF.
>
> **3.1.1 General-Purpose Cleaners**. The product shall remove at least 80% of the particulate soil in ASTM D4488-95, A5.

No information of cleaning performance as defined by the above ASTM procedure has been published. Nor are these devices registered by Green Seal® or other certifier of "Environmentally Preferred Products".

Public information on the ecH2O™ equipped scrubbers indicates that Aspen Research, an independent testing lab had conducted efficacy trials substantiating performance. Much of the other performance related information seems to rely on user testimonials.

Summary:

In summary, there are several questions that are not addressed by the marketing information on Activeion™ sprayers or ecH2O™ equipped scrubbers.

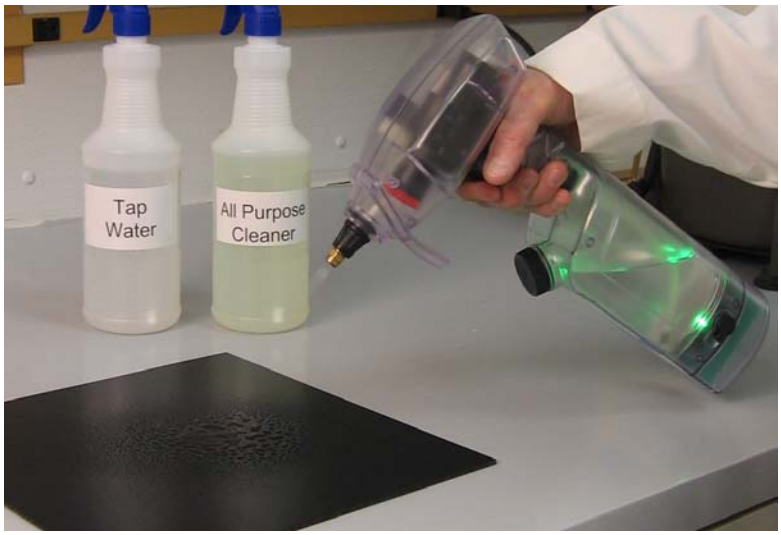
1. How do the vast differences in regional water quality and impurity levels impact the quality and performance of this cleaner?
2. How does removal of impurities (softening, deionizing or Reverse Osmosis) from tap water impact the quality and performance of this device?
3. What minimum level of impurities in the tap water need to be present for this system to work consistently?
4. Since it is well known that traditional cleaners work by reducing the surface tension of water, what impact, if any does the Activeion™ or ecH2O™ have on the surface tension of water?

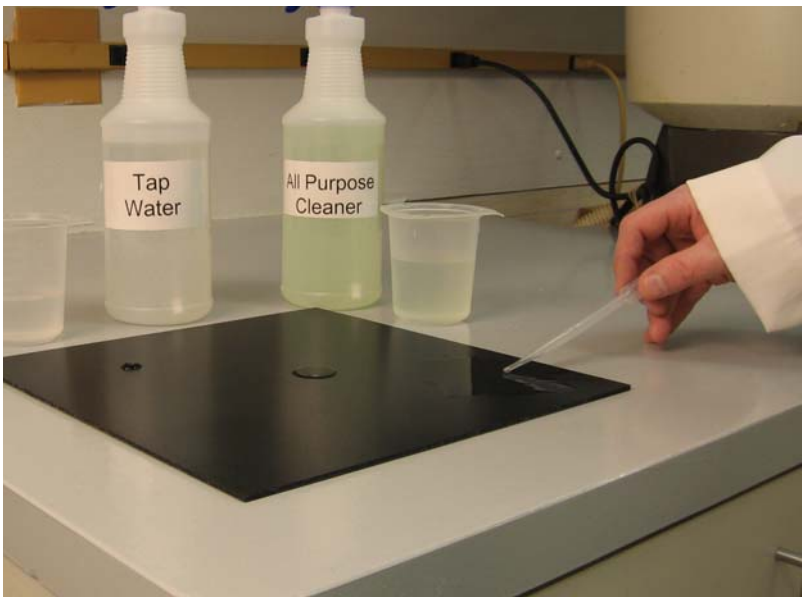
   The high surface tension of water is the result of cohesive forces that attract **water** molecules to one another. The property makes plain water a poor cleaner.
5. How effective is it on the following commonly found soils: oily & greasy soils, soap scum, hard water deposits, rust stains, petroleum or vegetable oils, etc.
6. How do I know that this device cleans and sanitizes any better than just using water and a good quality micro-fiber cloth?

Demonstrating Surface Tension

Plain water has a high surface tension so it tends to bead up on surfaces. Water molecules like to stick together and resist spreading and penetrating surfaces. This makes water a poor cleaner on surfaces.

When the Activeion™ water solution is sprayed on a vinyl tile surface, it also beads up on the surface similarly to ordinary water. The fine atomization of the water when sprayed makes it look slightly different than the larger droplets deposited by an eyedropper (above).





Adding a miniscule amount of a surfactant compound causes immediate spreading of the water over the surface. This shows the dramatic surface tension reduction that occurs due to the magic of surfactants. Now a true cleaning solution is made that penetrates and lifts soils from surfaces.

And Some Final Considerations……

ActiveIon™ Ergonomics

The AcitveIon™ sprayer eliminates manual pumping, a positive ergonomic feature. However, the Activeion™ sprayer is more than 2x times heavier than a standard 22 oz spray bottle. The Activeion™ also has less fluid capacity at only 500 ml (17 oz). The raised arm motion necessary for most spray cleaning by workers creates questions about negative ergonomics of this method of cleaning.

	Empty	Full
ActiveIon™ Sprayer	2.4 lbs	3.5 lbs
22 oz Spray Bottle	3 oz	1.6 lbs

Cost Savings? You Decide….

A potential sales pitch on the Activeion™ maybe cost savings as a result of eliminating the need for chemicals. The authors do not know anything about the longevity of the Activeion™ sprayer. It appears to be well constructed and heavy duty. The question becomes…. 'will it last long enough to break even?' You Decide. Simple math suggests it could take up to 970 filled quarts of an RTU cleaner to break even with the ActiveIon™ based upon the cost estimates detailed below:

Activeion™ Cost (estimated)	Breakeven Point*
$250	810 quarts
$300	970 quarts

*RTU Cost per Quart Multi-Clean #2 Multi-Shine Glass/Surface Cleaner is $0.31 per quart at published list prices.

The analysis above does not take into account intangible savings such as training, less purchasing, fewer SKU's, etc.

A potential sales pitch for the ecH2O™ equipped scrubber maybe cost savings as a result of eliminating the need for chemicals. The authors do not know anything about the longevity of the ecH2O™ equipped scrubbers. However, Tennant Company has a long history producing consistent quality cleaning equipment. The question becomes will it last long enough to break even? You Decide. Simple math suggests that it would take thousands of gallons of RTU cleaner before reaching the breakeven point.

ecH2O™ Cost (estimated)	Breakeven Point*	Sq. Feet Cleaned**
$1,000	5,260 gal	5.3 million
$1,500	7,900 gal	7.9 million
$2,000	10,500 gal	10.5 million

*RTU Cost per gallon Multi-Clean #5 Century Neutral Cleaner is $0.19 per gallon at published list price.
**Based on 1 RTU gallon cleans 1000 sq. ft.

The analysis above does not take into account intangible savings such as training, less purchasing, fewer SKU's, etc.

Resources:

Multi-Clean www.multi-clean.com

Multi-Clean Blog:
www.yourguidetoclean.blogspot.com

Videos:

The Science of Cleaning….

'Surface Tension'

CLICK HERE

Surface Tension Educational Video

CLICK HERE