



Industrial Water

Cooling Tower

Case studies and analysis

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Introduction

Sphagnum moss has been conditioning and purifying water in nature for millennia. I was exposed to the history of Sphagnum moss in a magazine article about its use as a wound dressing, by both the English and the Germans, in WWI. Wounded soldiers survived in higher numbers when their wounds were dressed with Sphagnum moss instead of cotton. After years of extensive laboratory study and ten years treating water in residential and commercial pools and spas, we started developing Sphagnum moss for cooling tower and industrial water treatment.

Harvesting and processing of Sphagnum Moss

We studied over 40 of the 120 species of Sphagnum to determine the desired properties. The moss used in this study is harvested by hand in a manner that does not harm the bog. The same bog can be harvested every three to five years, providing a totally natural and sustainable product. We have an independent expert microscopically examine random samples of each shipment to assure they contain over 95% of the proper species.



Effect of Sphagnum Moss

The water conditioning effect of the correct species of Sphagnum moss were tested at Embro Corporation laboratory and in field studies. They have the following properties:

Key Results

- Removes Positively Charged Metal Ions
- Inhibits and Removes Organic Contamination
- Reduces and Inhibits Scale Formation
- Reduces and Inhibits Corrosion
- Reduced Maintenance



Key Benefits

- Reduced Chemical Usage
- Reduced Water Usage
- Reduced Energy Usage
- Reduced corrosion in the tower and downstream
- Longer equipment life

Initial Commercial Experience with Sphagnum Moss

Our first commercial use of Sphagnum moss was in residential pools and spas. We delivered the predetermined dose of moss to the water body in a contact chamber designed for the size and use of the spa or pool. The moss was used in conjunction with the sanitizer already in use. The only sanitizer not compatible was biguanides.

We then designed products to treat commercial pools and spas. We presently treat over 350 commercial pools and spas in the US and Canada and are expanding to Europe this summer. An example of the results obtained with Sphagnum moss treatment is the effect at the University of Maryland 1.2 million-gallon facility. Comparing the water and chemicals used during the year before starting Sphagnum moss to the year with Sphagnum moss, they saved 760,000 gallons of water due to less frequent backwashing of the filters and \$43,995 in chemical and water expenses.



Cooling Towers

The cooling tower is one of the most critical and commonly encountered industrial water treatment systems. Of greatest concern is the water and chemical usage connected with cooling towers. Aside from the significant costs and toxicity related to standard treatments, cooling towers dump alarmingly high volumes of water, even during periods of minimal operation.

Chemical treatment and water dumping exist to stave off critical issues like corrosion and scale, but are also a standard of care that treats the symptom, and not the source. This pattern also leads to billions of gallons of potable water waste, and water supplies tainted by chemical introduction.

ProMoss™ for cooling towers offers a powerful, simple, and natural water treatment program that requires no installation or change to an existing cooling tower configuration. Using a simple “contact chamber” and the appropriate amounts of ProMoss™, any cooling tower (with an existing water basin) can experience the advantages and cost savings of ProMoss™.

ProMoss™ Advantages

- **Easy installation**
 - ProMoss™ is delivered to the cooling tower basin in a “contact chamber”. No additional plumbing, or change to the cooling tower water flow, is needed. Changed once-a-month, ProMoss™ light, non-toxic, and easily removed for disposal. Removal of the product is accomplished by simply removing the ProMoss™ from the contactchamber.

- **ProMoss™ works with:**
 - Chlorine
 - Bromine
 - Nonoxidizing Biocides
 - Dispersants
 - Anticorrosion Additives
 - Enzymes

Designed to maximize the quality of treatment, ProMoss™ has been tested for use with the most commonly used cooling tower industry treatments. Neither the activity of ProMoss™ nor chemicals were compromised. As with any natural, plant based product, excessively high levels of oxidizing biocides will bleach and destroy ProMoss™.



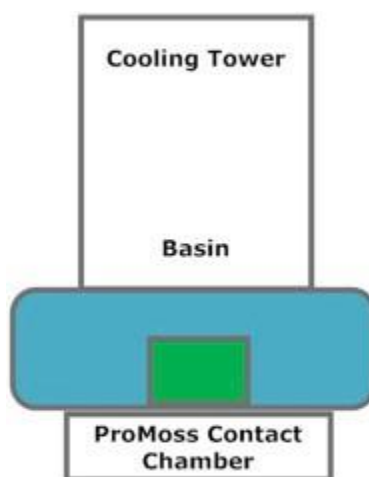
- **ProMoss™ use allows:**
 - Removal of Dispersants
 - Removal of Anti-Corrosion Additives
 - Increase in Cycles of Concentration Settings to Save Water
 - Less Cleaning/Service of Scale in Cooling Tower
 - Reduced Scale and Corrosion in Chillers

The water treatment with ProMoss™ allows the decreased or discontinued use of many expensive and commonly used chemicals, with no resulting increase in scale or corrosion. In systems that use natural water sources for cooling towers and return the water to the natural source, use of ProMoss™ has resulted in decreased scaling and corrosion, without need for additional chemicals or other electrically based water treatment systems.

- **Reduced costs:**
 - Less Makeup Water
 - Decreased Chemical Costs
 - Decreased Maintenance Costs

ProMoss™ has also demonstrated the ability to allow increased cycles of concentration, by 100% (or more), with no increase in scaling or corrosion. This results in significant water savings. ProMoss™, when used in conjunction with an oxidizing biocide, has given excellent results. Profound reductions in scale all but eliminate the need for power washing and acid washing.

Industrial Water Division Cooling Towers Treatment System



Goals of Cooling Tower Water Treatment

1. Inhibit scale formation
2. Inhibit corrosion
3. Stabilize water clarity
4. Reduce water consumption while retaining heatexchange
5. Minimize costs
6. Maximize equipment life

Phase One Trials

The facility had a single 16-year-old 250-ton evaporative cooling tower that contained 2500 gallons of water, circulating at 545 gallons/minute. The tower was used from March through December. Their make-up water was from the city and was treated with a salt-based water softener. US Water Services managed their water.

Year One

During this first year of treatment we visually monitored the tower for reduction in scale formation. No changes were made to the chemical additives or blow down settings. Sphagnum moss was delivered to the basin of the cooling tower and changed once a month. The maintenance manager noticed less foaming in the tower and a gradual reduction of scale on all surfaces of the exchanger in contact with the water. When the tower was cleaned at the start of the next cooling season it took 1.5 hours to power wash the interior compared to 8 hours the year before. All water parameters were stable and acceptable to US Water Services and dip slides showed no growth.

Year Two

All treatments stayed the same except the blow-down setting was increased from 1800 to 3600 to see if the increased TDS would result in scale formation, corrosion or less efficient chemical control. No scaling occurred on the tower, there was a decrease in chemical consumption, and it took 0.5 hours to clean the tower the next year. The heat exchanger was scheduled for maintenance during the winter. There was no scaling or corrosion on the exchanger tubes and no cleaning was required.





Chiller lid from phase one test facility after two cooling seasons on ProMoss™.



Chiller tubes from phase one test facility after two cooling seasons on ProMoss™





Cooling tower media from 16 year old phase one test facility before starting on ProMoss™



Cooling tower media from 16 year old phase one test facility after two cooling seasons on ProMoss™





Water, foam, and organic contamination before starting on ProMoss™



Water after two years treatment with ProMoss™ Note clarity, absence of foam and organic contamination



Year Three

The chemical dispersant and corrosion inhibitor have been discontinued and the tower water is being treated with Sphagnum Moss and 0.5 ppm chlorine. The blow-down setting was increased from 3600 to 5000. In line Linear Polarization Resistance (LPR) probes consistently show corrosion for galvanized steel at 0.02 MPY.

Costs for treatment of the tower consist of water, chemical, and maintenance savings over 50% per year.

Conclusions from Phase One Trials

ProMoss™ treatment was highly effective in removing foaming, organic contamination, scaling, and improving water clarity. It treated the water loop and resulted in no scaling or corrosion in the chiller. As a result the facility realized water savings, reduction in number and amount of chemicals needed, and an overall savings of over 50%.

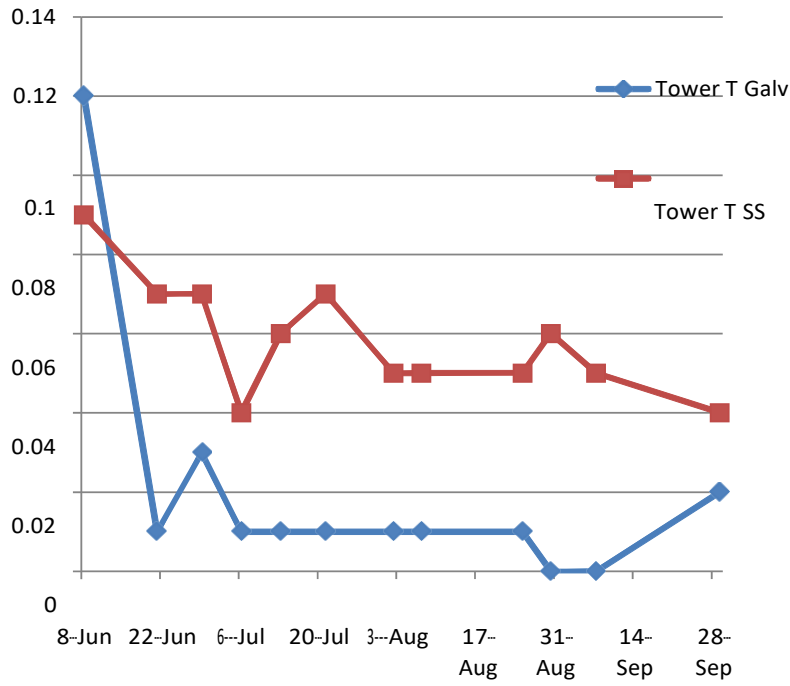
Phase Two Trials

We contracted a local water treatment company, Jay Tech, to independently test three different facilities. They created a flow through system with a filter and separate contact chamber similar to the system used to deliver the Sphagnum moss to a residential pool (Figure 2). LPR probes for galvanized and soft steel were installed inline. Sphagnum moss treatment was started on July 14, biocide delivery remained unchanged, and corrosion, dispersant and scale inhibitors were stopped.

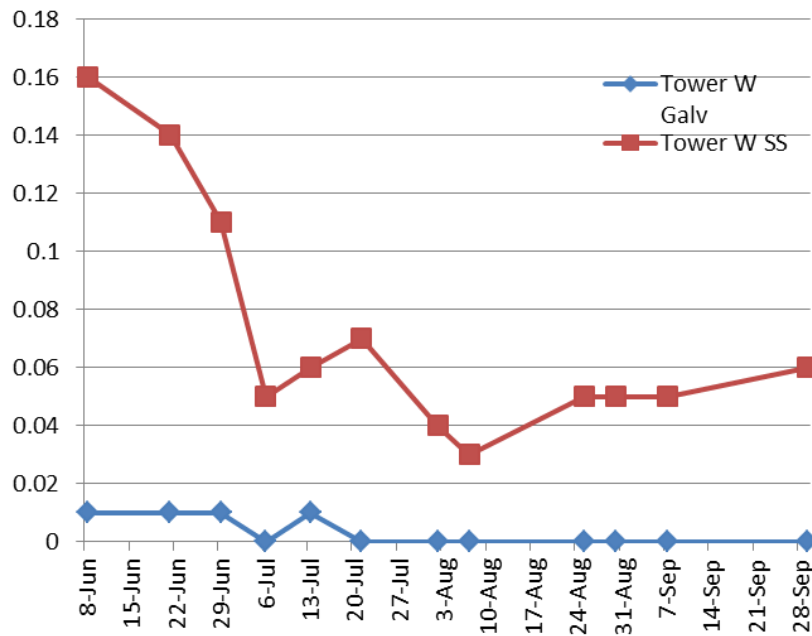


Sphagnum moss delivery system used on three different facilities. Stainless steel tank contains the Sphagnum moss, white PVC cylinder is a filter and two LPR probes are in line.



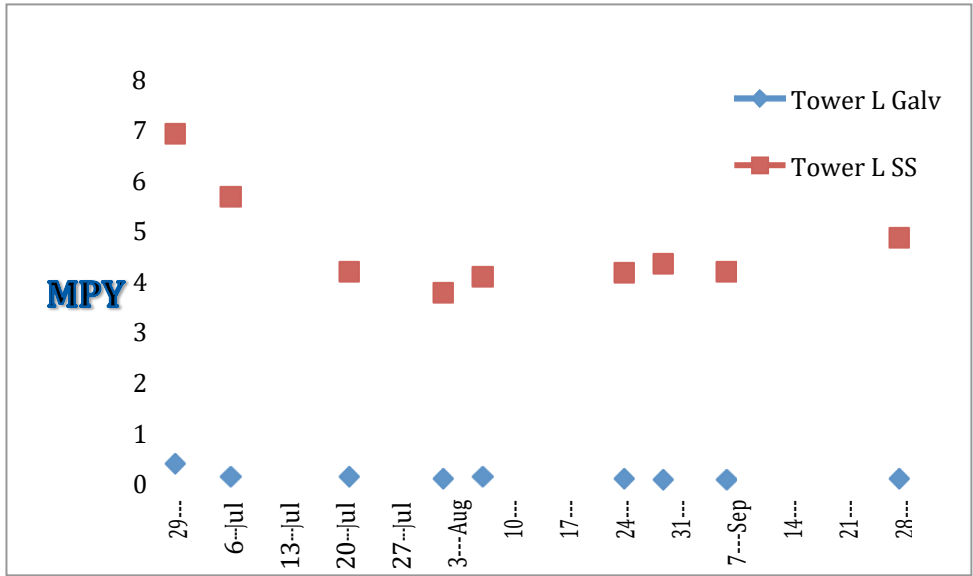


Corrosion values for Phase Two tower 1. Galvanized steel is in blue and soft steel in red. Dispersant and corrosion inhibitors removed on July 14.



Corrosion values for Phase Two tower 2. Galvanized steel is in blue and soft steel in red. Dispersant and corrosion inhibitors removed on July 14.





Corrosion values for Phase Two tower 3

Conclusions Phase 2 Trials

No scaling was observed in two towers after the scale inhibitor was stopped and the third showed softening of the scale after Sphagnum moss was started. Corrosion measurements are shown below.

We concluded that the measured corrosion was the same as or decreased when the corrosion inhibitor was discontinued on all three towers. The flows through systems had frequent fouling of the filters, were expensive, and were removed. We decided to return to the contact delivery cages in the basin of the towers for the next studies.



Phase Three Trials

Year one

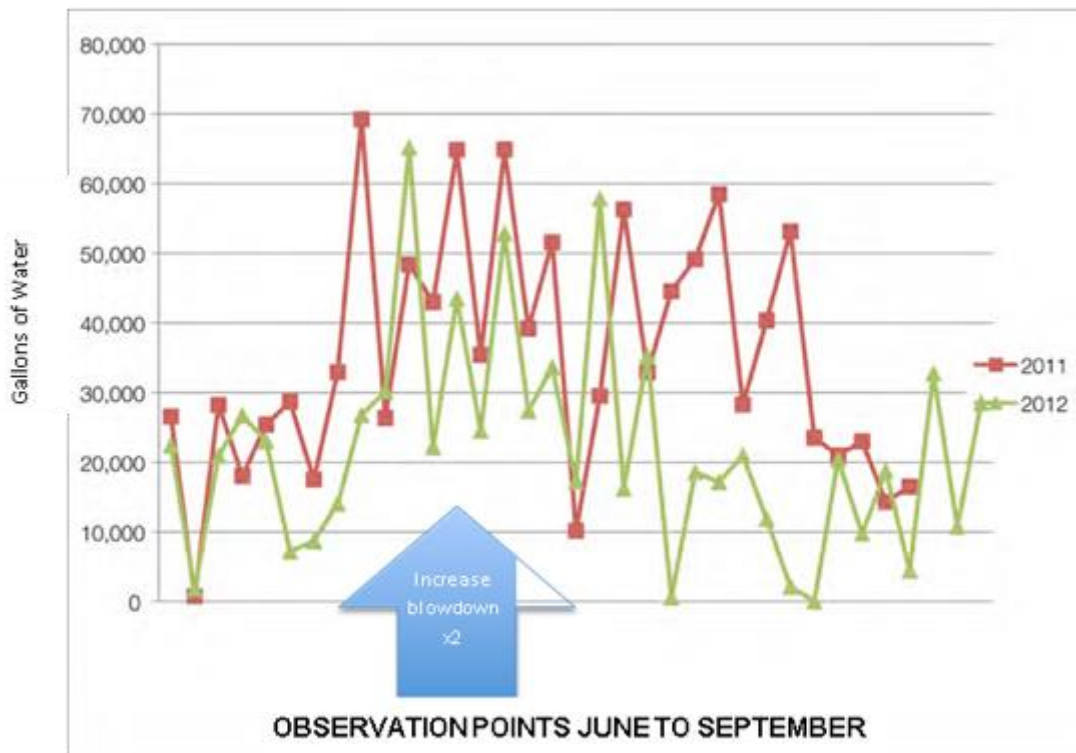
Delivery of the Sphagnum moss to the cooling tower basin was used in two of the six cooling towers in a large hotel complex.

Tower #3 – 550 ton

Tower #4 – 650 ton

Sphagnum moss was delivered to the tower basin using dosing criteria based on phase 1 and 2 testing; in tower three the blow-down setting was doubled in mid July; in tower 4 the chemical corrosion inhibitor was discontinued in mid July. All other chemical treatments were unchanged. Towers were inspected every other week. Water turbidity, pH, and corrosion on galvanized LPR probes were measured every other week.

Results were compared to data from the year before.

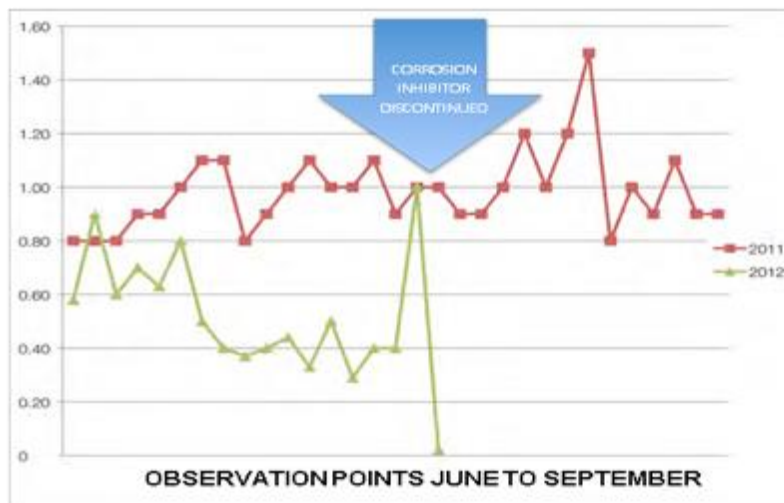


Water use comparison from Phase Three. Red is water used in 2011 with no Sphagnum moss and green is water used in 2012 with Sphagnum moss. Blue arrow is when blow-down setting is increased from 1800 to 3600 in tower 3. Temperature means for both years are similar





Corrosion inhibitor concentration comparison from Phase Three. Blue arrow is when blow-down settings were increased from 1800 to 3600



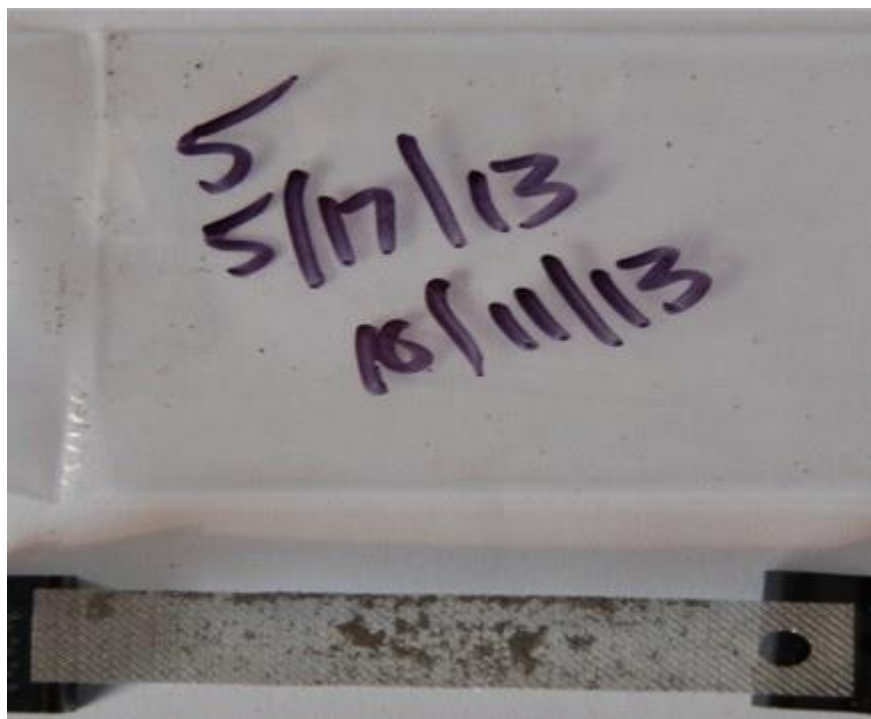
Corrosion inhibitor concentration from Phase Three tower 4. The blue arrow indicates when corrosion inhibitor feed was discontinued. Corrosion for galvanized steel was 0.09 mpy with corrosion inhibitor and Sphagnum moss and 0.55 mpy when corrosion inhibitor was discontinued.



Corrosion for galvanized remained below 0.6 mpy on tower #4 after the corrosion inhibitor was removed, and below 0.7 mpy on tower #3 after the blow-down was doubled on tower #3. Water use decreased by 42% on tower #3 after the blow-down was doubled. All dip slides for bacteria were negative, and scaling was observed to decrease on both towers.

Year Two

The same two towers as in year one were treated with Sphagnum moss and a third ,650 ton, tower was used as a control. We measured corrosion for copper with both coupons and probes, and measured organic contamination formation using special mesh coupons. All three towers were treated with two biocides, corrosion inhibitor and dispersant.

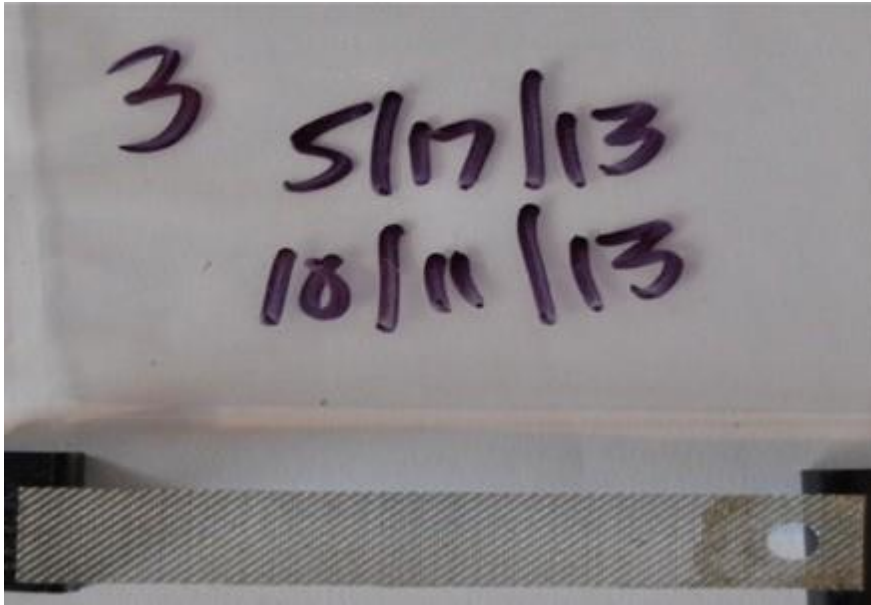


ORGANIC CONTAMINATION ACCUMULATION

Control Cooling Tower without ProMoss™

Water was treated with two biocides, a dispersant
and corrosion inhibitor.

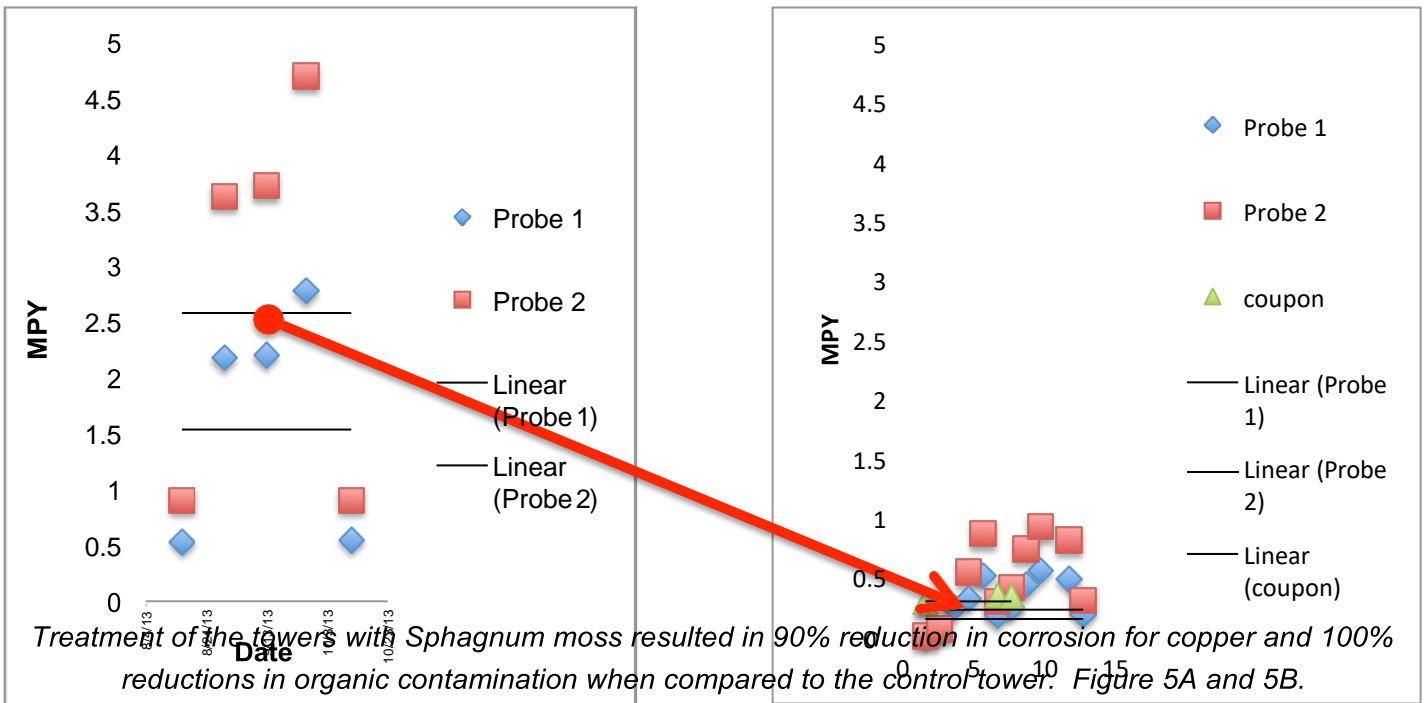




ORGANIC CONTAMINATION ACCUMULATION

Cooling Tower with Sphagnum Moss in addition
to two biocides, a dispersant
and corrosion inhibitor.





Conclusion Phase Three Trials

After three years of testing on five different facilities we have determined that:

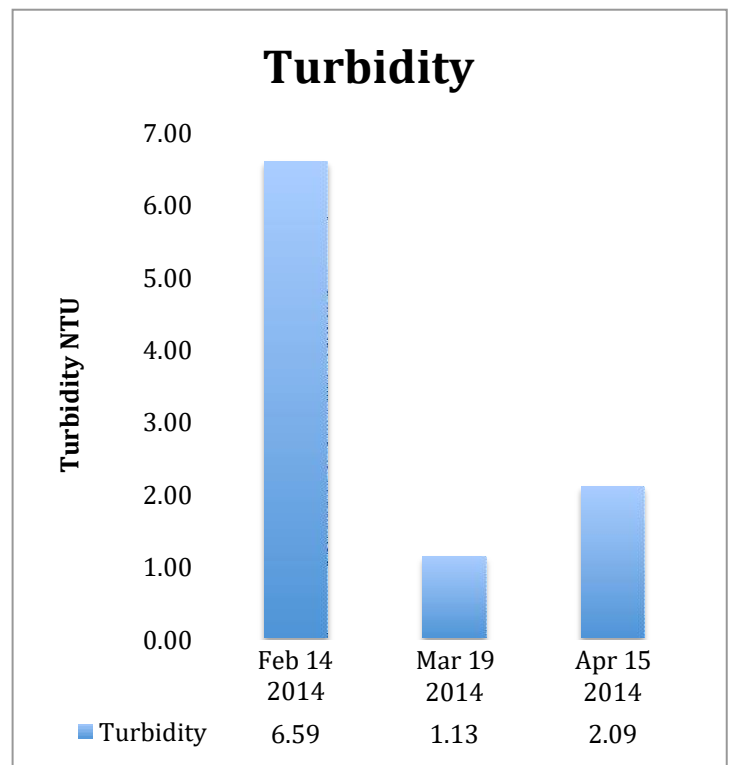
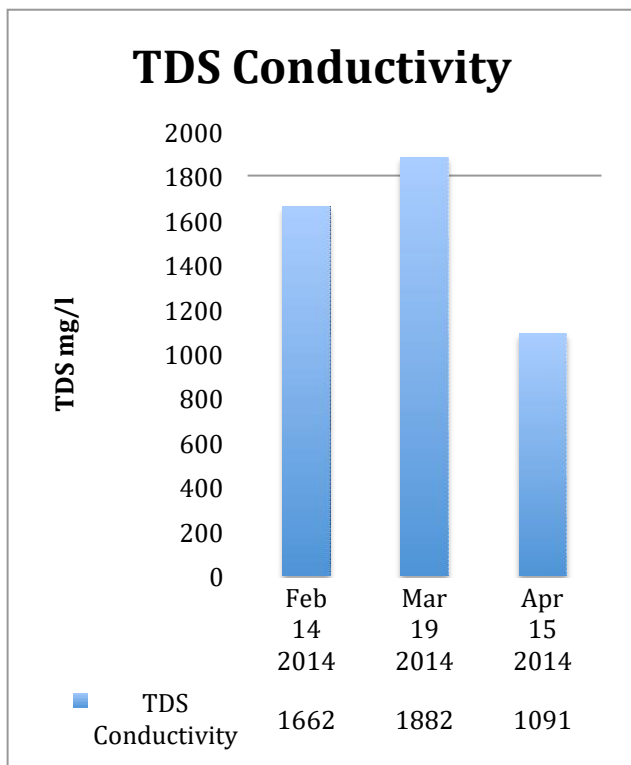
1. Sphagnum moss can be easily delivered to cooling tower basin water.
2. No deleterious effects were seen in the towers tested.
3. Sphagnum moss worked in concert with standard oxidizing biocides
4. Visible scaling was removed and progressive scaling was inhibited by addition of Sphagnum moss
5. Sphagnum moss can replace chemical corrosion inhibitors, dispersants and scale inhibitors

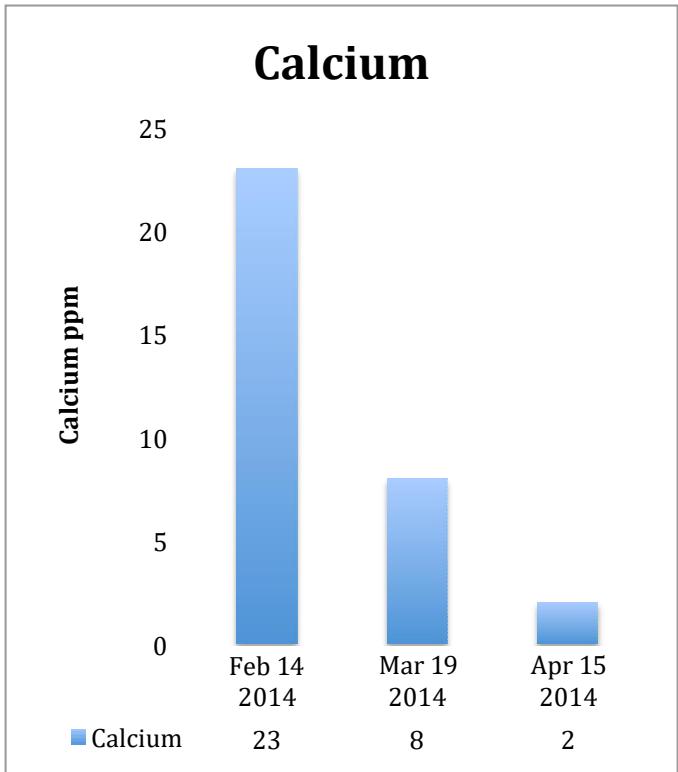
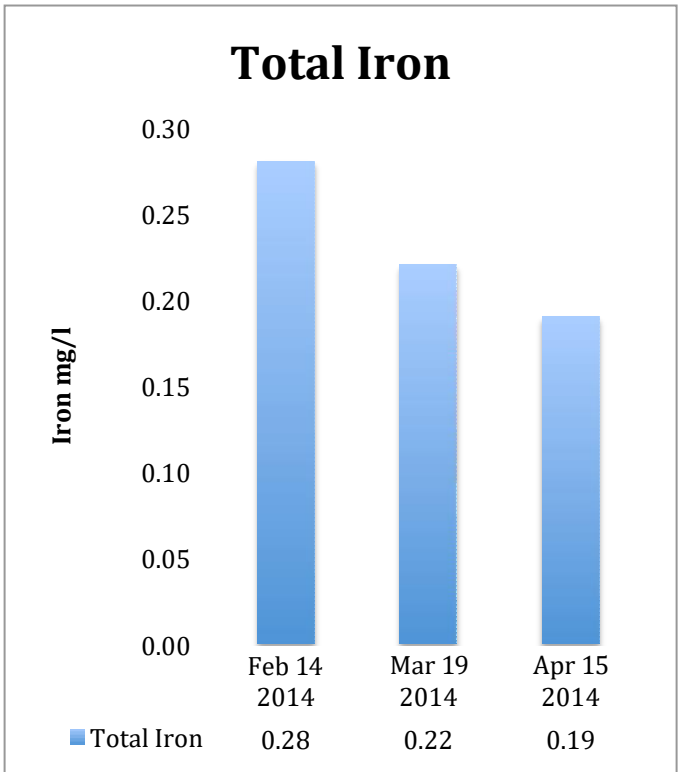
Water consumption can be decreased by increasing cycles of concentration without increasing scaling or corrosion; or adversely affecting bacterial dip slide results.



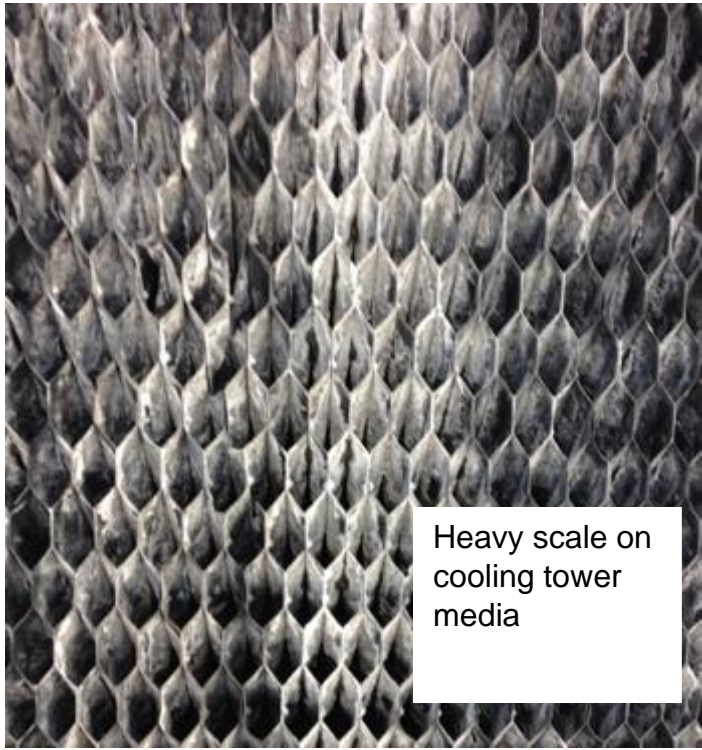
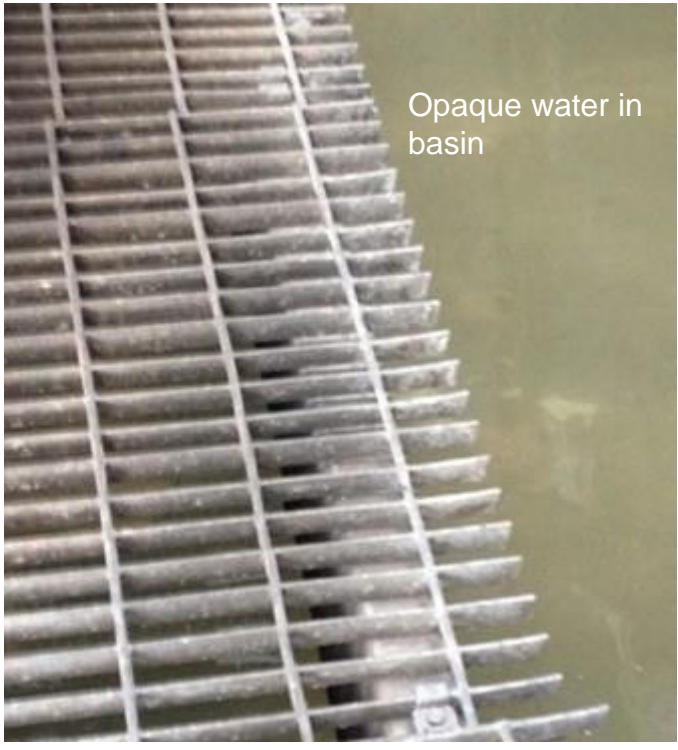
Commercial Case Study

Three fifteen year old cooling towers with a single water collection basin at the CertainTeed insulation factory near Kansas City, MO were treated with ProMoss™ for two months. All treatments remained the same throughout the treatment period. All ProMoss™ was delivered to the basin of one cooling tower and the treated water drained by gravity to the basin and then was delivered to all three.





Pre treatment with ProMoss™





ProMoss™ in the tower basin



Foaming in return water (note foam coming from the media)

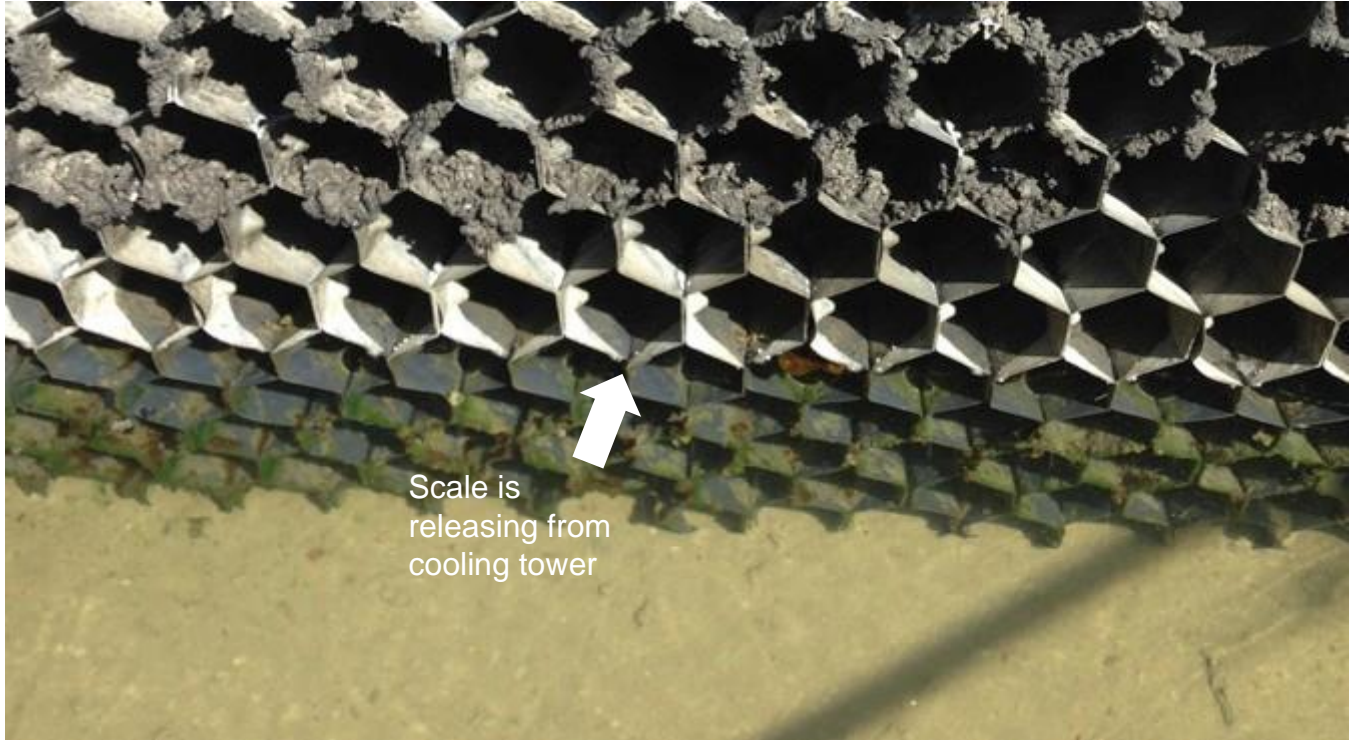
Two Months treatment with ProMoss™



Note bottom of basin is visible through crystal clear water

Sludge on the floor of the basin starting to loosen





Conclusion Case Studies

Treatment with ProMoss™ for two months resulted in significant improvements in water clarity, decrease in foaming, scale removal from the areas in contact with the water, and reductions in iron and calcium ion concentration with no change in the water treatment regimen.



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