Pilot Cooling Tower Study

Performed for HydroFlux Technology, LLC

Objective & Executive Summary

This study was intended to determine the success of scale prevention by treating the cooling water with the HydroFlux magnetic treatment technology.

Overall, based on observations and evaluation of a HydroFlux treated tube specimen over a nine-day window, the technology has shown a significant efficacy over the non-treated control tube specimen. The results observed were specific to the evaluation of the efficacy of HydroFlux technology in reducing scale potential and proved to be both measurable and observable.

Protocol

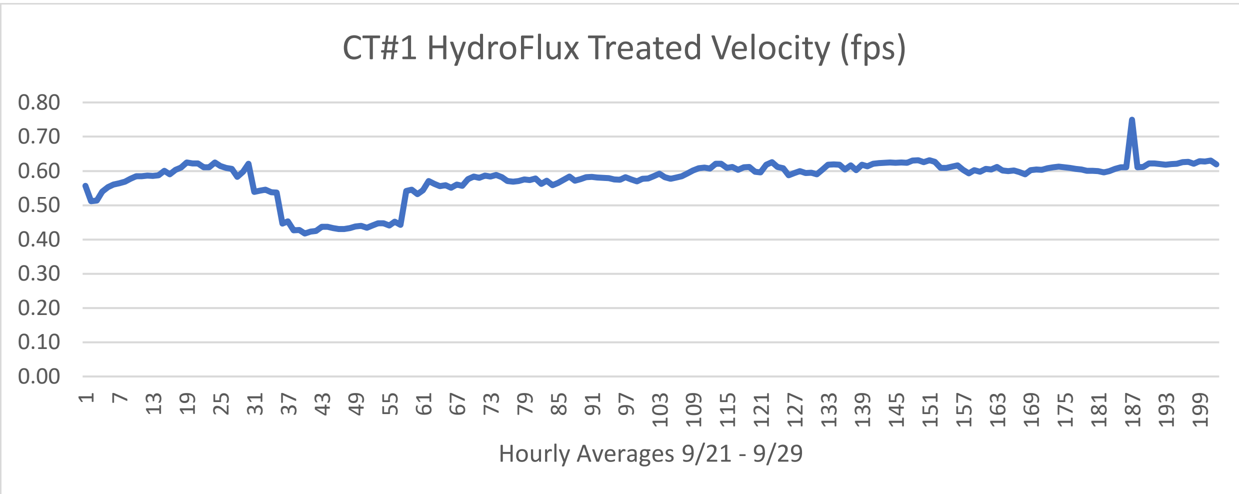
Two pilot cooling tower systems were utilized for this study which compared untreated well water (The Control) to treated well water (HydroFlux Treated) for scaling prevention or minimization using the HydroFlux treatment technology. Each pilot cooling tower system had one exchanger with 316 stainless steel metallurgy. Velocity of each exchanger was set at 0.5fps and the skin temperature of both exchangers was maintained at 190 deg F. The pH of each system was maintained at 8.0 – 8.5. These are incredibly stressed conditions and were selected to ensure a scaling potential would exist. The time of exposure to these conditions was 9 days before the exchangers and specimens were removed. The objective of the study was to see if there was a marked difference between the control and the treated system in terms of mineral scale formation. This comparison was made visually and empirically by weight. Both Sentinel tube specimens were pre-weighed before the test and will be weighed again dirty after the exposure period has ended. CT#1 which was treated by the HydroFlux Technology utilized three (3) bracelets mounted on a 1” copper pipe through which 100% of the recirculating cooling water passed. See photo below:

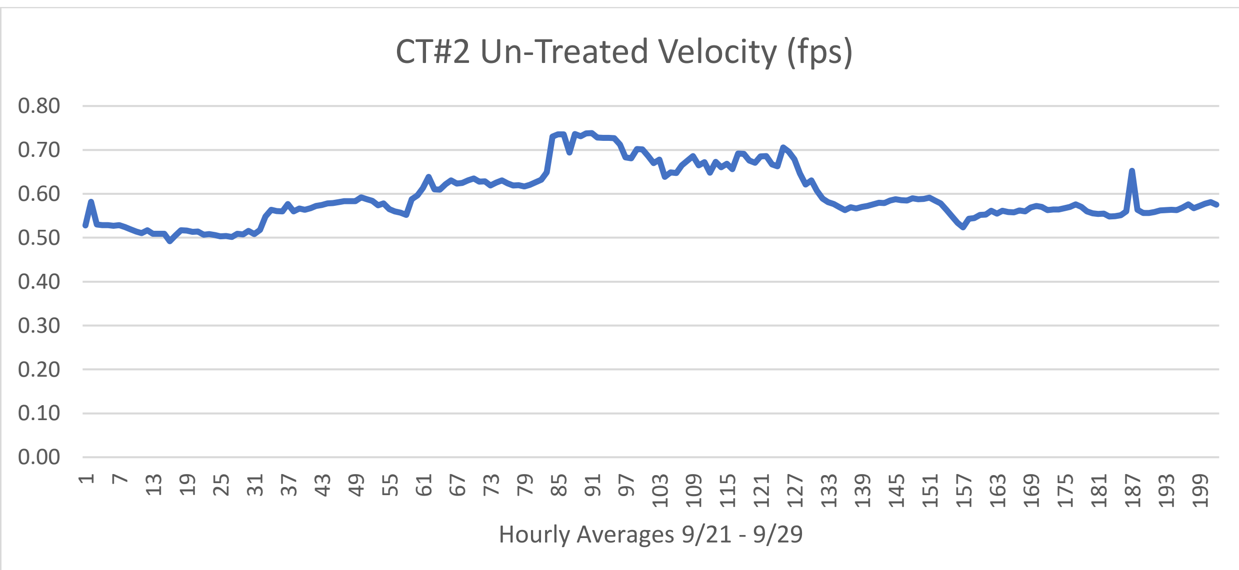
Results

Photographs of the specimens were taken every hour during the exposure period and have been saved electronically. These photos have been arranged in the following time lapse video which shows the accumulation of deposit on each of the specimens.

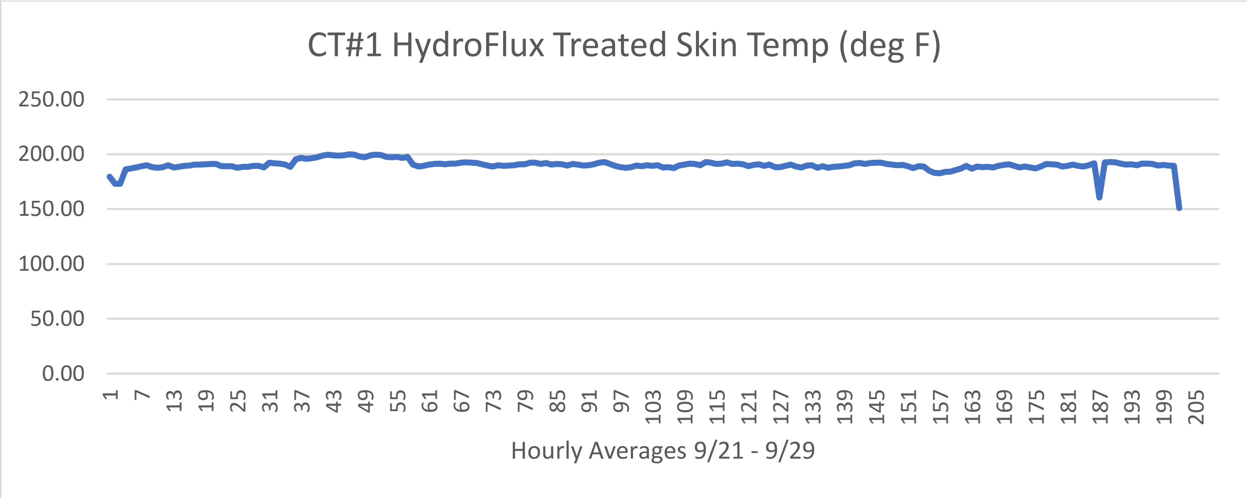
https://www.dropbox.com/s/bkid4nbxqdto5x8/HydroFlux_Timelapse_Run1.mp4?dl=0

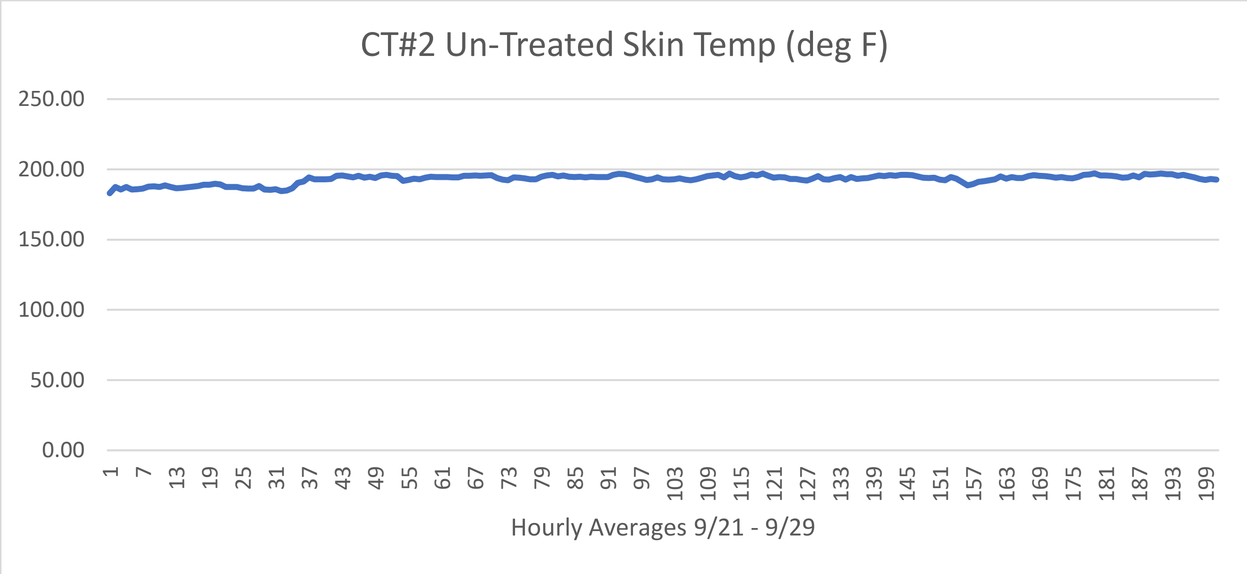
Deposition appeared on each of the tubes initially due to the very low velocity in the exchangers, 0.5fps. The following is a graphic analysis of the velocity control during the exposure period.





Another significant stress on this system during the exposure period was the high skin temperature. The following is the control of the skin temperature during the study.

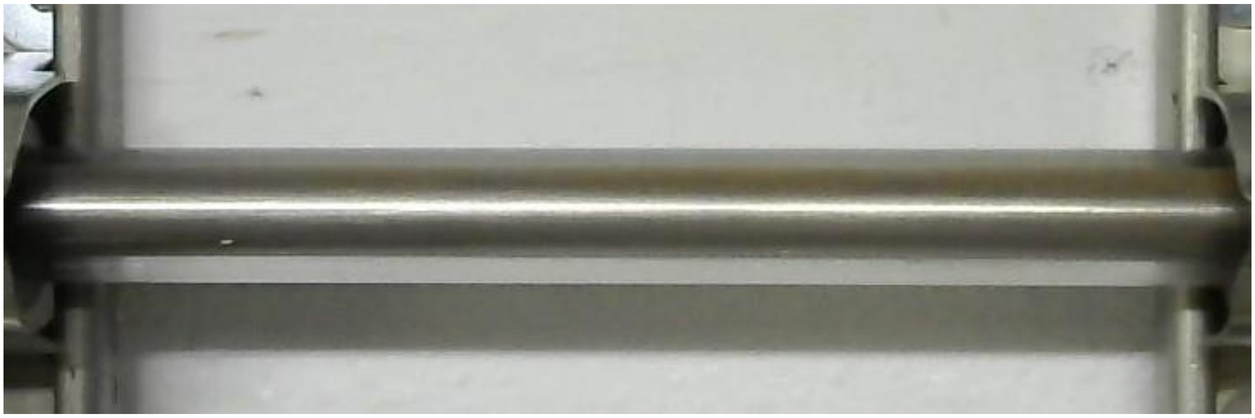




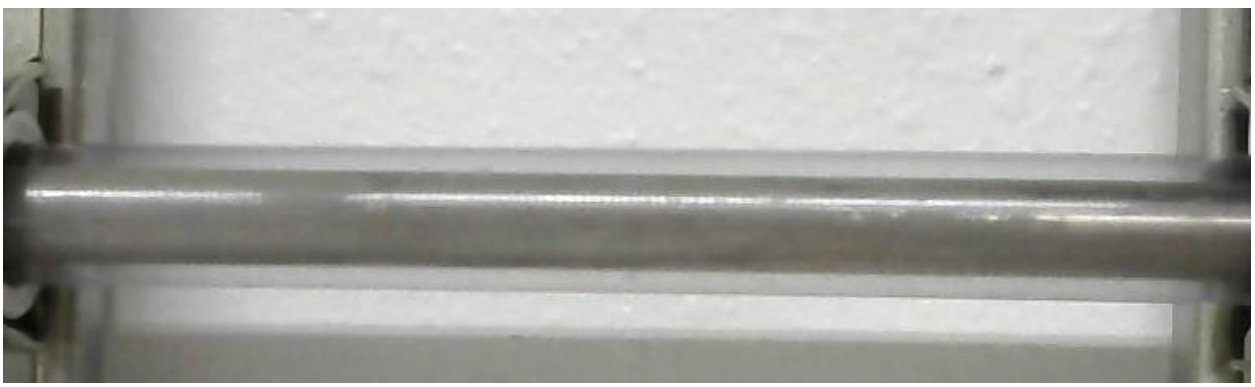
It is difficult to determine if the deposits initially were visible due to settling out on the top surface of the specimens in each exchanger or actual deposition mechanism.

As seen in the video, as time progressed it was obvious that the deposition formed in the control (untreated system) began to grow around the circumference of the specimen, unlike the treated system where the deposited material only accumulated on the top of the tube.

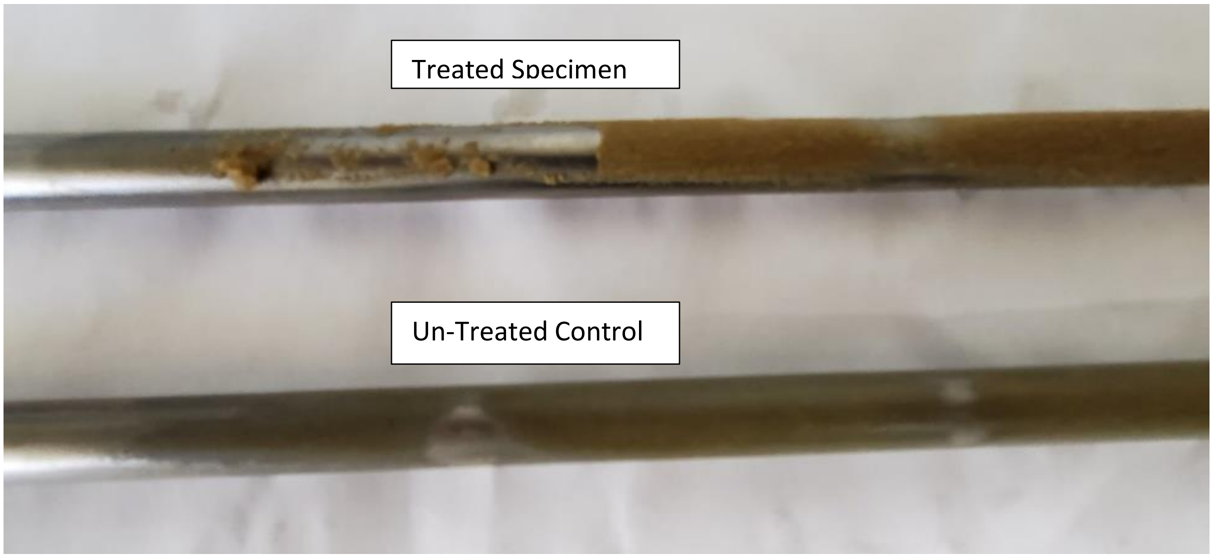
Early accumulation of deposit observed on the top of the HydroFlux treated specimen.



Early accumulation of deposit in the Control specimen (Untreated) shows the beginning of the deposit on the entire circumference of the tube.



At the end of the exposure period the specimens were removed from the exchangers, dried and re-weighed. The following is a comparison of the amount of deposition accumulated on both specimens, along with photographs of the tubes as removed, dried and following the shedding of the deposit from the treated specimen.



The treated specimen deposition was very soft and easily removed from the specimen surface unlike the much more tenacious deposit formed on the control specimen. You can observe a small area on the treated specimen that was slightly bumped which removed the deposit.

When rolling the specimens over to photograph the opposite side the treated specimen's deposit was shed from the tube.

In the chart below the tube was weighed a second time to capture the amount of deposit that simple fell off the top of the tube.

<u>Deposit Weight Comparison</u>

CT#1 HydroFlux Treated Specimen

Initial Specimen Weight	Final Uncleaned Weight After Drying	Deposit Weight
132.24gr	133.59gr	1.35gr
Weight after deposit shed from the specimen	132.63gr	0.39gr

CT#2 Untreated Control Specimen

Initial Specimen Weight	Final Uncleaned Weight After Drying	Deposit Weight
143.84gr	145.46gr	1.62gr

The following is a chart of the various wet chemistry tests that were performed during the evaluation on a daily basis. Please note that a small amount of evaporation did occur over each 24-hour period and as a result additional raw water was added to the basins and pH adjusted. The addition of raw water was not on a set schedule or quantity. Evaporation was not consistent and the topping up of the basin was done to maintain 5-gallon capacity.

CT-1 Cooling Tower HydroFlux Treated

Date	Cond	pH	Ca	TH	Mg	ORP	Cl2	SiO2
9/21	396	8.1	106	132	26	400	0.16	14.8
9/22	442	7.8	86	126	40	420	1.4	14.4
9/23	504	8.3	116	144	28	+500	+2.2	15.4
9/24	536	8.4	108	136	28	464	0.55	15.9
9/25	517	8.3	88	160	72	499	1.33	16.2
9/26	552	8.3	112	132	20	451	0.69	15.3
9/27	584	8.5	96	160	64	460	0.71	18.0
9/28	551	8.5	96	156	60	518	0.83	17.8
9/29	555	8.5	100	160	60	127	<0.1	18.0

CT-2 Cooling Tower Untreated Control

Date	Cond	pH	Ca	TH	Mg	ORP	Cl2	SiO2
9/21	396	8.0	120	140	20	410	0.24	15.9
9/22	428	7.9	110	124	14	425	0.36	14.8
9/23	462	8.3	126	132	6	+500	+2.2	15.3
9/24	487	8.4	96	152	56	361	0.67	16.7
9/25	471	8.5	96	120	24	513	1.28	17.1
9/26	498	8.4	120	130	10	462	0.57	17.6
9/27	524	8.5	112	140	38	470	0.6	18.3
9/28	505	8.5	112	124	12	509	0.67	18.4
9/29	525	8.5	115	130	15	130	<0.1	19.0

Analytical Notes: Calcium, Total Hardness, Chlorine, Magnesium and Silica are reported in ppm as $CaCO_3$. Standard conductance is in microohms. ORP is reported in millivolts.

Observations / Conclusions

Based on the objective of this study it appears that the HydroFlux treatment prevented the same type of typical scale formation seen on the untreated control specimen. The insoluble material accumulated on the top of the specimen and it is thought that this accumulation was due to the extremely low velocity of the testing parameters. It is possible that at a higher velocity this material would be swept out of the exchanger and may have accumulated in the basin. The deposition formed on the untreated specimen, the control, was over the entire circumference of the tube and accumulated more as determined by weight of both the total weight change and significantly more when the accumulated solids fell off of the tube. The consistency of the material accumulated on the specimens were significantly different. The control was much more tenacious, and the treated specimen contained a much more porous appearance and was easily removed.

It appears that the treatment with the HydroFlux technology aids in preventing scale when compared to an untreated control. Additional testing is recommended.

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