

9% INCREASE IN POWER OUTPUT REPORTED

ABSTRACT: A station chemist reports the ability to generate an additional 20 MW following the installation of Hydrolator technology, due to improved condenser cleanliness. The Hydrolator technology enabled the plant to eliminate costly biocidal chemicals and replace them with inexpensive generic bleach. Prior to the installation, bleach was completely ineffective. Both data and operational performance clearly indicate that the Hydrolator technology is the critical factor which has allowed the site to maintain its main condenser at, or near, theoretical cleanliness. Because standard condenser design engineers for maximum rated capacity at 15% fouling of condenser surfaces, the consistent ability to perform at better than design fouling factor amounts to additional cooling capacity - or the ability to generate greater power.

INTRODUCTION: A report follows which is excerpted from a letter dated late Spring of 2000 to one of this client's colleagues. It describes a demonstration installation which started out as chemical cost avoidance and plant clean-up program. What is not described is a surprise bonus of 20 MW additional production. Historically, this plant's peak output never exceeded 236 MW. Since the HYDROLATOR installation, output reached 256 MW, or 9% increase over designed capacity. We at HYDROLATOR have always known that a HYDROLATOR cleaned system goes beyond "design fouling allowances" because of equipment performances measured before and after installation. Consistent performance at or near "theoretical cleanliness" is the expected result, using Hydrolator technology.

HIS REPORT: "After acquiring several months of baseline data, I installed the Hydrolator system in the cooling tower during the fall '99 outage. The primary objective was to reduce the cost of effective biocide feed (targeting the tenacious blue-green alga and black slime molds) and secondarily to produce the maximum attainable state of cleanliness in the cooling tower and condenser. Thus far, it appears to be succeeding better than I had hoped.

"In an effort to control fouling, I was feeding a proprietary biocidal product. It is a mix of sodium hypobromite bleach and bromamines, which I was acquiring at a discounted rate of \$X.xx /pound. Being approximately 38% as hypobromite, it was an effective, if costly, tool. In fact, it was the only product we ever used that worked. It utilized the bromamines, which are largely neutral of charge, to attack the positively charged glycolyx of the alga. The hypobromite serves as the regenerative source of bromine for the bromamides. It worked very well for a while, but by trying to economize, I never fed to the point where the cooling system was completely free of alga. As a result, I

ended up only creating resistant strains. When the resistant strains became the only survivors, the product suddenly stopped working. The product was too expensive to feed like chlorine bleach, and I blew it by trying to economize.

"In the past, as I noted during initial commercial startup, bleach (and all similar variations on the theme) was completely ineffective against alga and slime molds. It didn't seem to matter how high a free residual was maintained. This was largely due to the need that the pH be neutral to acidic for chlorine bleach to work at an optimal level, and also because the above mentioned glycolyx

(a positively charged, modified-sugar slime layer which acts as a protective shell) provides an extremely effective barrier against charged ion penetration. That was the reason for choosing a bromine/bromamine mix; the bromine works better in the alkaline range, and the neutral bromamine is very effective at penetrating the slime layer.

"Since it is known that a properly designed and applied magnetic field will generate a significant electrostatic potential over the bulk of any solvent system and will pump huge amounts of energy into the internal energy side of the free energy equation of both solvent and actual- or potential solutes of the treated system, we thought that we might exploit these qualities and see if we could make chlorine-based bleach work. The objective of this project was to use the HYDROLATOR process to generate a significant electrostatic charge potential (positive relative to earth ground) to obtain a dispersancy action that would act against the protective layer in the alga (like charge repulsion, basically). The long and short of it was that potential energy pumped into the system via the magnetic fields so alters the equilibria of the system chemical thermodynamics that equilibrium favors dissolving the glycocalyx - the slime layer turns to soap and is washed away. This action would open the path to unimpeded attack by chlorine bleach. We would further exploit the tendency of such a configuration to push equilibrium strongly in favor of de-scaling (which seems to work equally well for organics as it does for inorganic scales).

"We obtained, literally overnight, an electrostatic potential in the water of about +400 mV (relative to earth ground), from a baseline potential that ranged from about (-) 150 to (-) 10 mV. De-scaling of silt and organics commenced immediately, to such point that we were cleaning strainers several times a shift. At that point I commenced weekly shock feeding of the bromine/bromamine mix once per week for a period usually lasting about six hours. This differed from my prior feed rates of multiple shocks per week in addition to a 2.5 gal/hour continuous maintenance dose. Visual results were immediately evident, as regards turning the alga and slime molds brown. In each case of shock regimen, a subsequent sloughing off of dead material rapidly ensued. This represented a significant acceleration of previously established cleanup rates, using a fraction of the chemical. Cleanup was accompanied by heavy foaming.

"The savings were immediate: a bulk load of the bromine/bromamine mix costs about \$55,000.00. I would blow through a load in about three weeks. After installing the magnetic assemblies, I had about half a load on hand. It lasted for about 3 months. That paid for the project right there. But it gets better. Towards the end of December I ordered the first load of sodium hypochlorite bleach, and commenced feed to one individual cell at a time, the same as I had been doing all along for the bromine/bromamine mix. It worked. I blew through that load in about 2 weeks with absolutely excellent results and ordered another load.

"About halfway through the 2nd load, I had to discontinue feed, because the bleach ate through the 316 stainless steel delivery lines. It was almost an overnight occurrence, and the feed lines developed multiple system-wide leaks (if you are going to feed NaOCl bleach in stainless, it needs to be in 316UL, seamless). Because the line runs 300+ feet underground, we made the decision to abandon all of the feed lines to the cooling tower and replace them with armored PFA Teflon tubing. It took 3 months to complete the job, a period in which no biocide feed was used whatsoever. During that time, the areas of the cooling tower that had previously been cleaned and de-scaled remained clean, while the remainder continued a slow but noticeable and steady sloughing of scaled organic material.

"I had read and heard first-hand accounts of how organically fouled systems would, under the sole influence of a properly applied magnetic system, clean themselves up without the assistance of any chemicals. I had seen the de-scaling of inorganic scales myself using this technology. But it was amazing to see the organic clean-up process happening on my system. We've got 3 major sewage treatment plants within about 10 river miles of us, and the consequent nutrient and organic loading is significant. It's an ideal environment for microbial growth. All that nutrient broth/solution is sucked right into our system. I had no idea how much organic material had been incorporated into the slime and algae layers until it started coming out. After the first major crud

bursts, which continued for a period of a few months with ever decreasing intensity, I saw an increase in foaming. Apparently, the organics are being turned into soaps. I've heard reports about this, but it's something to see first hand. Throughout the process, the cooling tower system just kept steadily keeps getting cleaner.

"In mid-April, we completed the new bleach lines, and I put the bleach back in service. No crud bursts this time, probably because there were no huge amounts of material left to slough off. But the sudsing intensified. It looked like the combination of the magnetic treatment and the bleaching was converting the remaining organics into detergents. At times it looked like shaving cream. We overflowed the basin to waste treatment in order to decant the foam. It had been going on for about a month, and the foaming was beginning to taper off as the clean up continued. I expected it to largely cease when I finally achieve a pristine state of cleanliness." (Ed. Note: As of December 2002, this has largely happened).

"However, when river conditions result in a heavy influx of organics, the sudsing reappears as process of converting organics into soap begins anew. The stuff is turned into soaps instead of gumming up the system. As of that date, I fed a tank and a half of NaOCl since mid-April. I'm still feeding to the individual cells. I will eventually convert to a basin-wide maintenance dose at sharply reduced levels. And to avoid the development of any resistant strains, I will periodically switch between the NaOCl, bromine/bromamine mix and NaOCl with sodium bromide. It is clear, that the program has already paid for itself in chemicals savings.

"What we put at risk to run this project was ~\$3,500.00. That paid for the custom forms used to contain the magnetic assemblies. The Hydrolator folks did such a good engineering job on these that it took one man and myself only one afternoon to install the entire cooling tower. They were so confident of the results, that they offered us the system to use until such time as we were satisfied that it was working. At that point we started paying them on a monthly basis on a lease to own purchase order, with the option to buy out the contract later. When I was spending about \$55K every 3 weeks during the prime growing season, (it's paid for itself along time ago) now my cost for a tank of bleach is ~ \$2,400/load. Big difference.

"But, wait! There's more!

"Part of the baseline data I accumulated was with the help of a deposit monitor. I've established baseline heat transfer data in order to characterize the losses due to fouling of heat transfer surfaces, most noticeably, the main condenser. Over a period of months, after starting with a meticulously cleaned surface, our untreated system saw a steady decline in heat transfer efficiency that reached an average heat transfer impairment due to fouling of about 8.886 Million BTU's/hour, assuming a 22 degree F temperature rise in the condenser. On the day before the outage in which the magnetics were installed, the heat transfer impairment was at ~962,000 BTU's/hour/degree F, over the entire condense. That's a about 21 Million Btu's/hr, net. Two days after installing the magnets, and without any further biocide addition, the heat loss, from conditions, was at only 18,500 BTU's/hour, net, deviation over the entire condenser. For all intents and purposes, that's theoretical cleanliness! Heat rate wise, I think we will see a lasting beneficial impact as regards back pressure during hot July and August days. As yet, I can not quantify the savings, but it should make the \$ savings in chemicals seem paltry by comparison.

"Additionally, I did Corratel studies before and after on ASTM grade 53B carbon steel. Because of the materials of construction, we have few worries about corrosion. What few corrodible materials are present are there in minor quantity. It would be cheaper to let them fail and eventually replace them with non-corrodible materials than it would be to chemically treat for corrosion. Also, our environmental permit precludes any such chemical programs. Still as a matter of idle curiosity, I monitored the corrosion rates before and after, using sandblasted electrodes of the grade 53B carbon steel. Before the installation, corrosion rates on fresh new electrodes would start out above 100 mils/year, as general corrosion and gradually settle out to

an average of about 12 mils/year. It would jump up and down somewhat, depending upon what was happening in the system.

"Over a period of months, as the passivation layer was established under a coating of hematite, the corrosion rate settled out at an average about 6 mils/year. Above the 2 mils/year recommended level, but not bad at all for an untreated cooling tower system. No significant difference was witnessed between general and general-plus-pitting.

"After the HYDROLATOR installation, initial corrosion rates on a new set of electrodes were about the same, but settled out very rapidly (a couple of hours) to 3 mils/year, and then began a steady decline over the course of a few weeks to ultimately settle out at 0 to 1 mils per year, summertime temperatures. This duplicates the results I got in other systems I've used HYDROLATOR's technology, and amounts to the standard result in their systems that are well grounded. The company will not derive any monetary benefit from this, other than the longer life of some isolated materials, because I'm not spending any money on corrosion control in the first place. But, it is a phenomenon that is worthy of note.

(His Update as of December 2002): "We have been generating and selling an additional 20 MW's above original contract since June of 2000. This has been made possible because we have been able to consistently maintain a high state of condenser and cooling tower cleanliness (we no longer clean either equipment). The income from generation and increased capacity payments, while I cannot disclose the amount, is substantial. We still bleach once every one to two weeks, with standard care and feeding of the condenser. The system is performing so well, that I'm not even monitoring it - I can see at a glance that it is working, and the in-plant operational performance speaks for itself. Feel free to use me as a reference; I'll talk to anybody who is interested."