TITLE OF PAPER:
Reuse of treated municipal wastewater in the cooling systems of coal-based thermoelectric power plants

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ABSTRACT

The growing demand for fresh water and water shortages in many parts of the U.S. have led the power industry, one of the largest water consumers, to look for alternative water sources to meet their cooling needs. This project examined three types of wastewaters with potential to meet power plants' cooling needs: secondary treated municipal wastewater, passively treated acid mine drainage, and power plant ash sluicing pond water. Special focus was directed to the secondary treated municipal wastewater, arguably the most promising alternative cooling water source in terms of its quantity and geographical proximity to power plants.

Municipal wastewater can pose several technical difficulties when used in cooling tower systems due to its quality. Corrosion, scaling, and biofouling are the major challenges. In this study, bench-scale recirculating systems were employed to explore optimal chemical treatment strategies for corrosion, scaling, and biofouling control. Such strategies were then applied to pilot-scale cooling towers operated with the secondary treated municipal wastewater (Figure 1).

Results from the bench-scale study with the secondary treated municipal wastewater indicated that 1) monochloramine is a more appropriate disinfectant for control of biofouling

than free chlorine, 2) tolyltriazole (TTA) is a very effective corrosion inhibitor for copper alloys, even under the elevated oxidation potential due to the presence of monochloramine, and 3) polymaleic acid (PMA) can successfully reduce mineral scale formation.

The effectiveness of monochloramine, TTA, and PMA were examined in the pilot-scale cooling tower testing conducted at Franklin Township Municipal Sanitary Authority, Murrysville, PA. Results of the pilot-scale testing showed that continuous monochloramine dosing to maintain 3 – 4 ppm of monochloramine (as Cl_2) in solution successfully inhibited biomass growth, with the planktonic heterotrophic plate count (HPC) under 10^4 CFU/mL and the sessile HPC under 10^4 CFU/cm^2. PMA effectively reduced calcium carbonate precipitation, and to a lesser extent, phosphate scaling. The corrosion of copper alloys was acceptable even without the addition of any corrosion inhibitor. TTA did not exhibit significant impact on the copper corrosion rates. A scaling layer formed on the metal surface appears to be primarily responsible for corrosion protection of the metal (or metal alloys tested in this study).

Overall, this study provided encouraging results, which suggest that secondary treated municipal wastewater, when treated properly under typical cooling system operating conditions, can be used as a substitute for freshwater as cooling system makeup water.

Figure 1. The pilot-scale cooling towers employed at Franklin Township Municipal Sanitary Authority (Murrysville, PA) to study corrosion, scaling, and biofouling when secondary effluent is used as the cooling tower makeup water.