An Innovative System for the Efficient and Effective Treatment of Non-traditional Waters for Reuse in Thermoelectric Power Generation

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OBJECTIVES

We are evaluating specifically designed pilot-scale constructed wetland systems for treatment of targeted constituents in non-traditional waters for reuse in thermoelectric power generation or other purposes. Non-traditional wastewaters investigated in this study include ash basin waters, cooling waters, flue gas desulfurization wastewaters, and produced waters. The overall objective of this project is to decrease targeted constituents posing risks in non-traditional waters to achieve reuse criteria or to meet discharge criteria established by the National Pollution Discharge Elimination System (NPDES) and Clean Water Act (CWA). Although targeted constituents in non-traditional waters vary from site to site, metals, organics, and biocides are among the more difficult to treat and tend to limit the utility of these waters for reuse or other purposes. Specific objectives of this research are: 1) identify targeted constituents for treatment in four non-traditional water sources; 2) determine reuse or discharge criteria (performance criteria for treatment); 3) configure appropriate pilot-scale constructed wetland treatment systems for each type of non-traditional water; 4) measure performance of pilot-scale constructed wetland treatment systems and removal rate coefficients for targeted constituents using both analytical and toxicological techniques; 5) determine suitability of the treated non-traditional waters for reuse or discharge to receiving aquatic systems; and 6) develop a decision support system for using this approach to renovate non-traditional waters for reuse or other purposes.

ACCOMPLISHMENTS TO DATE

Constituents targeted for treatment in ash basin waters, cooling waters, flue gas desulfurization (FGD) wastewaters, and produced waters have been identified. Ash basin waters are generally low ionic strength waters contaminated with elements or compounds associated with combustion by-products (i.e. bottom ash) from coal burning. The contaminants of concern identified in ash basin waters are predominantly inorganics including arsenic, chromium, mercury, selenium, and zinc. Cooling waters characteristically contain additives such as free oxidants (e.g. ClO_2, HOCl, NaBr, etc.) for control of biofouling within the once-through cooling system. Constituents such as copper, zinc, lead, and other metals may be present in the wastewater from leaching of cooling pipes caused by biocide reactivity. These metals can cause potential problems in receiving aquatic systems, specifically in low hardness waters (e.g. southeastern United States). FGD wastewaters contain various elements including arsenic, chloride, selenium, mercury, and zinc.

Biochemical oxygen demand and chemical oxygen demand in FGD wastewaters may also be elevated. Similar to FGD waters, produced waters contain contaminants of concern that are dominated by inorganics (chlorides, mercury, selenium, arsenic, cadmium, copper, lead, and zinc). Produced waters may also contain some organics (alkanes, alkenes, PAHs, oil, and grease) depending on the source water. National Pollution Discharge and Elimination System (NPDES) permits were obtained from the Environmental Protection Agency (EPA) for each of the non-traditional waters, and these limits were used for establishing treatment goals for this research (discharge criteria).

FUTURE WORK

New, innovative treatment strategies based on comprehensive analysis of non-traditional waters are needed for independent assessments of treatment efficiency, cost-effectiveness, and potential to protect receiving systems from toxic effects that can result from ash basin waters, cooling waters, FGD wastewaters, and produced waters. Pilot-scale constructed wetland systems will be configured specifically for treating the non-traditional waters. Performance of the pilot-scale constructed wetland treatment systems will be measured using both analytical and toxicological techniques, and removal rate coefficients for targeted constituents will be determined. The suitability of the treated non-traditional waters for reuse or discharge to receiving aquatic systems will be assessed, and a decision support system will be developed for using this approach to renovate non-traditional waters for reuse or other purposes.

LIST OF PAPERS PUBLISHED, U.S. PATENT APPLICATIONS, CONFERENCE PRESENTATIONS, AWARDS RECEIVED AS A RESULT OF SUPPORTED RESEARCH, STUDENTS SUPPORTED UNDER THIS GRANT

CONFERENCE PRESENTATIONS

Iannacone, M.M., Eggert, D.A., Rodgers, J.H., Jr., and Castle, J.W. 2006. The Role of an Equalization Basin in a Constructed Wetland Treatment System for Flue Gas Desulfurization Wastewater. Presented at Geological Society of America Southeastern Meeting, Knoxville, TN (March 23-24, 2006).

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