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ADVANCED OXIDATION PROCESSES PROVE SUCCESSFUL

Researchers with Texas Tech University's Hazardous and Toxic Waste Studies Center are investigating the use of ozone and mixtures of ozone and hydrogen peroxide with selected catalysts and U.V. radiation as an advanced oxidation process (AOP) for groundwater restoration. The research project is led by Dr. Richard Wm. Tock of the Department of Chemical Engineering and funded by the Water Resources Center.

Dr. Tock explains, "the commercial production of oxygenated organic compounds frequently generates aqueous product streams from which the desired organics are separated by distillation. These separations produce sizeable flows of process water, known as 'tower bottoms,' which are contaminated with residual traces of the oxygenated organics. The dissolved organics make these process water streams unacceptable as makeup water for cooling towers or as boiler feed water. This is so even though dissolved organic levels are low, and the dissolved inorganics are nonexistent."

Thus, a series of experimental studies is being conducted by the Texas Tech researchers in which simultaneous aeration and AOP are used to reduce the level of total organic carbon (TOC) in a specific process water stream. A reduction of

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Albuquerque Hosts UCOWR

UCOWR Annual Meeting Focuses on Water Rights East and West

Water Rights East and West: Environmental and Allocation Issues is the focus of the 1991 Universities Council on Water Resources (UCOWR) Annual Meeting scheduled for July 30 to August 3, 1991 in Albuquerque, New Mexico.

The meeting is hosted by New Mexico State University, The University of New Mexico and Texas Tech University through the Water Resources Center.

Background

Allocation of water rights has long been a topic of interest and controversy in the arid western United States. In recent years, water allocation issues have intensified as a result of rapidly growing populations, extreme droughts, and a growing awareness of the ecological values of water in natural streams. These factors plus growing conflicts between urban and recreational demands for water also have led to major water allocation controversies in the once water-rich east.

Concepts of water rights differ fundamentally between eastern and western states, but there is increasing awareness that neither the riparian nor the prior appropriations doctrines in their classical forms are adequate to handle current allocation controversies. As water managers face more and more conflicts in allocating scarce

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TOC by 90 percent is targeted. If achieved, this could allow the process water to be utilized in-plant for cooling towers and thereby relieve the burden on biological treatment ponds.

"Basically," notes Tock, "this research seeks first to identify the rate processes which control the destruction of organic matter over a range of contaminant levels. Secondarily, we are looking at the possible products of the oxidation process as a means of determining the success of a given approach." In addition, actual groundwater samples from two petrochemical plant sites in the Texas Panhandle are being used in the investigation.

"Thus far," states Tock, "the parameters having an influence on the destruction of organic matter have been identified as: (1) the amount and nature of oxidant, (2) the catalysts used, (3) temperature and (4) treatment time."

The process waste water used in this investigation contains only dissolved organics. The chief components are formaldehyde, methanol, isopropanol, ethanol, acetic acid, formic acid and pentanol. The groundwater samples contain aromatic and chlorinated hydrocarbons.

Tock explains that in his research, "One to two liter quantities of contaminated groundwater samples are treated with air-ozone mixtures in liquid-gas contacting equipment to increase oxidizer-contaminant contact time and decrease gas stripping. A significant part of the research program centers on the testing of catalysts that allow the desired oxidation to occur at or near ambient temperatures."

All experiments are carried out in a 500 ml flask explains Tock. "Air and the oxidizer, when used, are added in a continuous manner. The air passes through a platinum gauze immersed in the flask. Different quantities of two oxidizing solutions, ammonium nitrate in water (1000 g/L), or aqueous hydrogen peroxide solutions (3 percent H^2O^2 and 30 percent H^2O^2) have been tested for effectiveness in treatment results."

"Thus far," continues Tock, "hydrogen peroxide has been found to be the better oxidizer for these dissolved organics. Temperature was found to have the greatest impact on TOC reduction. Formaldehyde, methanol, benzene and chlorinated hydrocarbon levels were found to be readily reduced by air stripping, while the acids and higher alcohols were observed to be removed primarily through chemical oxidation. The oxidation of the higher molecular weight components was observed to generate additional methanol, formic acid and formaldehyde as intermediate products. In addition, the formaldehyde is believed to form dimers and trimers (dioxane and trioxane) which resist oxidation and are not readily stripped from the water."

"Finally," states Tock, "for this particular waste process water stream, our findings indicate that 90 percent reductions in dissolved TOC can be achieved in reasonable time periods (less than 30 minutes), but only with the use of elevated temperatures and pressure to assist the AOP. "A statistical analysis has also been performed to determine the percentage contribution of the four factors previously identified in the destruction of the dissolved organics. The percentage removal of organic matter is determined by measurement of the chemical oxygen demand (COD) in triplicate before and after treatment. The average is then used as a response in the statistical analysis."

Tock indicates that a mathematical model has been developed to describe the experimental phenomena. The model predicts the rate of COD removal due to physical stripping as well as to chemical oxidation of the organic components. As of this writing, the model has been through a first iteration debugging process. The model predicts that the desired 90 percent reduction in TOC levels for contact times of less than one hour can be achieved at 180°C and 10 atm. This was confirmed with reductions of 92 percent, 94 percent and 94 percent on three runs at the predicted conditions.

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RESEARCHERS INVESTIGATE CAUSES OF AND CURES FOR SEDIMENT DEPOSITION AT BIG SANDY DRAW

Dr. Billy J. Claborn, Professor of Civil Engineering, recently received a grant from the Texas Department of Highways and Public Transportation in response to a research proposal he submitted entitled, "Control of Sediment Deposition at Big Sandy Draw Bridge and Interstate 20."

"Big Sandy Draw in Howard County has deposited sediment to a depth sufficient to impede the flow of storm water through the bridge openings on both access roads and both lanes of Interstate 20," states Claborn. "The sediment has been removed twice in the last three years by mechnical means, but is again approaching the point where flooding of the interstate roadway could occur."

The objective of this study, explains Claborn, is to develop an understanding of the causes of this sediment deposition and to evaluate possible means to alleviate the deposition.

Background

"Moving water has the capacity to carry sediment," notes Claborn. "This capacity is influenced by (1) the velocity of the moving stream; (2) the sediment load of the stream; and (3) the size of the sediment. Two transport mechanisms are generally recognized: (1) material carried in suspension, and (2) material carried by saltation, e.g., 'bouncing' along the bed."

According to Claborn, interactions occur between the three influencing factors. "If the velocity is increased, more sediment can be carried by the stream and the bed of an erodible stream will degrade, thereby adding sediment to the flow and providing additional flow area. Conversely, if the velocity is reduced, for example when a backwater condition is encountered, the power of the stream to transport sediment is reduced and deposition will occur.

"A recent field trip to the research site strongly suggests that backwater caused by the confluence of Big Sandy Draw and Beals Creek has retarded the velocity in Big Sandy Draw, causing deposition of bed load and some suspended material."

During this two-year study, Claborn will investigate the contributing factors involved in the sediment deposition at Big Sandy Draw and investigate possible solutions as well as evaluate the possible solutions as to effectiveness, cost and environmental acceptability.

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water supplies, new legal mechanisms and new analytical tools must be developed to address the environmental, economic, and social impacts of water allocations and reallocations.

This Year's Conference

UCOWR's 1991 conference is designed to provide a broad overview of the legal, environmental, economic, and social issues involved in water allocations and specific examples of such controversies in western and eastern states. In addition, the conference will examine innovative and interdisciplinary approaches to graduate and undergraduate education in water and environmental resources to meet the growing demand for broadly trained scientists and managers in the 1990s.

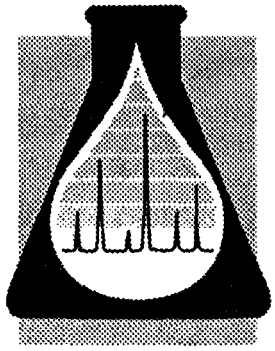
UCOWR is an organization of representatives of over 100 universities in the United States and throughout the world. The purpose of the council is to: (1) facilitate water-related education at all levels; (2) promote meaningful research and technology transfer on contemporary and emerging water resources issues, (3) compile and disseminate information on water problems and solutions; and (4) inform the various publics on water issues with the objective of promoting informed decisions at all levels of society.

The annual meeting will be conducted at the Albuquerque Sheraton Old Town. Registration fees for the conference will be $195 in advance and $225 after July 1, 1991. For more information contact the Water Resources Center at 742-3597.

New Analytical Methods Validated in ESL

The staff and student research assistants of the Environmental Science Laboratory (ESL) and Water Resources Center have started the process of validating several new analytical methods that are used in soil and water analyses. Brad Thornhill, Technician II for the Water Resources Center, says that the primary purpose for the current validation process is in preparation for performing laboratory analyses that will be used in connection with the geologic and hydrologic site characterization study of the Pantex facility located near Amarillo, Texas.

"The Pantex plant manufactures high explosives," states Thornhill. "Some residues of the materials used in this manufacturing process may be encountered in the site characterization study. Therefore, among the completely new laboratory analytical procedures being validated are those for residues of several kinds of high



explosives. The explosives are generally nitrogen-bearing, somewhat water soluble, and biodegradable--thus trace amounts would not be expected to linger in either soil or water."

Dr. Tony Mollhagen, Director of the ESL, says that total chlorophyll is another new procedure being validated in the lab. "This procedure will be used to determine the productivity of the permanent playa lakes maintained at the Pantex site."

Dr. Mollhagen also notes that for some time assays of nutrients (nitrogen and phosphorus species) have been standard tests in the ESL. "Several of these tests, notably Total Kjeldahl Nitrogen and Total Phosphorus, are being validated on new instrumentation," notes Mollhagen. "This new instrumentation [see related article in the January 1991 issue of the WRC Newsletter] will permit better precision and accuracy in the analyses while utilizing smaller samples and a shorter time period. Additionally, many of the analyses will be performed by automation."

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