Treatment of Produced Waters using a Surfactant Modified Zeolite/Vapor-Phase Bioreactor

DE-FC26-02NT15461

Program

This project was selected in response to DOE's solicitation DE-PS26-02NT15373, Focused Research in Air Quality and Produced Water Management in Oil and Gas Exploration and Production, May 3, 2002. Projects within this solicitation addressed either 1) solutions to air quality issues in emission control technology, monitoring technology, or air modeling; or 2) produced water management issues in low-cost treatment technologies, beneficial use of produced water, or best management practices for handling, treatment, and disposal. The goal is to provide solutions to issues that are limiting domestic onshore or offshore production while providing the same or higher levels of environmental protection.

Project Goal

The primary goal of this project is to develop a robust treatment system to efficiently remove organic constituents from produced water in a cost-effective manner. The process consists of a surfactant modified zeolite (SMZ) system developed as part of DOE Contract No. DE-AC26-99BC15221, "Treatment of Produced Oil and Gas waters with Surfactant-Modified Zeolite," combined with a vapor-phase bioreactor (VPB) developed as part of this research.

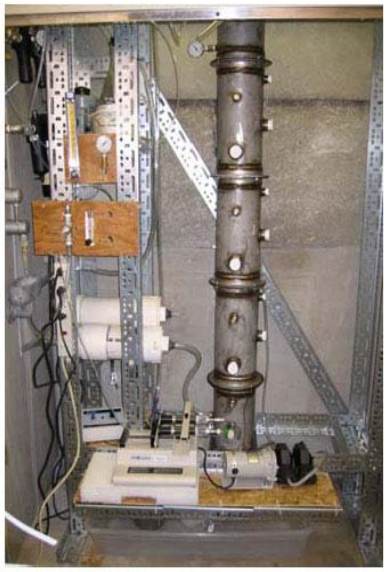
Performers

University of Texas at Austin
Department of Civil, Architectural, and Environmental Engineering
Austin, TX

Department of Earth & Environmental Science
New Mexico Institute of Mining and Technology
Socorro, NM

Project Results

The major accomplishment of this work has been the development of a treatment process for BTEX (benzene, toluene, ethylbenzene, and xylene) removal from produced water that can yield complete destruction of the BTEX compounds.



Waste Gas Composition

Compound	ppm_v
benzene	12
toluene	24
ethyl benzene	32
p & *m*-xylene	20
o-xylene	40
Total	130

Total VOCs Loading Rate = 40 g/m^3-hr

Analysis of waste gas composition in the vapor-phase bioreactor.

SMZ adsorption followed by regeneration has been demonstrated over multiple cycles without loss of adsorption capacity. The vapor phase bioreactor is capable of treating the offgas produced during regeneration and operating over the intermittent cycles of operation that will be required in small-scale systems.

Benefits

Reuse of produced water will greatly impact production costs in the oil and gas industry. Estimated produced-water disposal costs per barrel range from $0.50 to $4.00, based on such factors as transportation, treatment, and reinjection costs. In the United States, the average production of produced water is 10 barrels of water for each barrel of oil. The BTEX/VPB technology is being designed as a robust system to facilitate treatment at water disposal sites, thereby reducing production costs and providing beneficial reuse of the water.

Background

SMZ is an innovative filtration/sorption medium that has been shown to remove contaminants such as BTEX from produced waters. Cost-effective operation of an SMZ requires way to regenerate the SMZ onsite. Air-sparging has proven effective for regeneration; however, this process generates a moist air stream contaminated with relatively low concentrations of volatile organic compounds (VOCs), including BTEX. Because these VOCs are biodegradable and present in dilute concentrations, a vapor-phase bioreactor can be used to destroy the pollutants generated in the SMZ regeneration step. In VPBs, microorganisms growing on a fixed packing media are used to biodegrade organic pollutants found in the waste gas stream being treated. Products of the biodegradation include carbon dioxide, water, and new biomass. Once the VPB is developed, a series of laboratory and field-scale experiments are required to optimize the SMZ/VPB combination specifically for produced water. Furthermore, evaluation and design of the regeneration method for the SMZ process has not been fully addressed in previous research but will be a key component in the success of this project.

Project Summary

In this project, researchers:

- Demonstrated that SMZ can be regenerated over a number of cycles without loss of sorption capacity for BTEX.
- Demonstrated the capability of a VPB to remove BTEX from multicomponent gas streams.

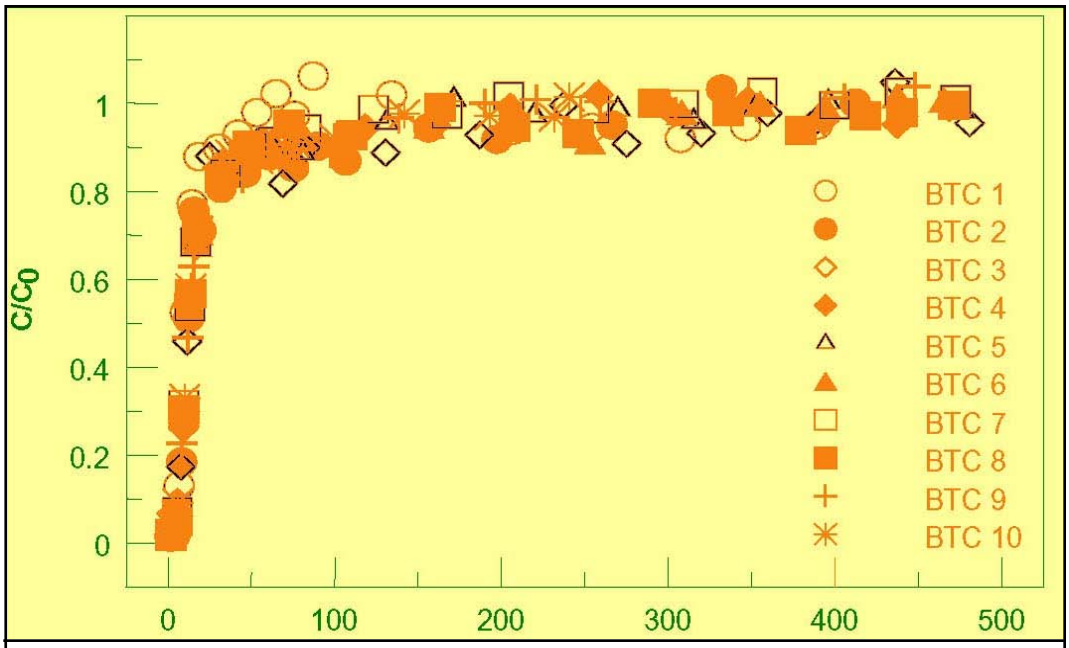
•Demonstrated that the VPB system can rapidly recover from downtime, thus enabling periodic operation during regeneration cycles.

•Quantified BTEX desorption from the SMZ during air-stripping regeneration and developed a correlation that allows prediction of the time required (number of pore volumes) to achieve regeneration based on the hydrophobicity of the compound. (This is an essential task for sizing the VPB system.)

•Designed and constructed the field-scale SMZ/VPB system and associated building at a field site in McGrath, NM, in cooperation with Burlington Resources Inc.

Current Status (July 2005)

Researchers completed construction of the building and reactors for the field-scale evaluation of the SMZ/VPB system in August 2005. A change in location from a site in Wyoming to the McGrath location was made to provide the necessary "pilot" level data for a larger-scale, long-term, follow-on study that was funded based on the results of this project. A no-cost extension request has been submitted to allow researchers to complete the field-scale evaluation and summarize the results of the testing



Pore volumes of produced water.

Publications

Ranck, J.M., Bowman, R.S., Weeber, J.L., Katz, L.E., and Sullivan, E.J., 2005, BTEX removal from produced water using surfactant-modified zeolite. J. Environ. Eng.131:434-442.

Project Start: September 12, 2002
Project End: January 31, 2006

Anticipated DOE Contribution: $783,066
Performer Contribution: $241,176 (24% of total)

Other Government Organizations Involved
Los Alamos National Laboratory

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