Treatment of produced water using a surfactant modified zeolite/vapor phase bioreactor system

Lynn E. Katz and Kerry A. Kinney

Dept. of Civil, Architectural and Environmental Engineering
University of Texas
Austin, Texas 78712

lynnkatz@mail.utexas.edu

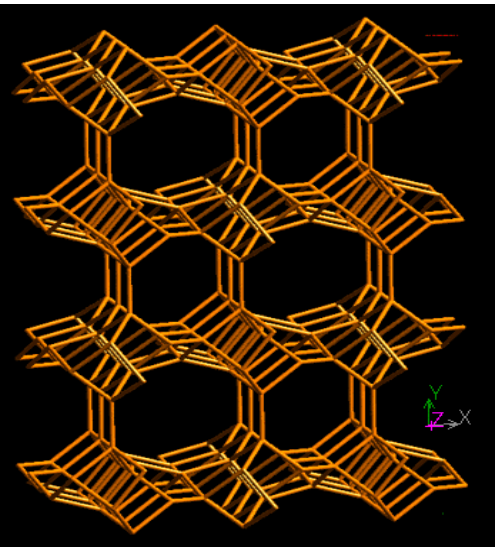
Partners/Subcontractors

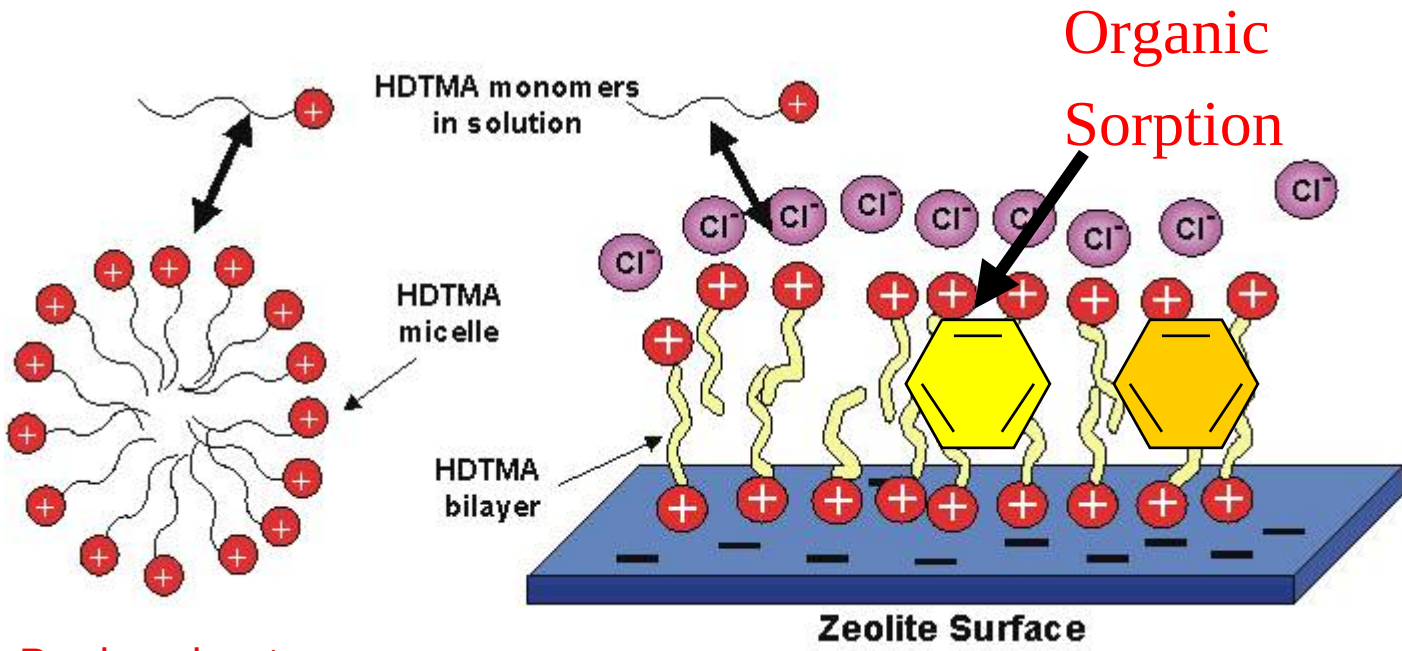
- Robert Bowman, New Mexico Tech
  - Process Development Team
- Enid J. Sullivan, Los Alamos National Laboratory
  - Economic Analysis and Industrial Liaisons
- PNM
  - Field Scale Evaluation
- Burlington Resources
  - Field Scale Implementation

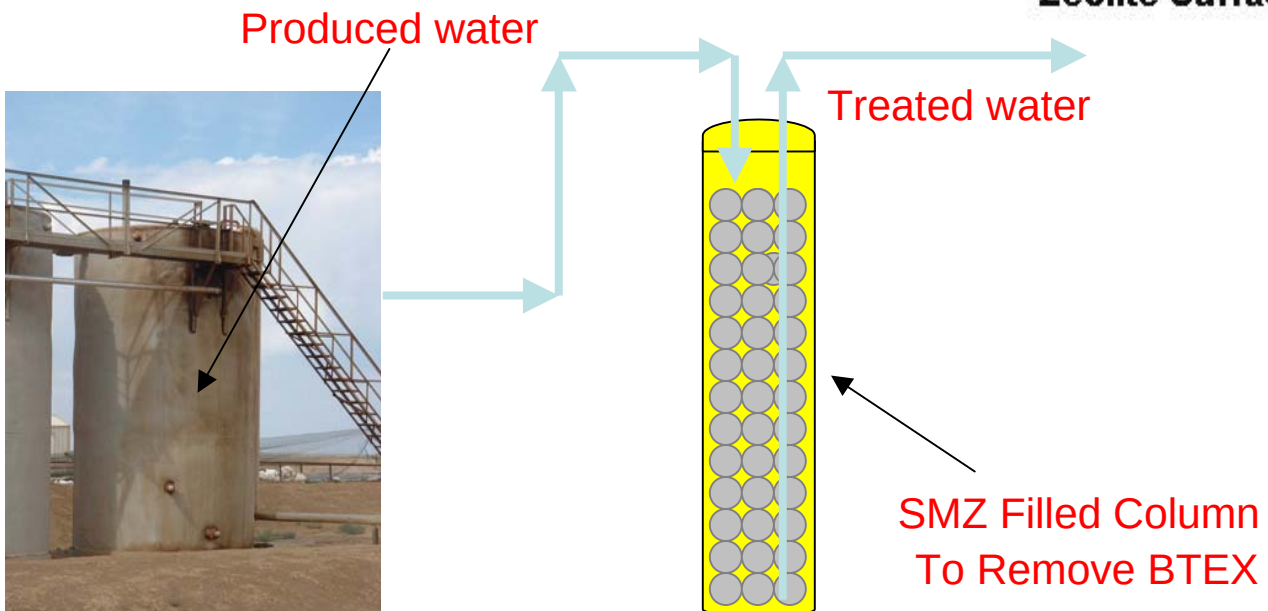
Project Goals

- Develop a treatment system for removing hazardous organic contaminants from produced water
  - 26 billion bbl. (1993) from petroleum, natural gas, and coalbed methane
  - BTEX concentrations in produced water range from 68 – 600,000 μg/L
- Low cost system that can be deployed at the wellhead or at a treatment facility
  - Cost of SMZ is $450 per ton
- Obtain water that is ready for desalination or can be put to beneficial use (dust control, make-up water, irrigation)

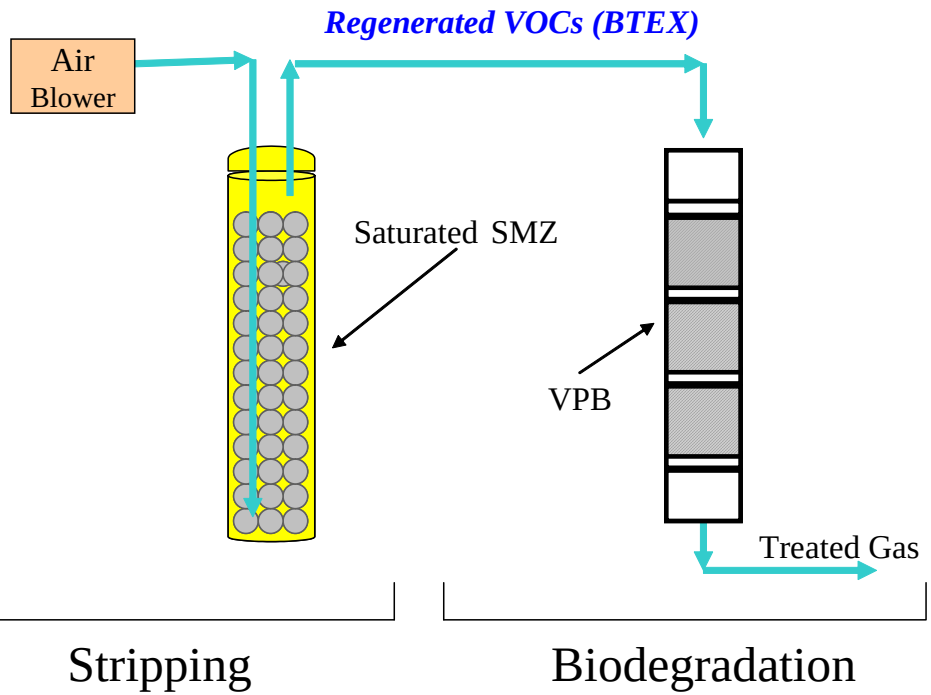
Surfactant Modified Zeolite Sorption Process

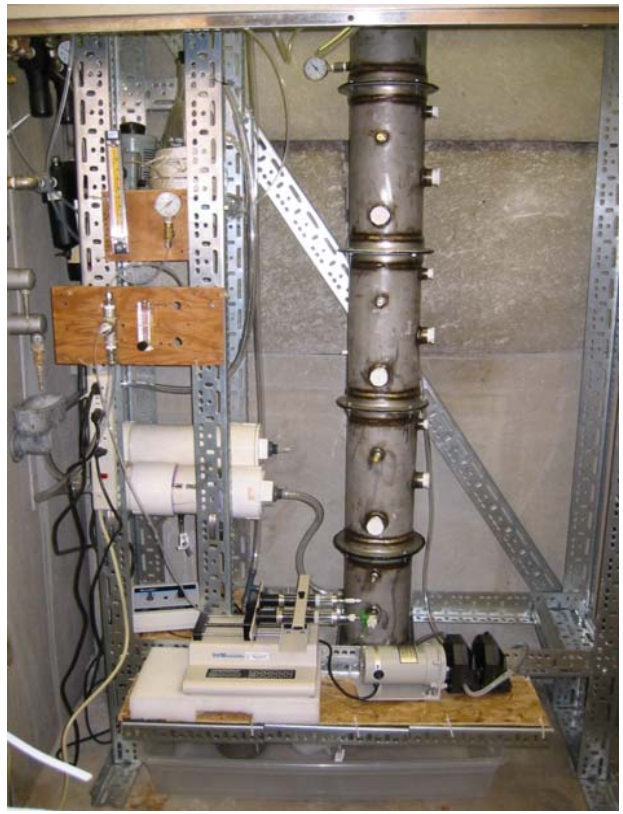


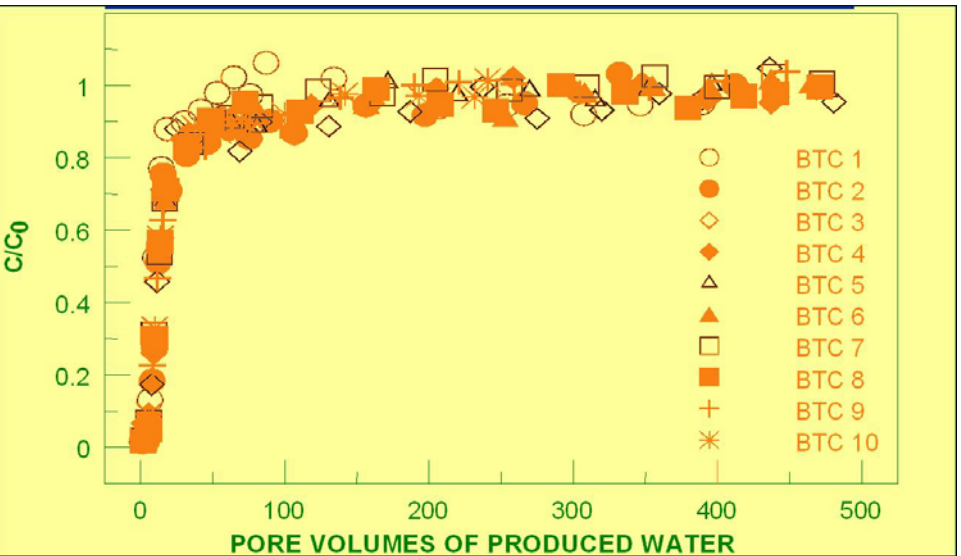




Regeneration and Off-Gas Treatment







Compost-based packing

- Compost (60%),
  Perlite (36.5%),
  Oyster shell (3.5%)
- Contains nutrients

Packing Volume : 12 L

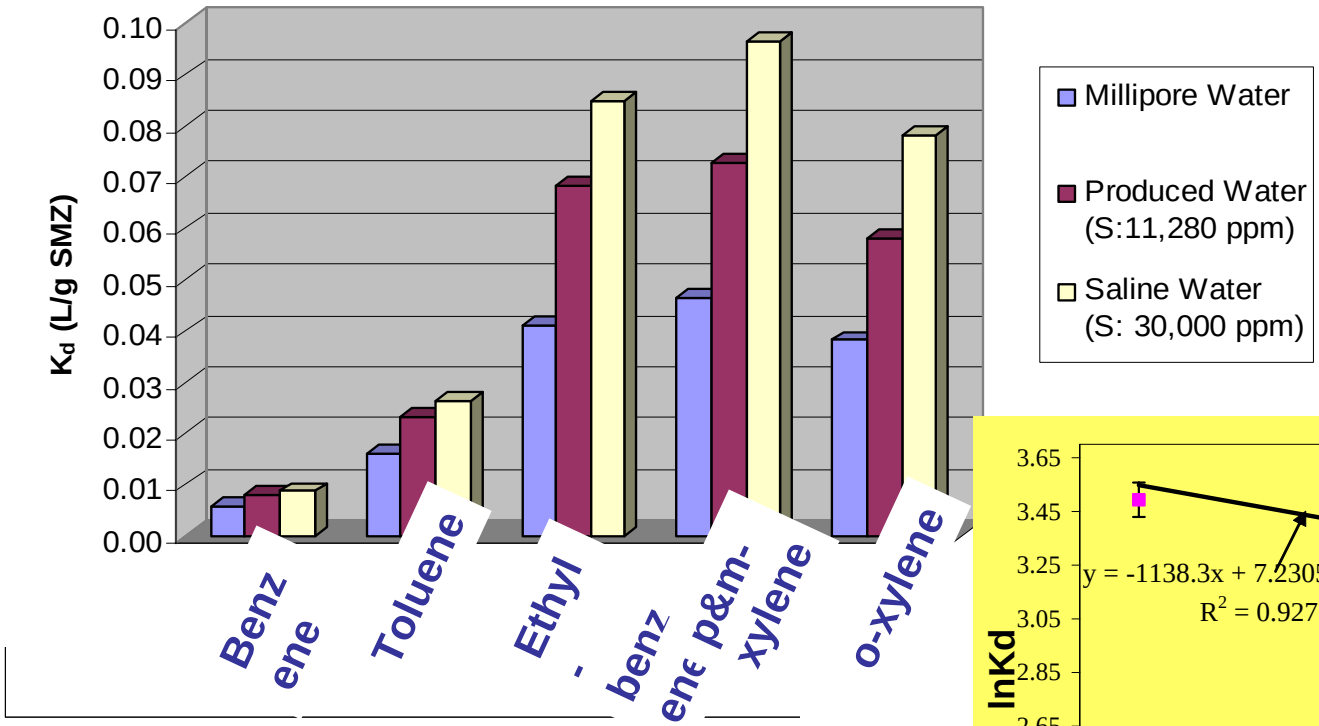
Air flow : 12L/min (1min EBCT)

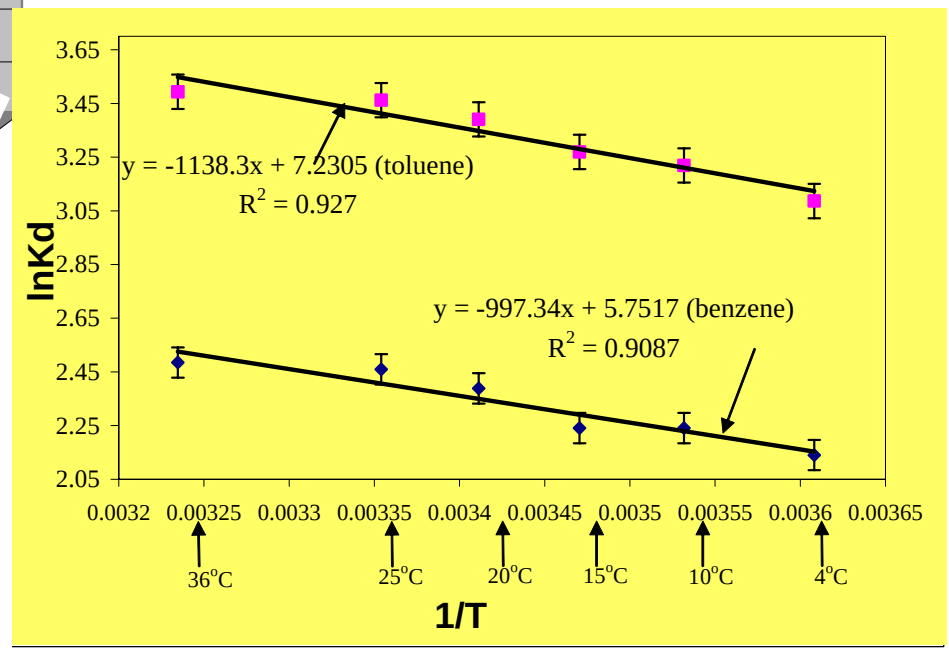
Total BTEX concentration : 130ppm$_v$

(Loading rate = 40g/m^3-hr)

Scope

- Lab Testing of SMZ Sorption/Regeneration



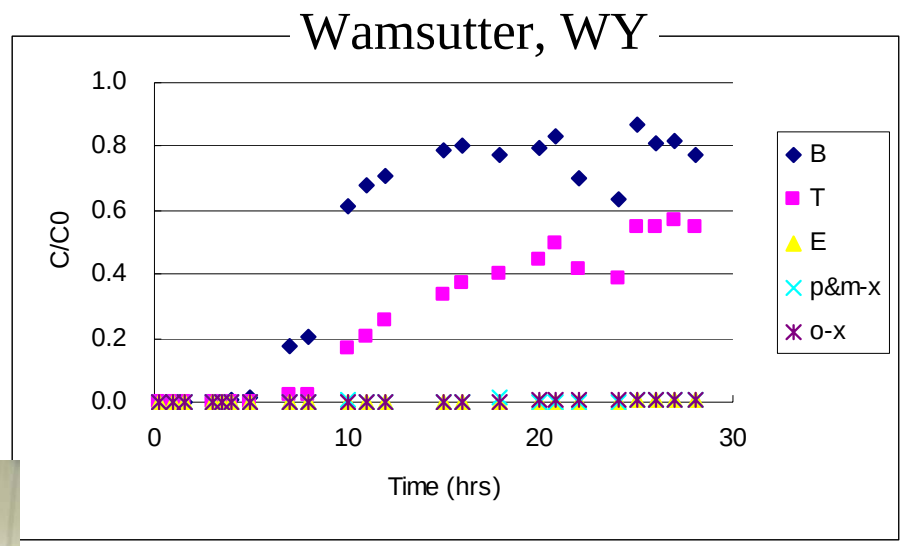


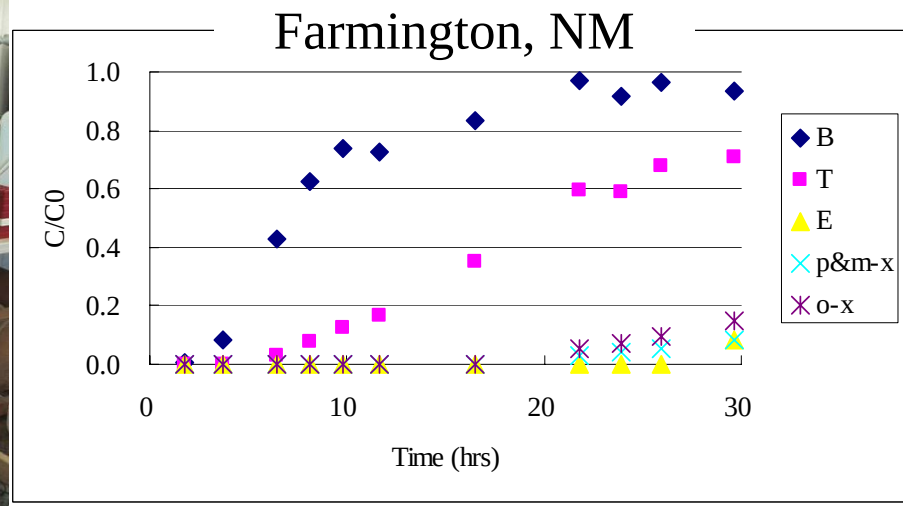
Current Status

- SMZ and VPB Process Development Has Been Completed and Verified in the Field (9/05)
- Long Term SMZ/VPB System has been Designed and Modifications are Underway to Optimize Based on Recent Field Test Results
- Field Site Facility Completed by Burlington
- Project Completion is expected Fall 2007

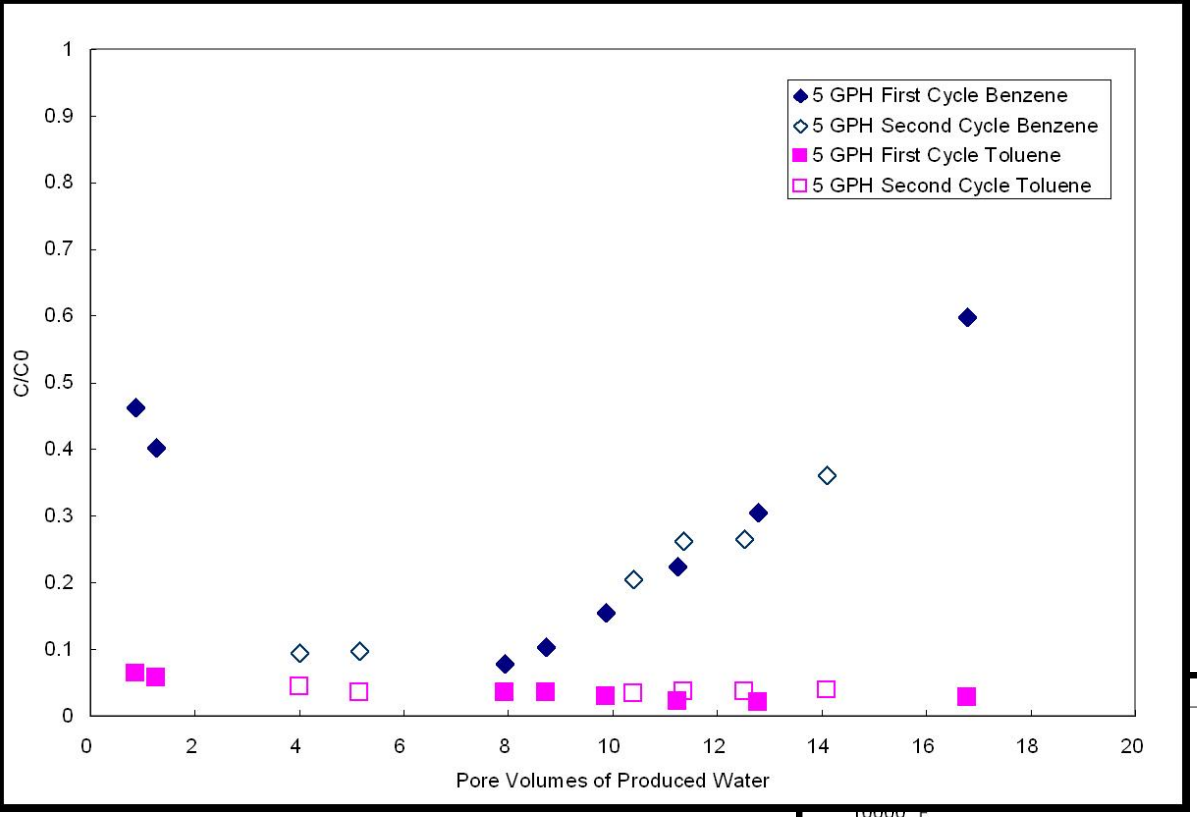
SMZ Field Test Results

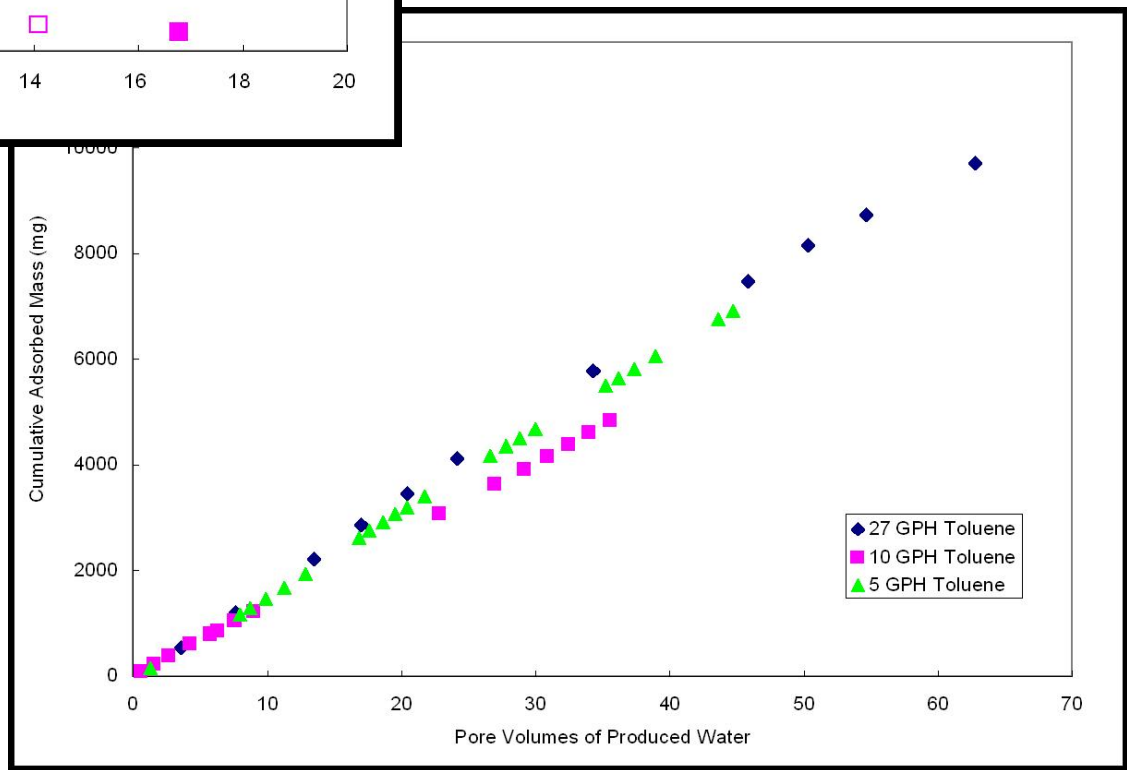
	SMZ System	Coupled SMZ/VPB system
Time	2002	2005
Location	Wamsutter, WY Produced water treatment facility	McGrath, NM Salt water disposal /treatment facility
TDS	12,000	10,000
TOC	1,000	300
Benzene	15.8	2.2
Toluene	36.7	7.1
Ethylbenzene	1.4	0.4
m,p-Xylenes	6.4	3.9
o-Xylene	3.4	1.1



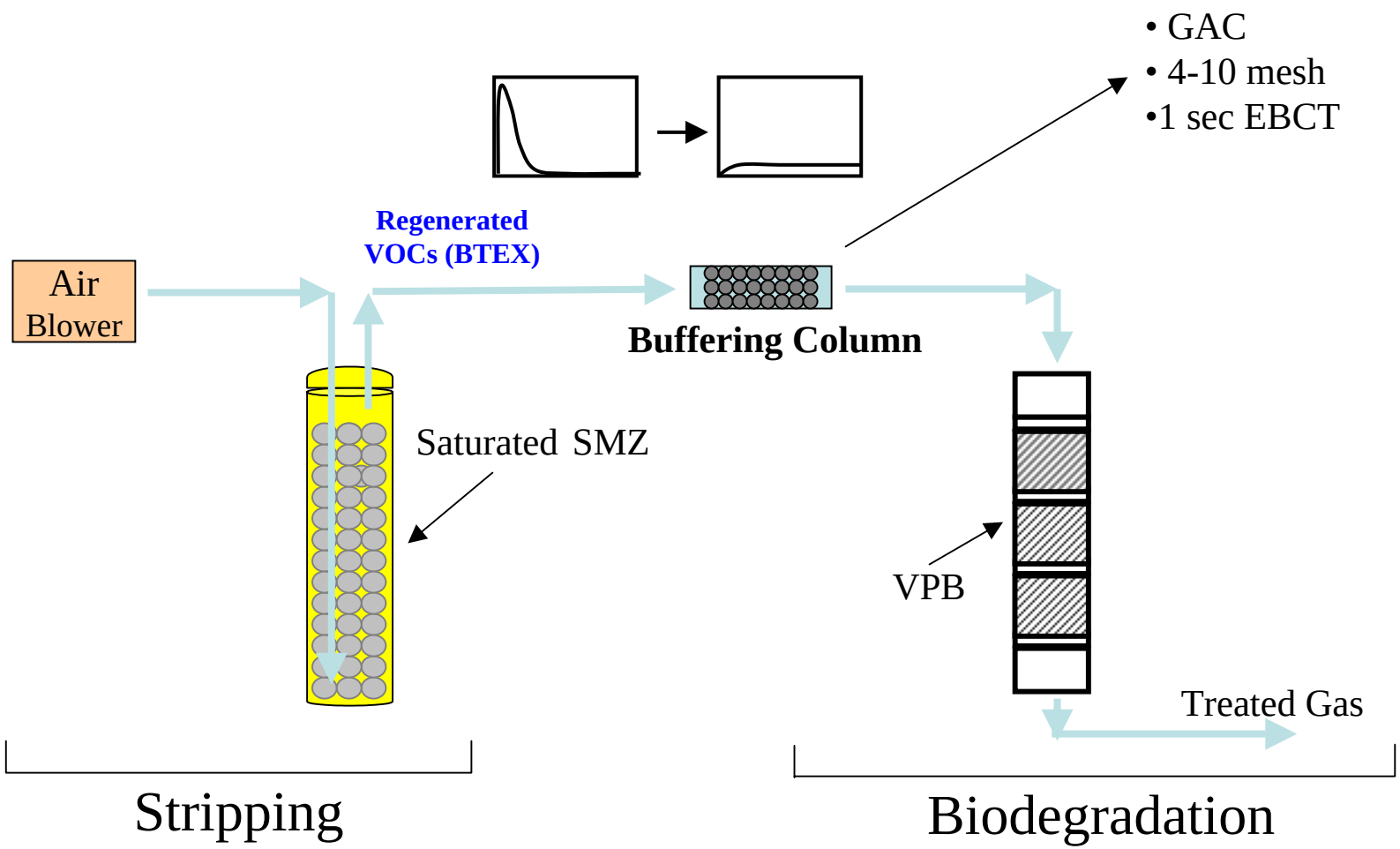


Effect of Multiple Cycling and Flowrate on VOC Removal

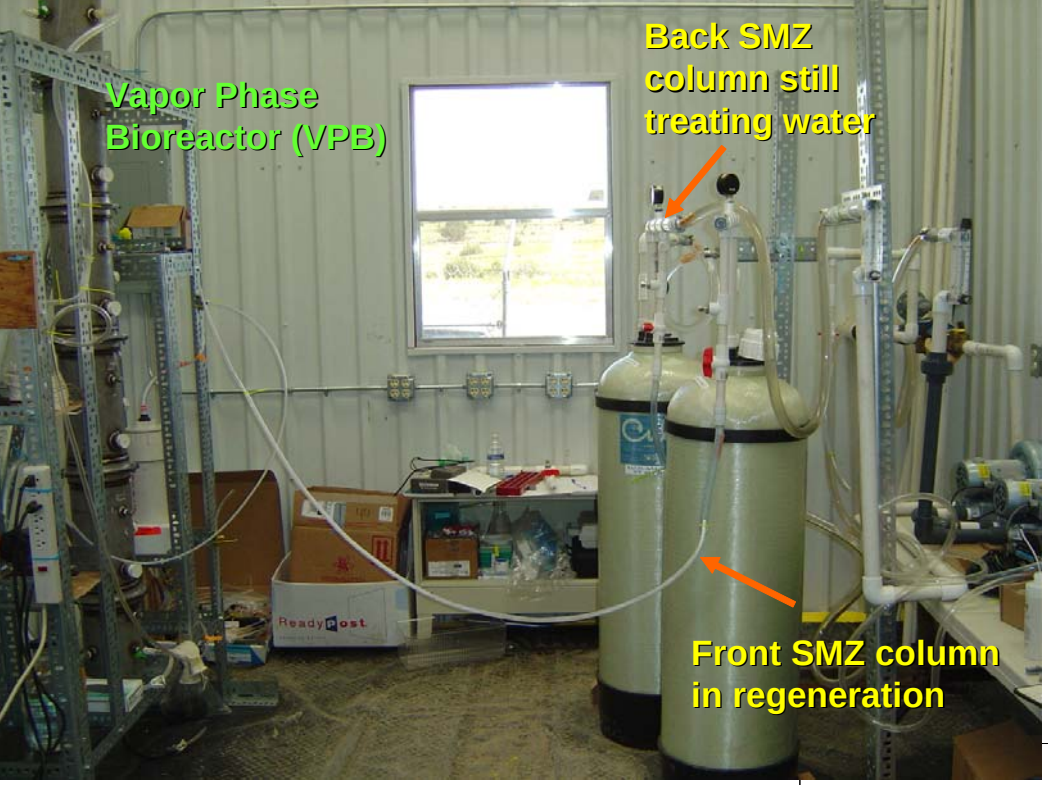




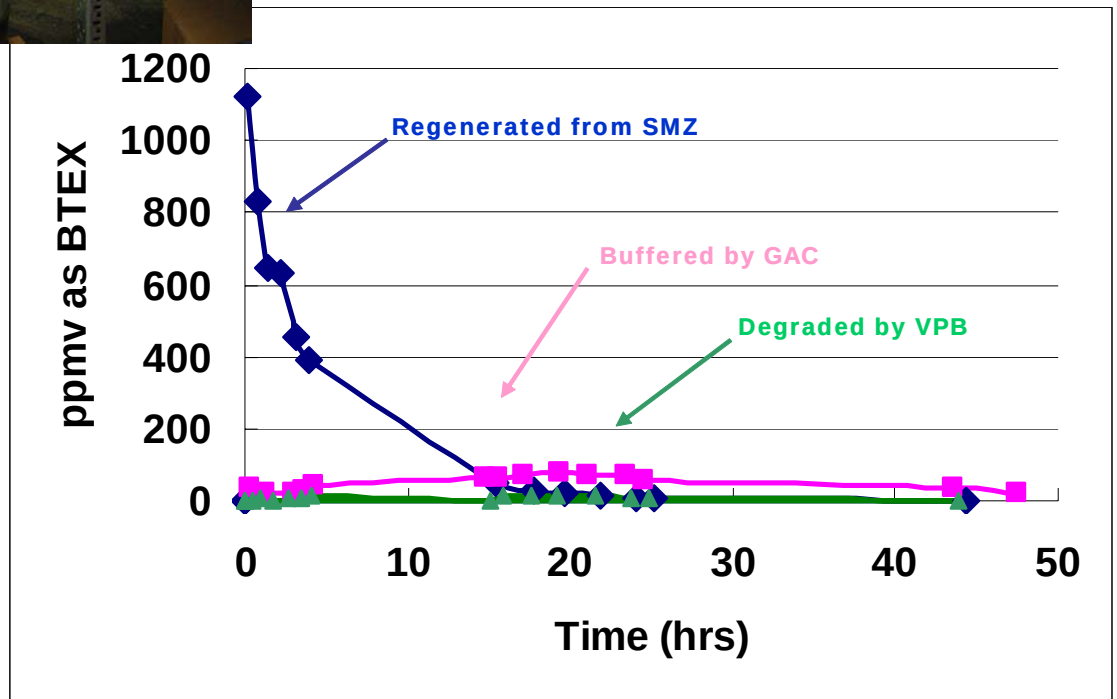
Example Modifications: GAC Buffering



Effect of GAC Buffering



- Max out from GAC:
  75 ppmv at 20hrs
- 20ppmv at 50hrs later



Benefits to Oil and Gas Industry

- Simple, Cost-Effective Method for VOC Removal from Produced Water
  - Usable at Point Source
  - Low Maintenance
  - Insensitive to salt/mineral content, clogging, bacteria
  - ~$3.00/1000 gal for small scale system
- Examining Several Industries for Potential Application
  - Power Industry
    - Process water
  - Oil & Gas Industry
    - Cementing and frac waters
  - Agriculture
    - Irrigation and Livestock Watering
-

San Juan Generating Station
(for cooling towers and APC)

	TDS (ppm)	Chlorides (ppm)	BTEX (ppm)
Current Plant Influent	500	20	0
Produced Water at near by SWD facility	10,000	5360	23
Produced Water Targets for SJGS		1000	<5

Transfer of Knowledge

- Field Test Publications and Presentations
  - **BTEX removal from produced water using surfactant-modified zeolite**. Ranck, J.M., R.S. Bowman, J.L. Weeber, L.E. Katz, and E.J. Sullivan. 2005. J. Environ. Eng.131:434-442.
  - **Treatment of Produced Water with a SMZ-VPB System: Buffering of the Gas Phase Regeneration Stream:** Kwon, Soondong 1, Kinney, Kerry A., Katz, Lynn E., And Bowman, Robert, Presented at the GSA National Meeting, Salt Lake City, Utah, Oct. 2005
  - **Removal of Organic Contaminants From Produced Water Using a Surfactant-Modified Zeolite System,** Altare, Craig R.1, Bowman, Robert S., Sullivan, Enid J., Katz, Lynn E., and Kinney, Kerry A**.,** Presented at the GSA National Meeting, Salt Lake City, Utah, Oct. 2005
  - **Water Treatment Technologies for Oil and Gas Produced Water – Organic Removal Utilizing SMZ/VPB System**, and **New Opportunities For Re-Use of Produced Water - Water Quality and Permitting Issues** Darby, Elaine B/, Katz, Lynn, Kinney, Kerry, Bowman, Robert, and Sullivan, Enid, Abstract Accepted for Presentation at the GSA National Meeting, Salt Lake City, Utah, Oct. 2005
- IPEC, ACS, GSA, NMWRI

Funding

DE-FC26-02NT15461
9/12/02 to 1/31/06

Dept . of Energy	$ 783,066
Univ. of Texas	$ 188, 593
New Mexico Tech.	$ 52, 583
Project Total	$1,024,242

DE-FC26-04NT15546
11/1/04 to 10/31/07

Dept . of Energy	$ 973,970
Univ. of Texas	$ 48,742
Burlington Industries and PNM	$ 194,794
Total Budget	$ 1,217,506