



SITE

SUPERFUND INNOVATIVE
TECHNOLOGY EVALUATION



Demonstration Bulletin

ZenoGem™ Wastewater Treatment Process

ZENON Environmental Systems

Technology Description: Zenon Environmental Systems (Zenon) has developed the ZenoGem™ process to remove organic compounds from wastewater by integrating biological treatment and membrane-based ultrafiltration. This innovative system combines biological treatment to remove biodegradable organic compounds with ultrafiltration to separate residual suspended solids from biologically treated effluent. Zenon claims the technology reduces organic contaminants in wastewater to nondetectable levels, improves effluent quality, and reduces the quantity of sludge for disposal. The major components of the ZenoGem™ system are an influent holding/equalization tank, an enclosed biological reactor (bioreactor), a pH buffer tank, a nutrient solution tank, an ultrafiltration module, an air blower, an off-gas carbon filter, a permeate carbon filter and process, feed, and metering pumps (Figure 1). A pilot-scale ZenoGem™ system, contained in an 8-ft by 48-ft ZenoSite™ trailer, was used for the demonstration.

Contaminated wastewater is continuously introduced into a stirred-tank bioreactor that contains an acclimated aerobic microbial culture. The aerobic suspended-growth environment is maintained by diffused aeration, which continuously mixes the bioreactor's contents. The mixture of organic contaminants and microbes, called mixed liquor, is retained in the bioreactor for a period of time sufficient to allow the microbes to metabolize the organic contaminants into inorganic end-products and intermediate by-products.

The biologically treated effluent is continuously pumped from the bioreactor into the ultrafiltration module. The ultrafiltration module consists of 1-in. diameter tubes connected in series and contained in a 12-ft by 4-in. diameter polyvinyl chloride housing. The tubes support

the ultrafiltration membrane, which filters dissolved contaminants and suspended solids (concentrate) from the biologically treated effluent. Concentrate accumulating on the membrane surface is detached by cross-flow water movement. The concentrate is then continuously recycled to the bioreactor to maintain a desired biomass and to further degrade higher molecular weight organic compounds. Ideally, the filtered effluent (permeate) passing through the membrane does not contain parent organic contaminants. However, the system is equipped with a permeate carbon filter that removes trace organics before the final treated effluent is discharged. According to Zenon, the treated effluent water may be disposed of at a publicly owned treatment works (POTW), reused on site, or discharged directly to surface water under an appropriate National Pollutant Discharge Elimination System permit.

Demonstration Approach: The ZenoGem™ technology was demonstrated at the Nascolite Superfund Site in Millville, NJ from September through November 1994. Groundwater at this 17.5-acre site is contaminated with methyl methacrylate (MMA) and other volatile organic compounds (VOCs) from manufacturing polymethyl methacrylate plastic sheets, commonly known as plexiglass.

During the demonstration, contaminated groundwater was pumped from four production wells into a 6,000-gal equalization tank to minimize variability in contaminant concentrations during the demonstration. Following equalization, the contaminated groundwater was pumped to the 1,100 gal influent holding/equalization tank located in the ZenoSite™ trailer. During full-scale operation, Zenon uses the influent holding tank as the equalization tank prior to treatment. The contaminated groundwater was then pumped into the bioreactor for

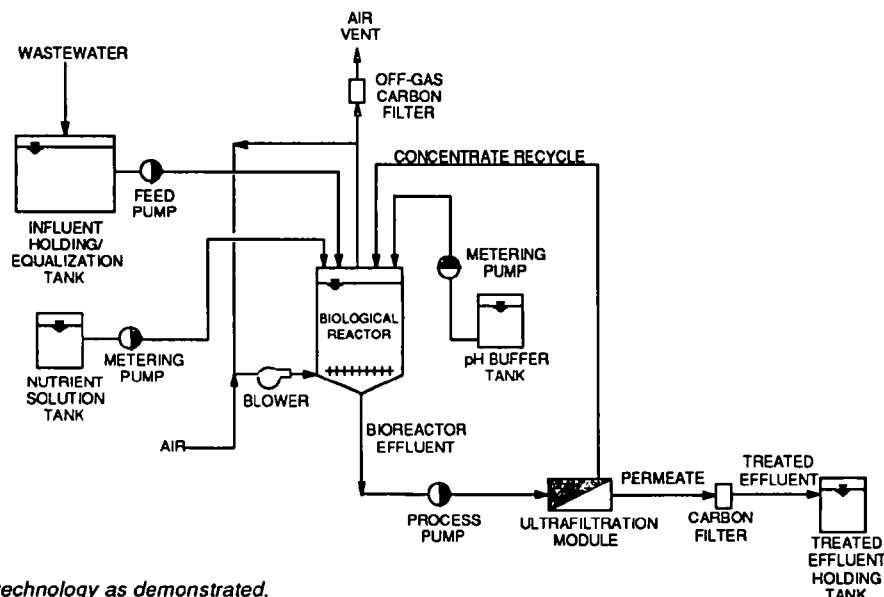


Figure 1. The ZenoGem™ technology as demonstrated.



treatment. Following treatment, effluent water was pumped into a 6,500-gal holding tank prior to disposal at the local POTW.

The demonstration consisted of a continuous operation over a 10-week period, during which MMA concentrations varied from approximately 1,800 ppm to 2,500 ppm and overall flow rates ranged from 350 gallons per day (gpd) to 500 gpd. To evaluate the system under shock loading, MMA concentrations were instantaneously increased from an average of 2,100 parts per million (ppm) to 7,800 ppm for the last 2 weeks of the demonstration. Flow rates during this period decreased to 50 gpd and then eventually increased to 150 gpd. Influent, permeate, and treated effluent samples were collected to determine the technology's effectiveness in removing MMA and chemical oxygen demand (COD) from contaminated wastewater.

Demonstration Results: MMA and COD results from the ZenoGem™ demonstration are presented in Table 1. Findings from the demonstration are summarized as follows:

- Permeate results show that the system achieved average removal efficiencies of >99.9% for MMA and 89.3% for COD. During the demonstration, Zenon decreased the flow rate and achieve an established demonstration objective of 95% COD removal in the permeate stream. After adding a permeate carbon filter as a polishing step, Zenon was able to achieved an average COD removal efficiency of 98.2% in the effluent process stream.

- The system consistently removed MMA at >99.9%. This removal efficiency was maintained even under minor flow rate fluctuations caused by semi-polymerized MMA accumulation in the feed pump.
- The process effluent was clear and odorless, and accepted for discharge by the local POTW.
- The system effectively dewatered the process sludge, which yielded a smaller waste volume for off-site disposal. Sludge dewatering resulted in an approximate volume reduction of 60% and a solids increase from 1.6% to 3.6%.
- The system is computer-controlled and equipped with alarms to notify the supervisor of operational problems.

To provide additional information on the technology's capabilities, samples were collected and analyzed for other VOCs and inorganic constituents. These analytical results and the ZenoGem™ SITE demonstration findings will be discussed in the SITE Technology Capsule and the Innovative Technology Evaluation Report.

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Table 1. MMA and COD Results from the ZenoGem™ Demonstration

Weeks	Number of Samples	Influent		Permeate		Effluent	
		MMA Concentration™ (ppm)	Average Flow Rate™ (gpd)	MMA Concentration™ (ppm)	Percent Reduction	MMA Concentration™ (ppm)	Percent Reduction
1-4	28	2,450	348	0.016	>99.99	NA	NC
5-8	28	1,780	510	0.015	>99.99	ND	>99.99
9-10	14	2,060	497	ND	>99.99	ND	>99.99
Shock Loading	18	7,800	139	ND	>99.99	ND	>99.99
Weeks	Number of Samples	Influent		Permeate		Effluent	
		COD Concentration™ (ppm)	Average Flow Rate™ (gpd)	COD Concentration™ (ppm)	Percent Reduction	COD Concentration™ (ppm)	Percent Reduction
1-4	28	6,750	348	653	90.33	NA	NC
5-9	28	4,900	510	634	87.06	63.81	98.71
9-10	14	6,930	497	1,020	85.35	204	97.06
Shock Loading	18	17,900	139	1,010	94.36	234	98.69

NA Not analyzed ND Not detected TM Average values for weeks noted NC Not calculated

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