

Adsorption-Oxidation – Preliminary Research

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Preliminary research has been conducted involving the adsorption and oxidation of two contaminants, 2-chlorophenol and N-nitrosodimethylamine (NDMA).

2-chlorophenol

Laboratory results are presented in which 2-chlorophenol (2CP) was first adsorbed to GAC and subsequently oxidized via the Fenton-driven mechanism. Transformation of 2CP was indicated by the formation of carboxylic acids and Cl⁻ release. 2CP treatment efficiency, defined as the molar ratio of Cl⁻ released to H₂O₂ consumed, increased with increasing amounts of iron oxide and 2CP on the GAC. The extent of 2CP oxidation increased with H₂O₂ concentration. Lower treatment efficiency was evident at the highest H₂O₂ concentration utilized (2.1 M) and was attributed to increased ·OH scavenging by H₂O₂.

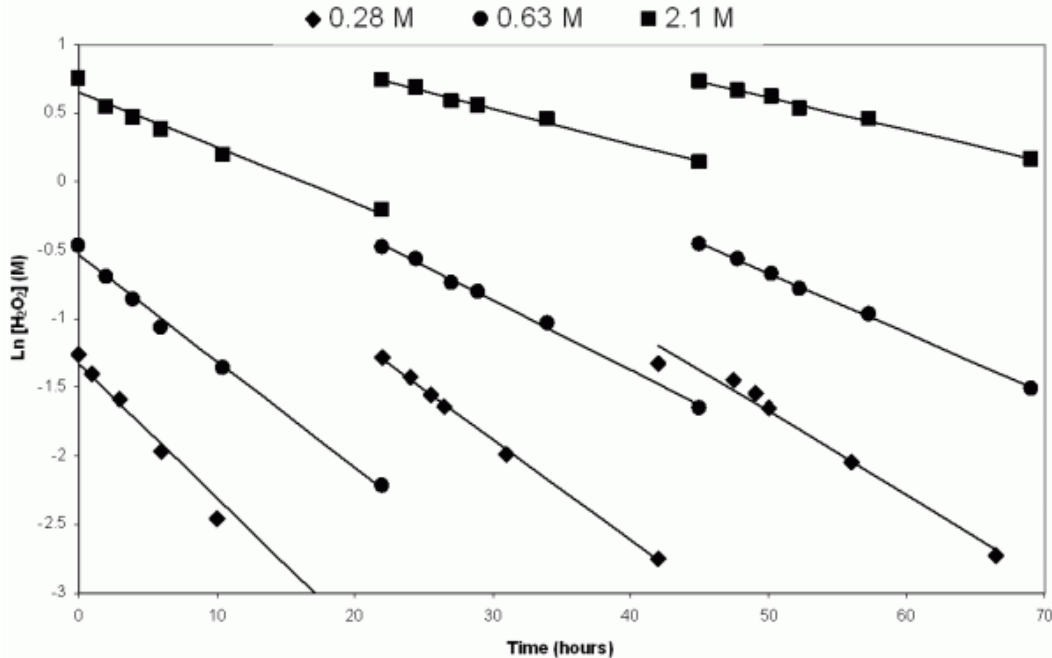


Illustration 1: Log-linear, time-dependent concentrations of H₂O₂ in batch reactors containing GAC ($FeT = 5500.0$ mg/kg)

Aggressive oxidation procedures used in sequential adsorption/oxidation cycles did not alter the GAC surface to a degree that significantly interfered with subsequent 2CP adsorption reactions. Although process feasibility has not yet been established beyond

bench-scale, experimental results illustrate the potential utility of the adsorption/oxidation process in above-ground systems or permeable reactive barriers for the treatment of contaminated ground water.

Huling, S.G.; Arnold, R.G.; Sierka, R.A.; Jones, P.K.; Fine, D. 2000. "Contaminant Adsorption and Oxidation via Fenton Reaction." *J. Environ. Engin.* 126, (7), 595-600.

N-nitrosodimethylamine

N-nitrosodimethylamine (NDMA) is a highly toxic microcontaminant that was first detected in groundwater tainted by rocket fuel manufacturing wastes. Treatment by carbon adsorption is costly because NDMA partitions only sparingly to carbon and frequent carbon replacement or regeneration is required. If activated carbon could be regenerated cheaply and quickly in-place, this easily implemented technology would become attractive. In this study, the feasibility of adsorption of NDMA onto carbon followed by in-place regeneration using Fenton's reagents is assessed.

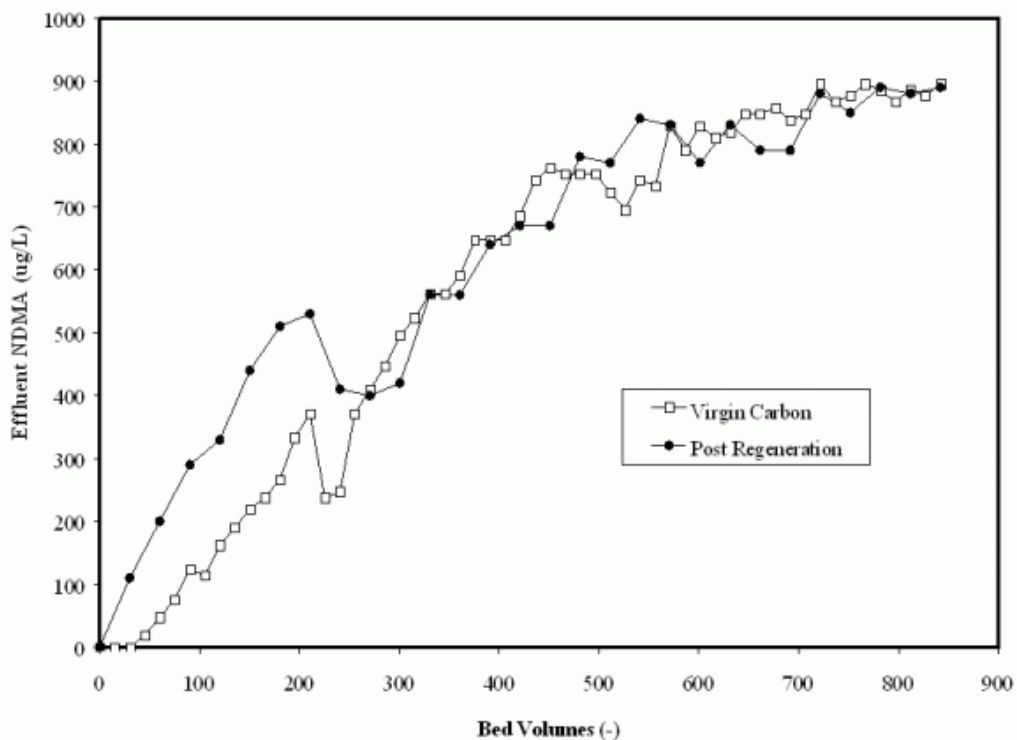


Illustration 2: N-nitrosodimethylamine breakthrough in virgin and Fenton-regenerated granular activated carbon.

Batch and column tests indicate that carbon-sorbed NDMA can be destroyed to nondetectable levels in hours using reasonable hydrogen peroxide and iron concentrations. Three-log destruction of sorbed NDMA on carbon loaded to 1.04 mg NDMA/g carbon was achieved in approximately 12 hours. Results of both readsorption studies and modified iodine number tests indicated that the aggressive regeneration treatment results in little loss of carbon adsorptive capacity. The destruction efficiency of Fenton's reagents was dependent on pH and hydrogen peroxide concentration, although little advantage was obtained at very high hydrogen peroxide concentrations. Iron solubility and availability for participation in Fenton's reaction was enhanced by addition of EDTA at near neutral pH, but the NDMA destruction efficiency was still more efficient in a comparable system without the ligand at pH 2.

Kommineni, S.; Ela, W.P.; Arnold, R.G.; Huling, S.G.; Hester, B.J.; Betterton, E.A. 2002. "NDMA Treatment by Sequential GAC Adsorption and Fenton-Driven Destruction." *J. Environ. Eng. Sci.* 20(4)361-373.

U.S. Patent

A patent has been granted on behalf of U.S. EPA. by the U.S. Patent and Trademark Office (<http://www.uspto.gov/>) regarding the Adsorption/Oxidation technology. Through the Environmental Technologies Program, EPA GWERD is collaborating with EPA Tech Match (<http://www.epatechmatch.com/epa/index.aspx>) to develop partnerships with companies that would employ the use of the technology. Specifically, EPA is interested in a partnership with a company and/or an agency to enter into a cooperative research and development agreement (CRADAs). The purpose of a CRADA is to widen the scope of research being conducted and to advance the technology further (Refer to Carbon Regeneration Final.pdf and NTTC website for Technology Opportunities Announcement)

Huling, S.G., R.G. Arnold, R.A. Sierka. December 16, 2003. "Contaminant Adsorption and Oxidation via Fenton Reaction." Patent No. US 6,663,781, United States Patent and Trademark Office. Application No. 09/649/816 (Aug. 28, 2000). 19 Claims, 7 drawing sheets. Washington, D.C. 20231.