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NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION RESEARCH

Fenton-Driven Regeneration of MTBE-Spent Granular Activated Carbon – Effects of Particle Size and Iron Amendment Procedures

Abstract

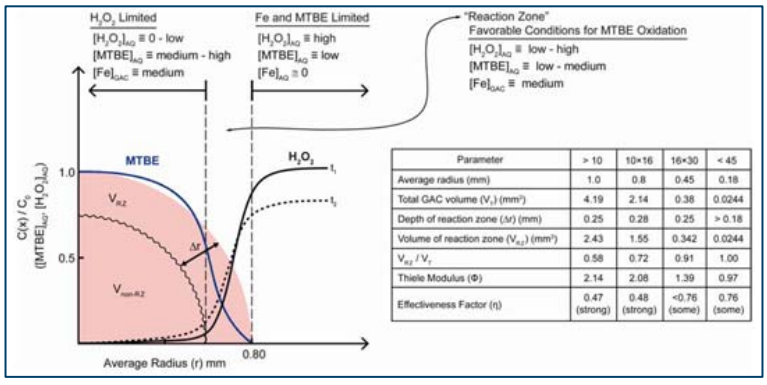
Fenton-driven regeneration of spent granular activated carbon (GAC) can be used to regenerate organic contaminant-spent GAC. In this study, researchers evaluated the effects of GAC particle size (greater than 2 millimeters [mm] to less than 0.35 mm) and acid pre-treatment of GAC on Fenton-driven oxidation of methyl tert-butyl ether (MTBE)-spent GAC. Iron was amended to the GAC using two methods:

- Untreated, where GAC was amended with a concentrated solution of ferrous sulfate
- Acid pre-treatment, where GAC was amended with acid followed by sequential applications of a dilute ferrous sulfate solution

Subsequently, MTBE was amended to the GAC, followed by oxidative treatments with hydrogen peroxide (H_2O_2). H2O2 reaction and MTBE oxidation were inversely correlated with GAC particle size and were attributed to shorter intra-particle diffusion transport distances for both H_2O_2 and MTBE. Image analysis of the GAC cross-sections (i.e., prepared thin sections) revealed that the iron amended to the GAC extended to the center of the GAC particles. Iron accumulated at higher levels on the periphery of the untreated GAC, but iron dispersal was more uniform in the acid pre-treated GAC. In the acid pre-treated GAC, conditions for MTBE oxidation were favorable and greater levels of MTBE oxidation were measured for all particle-size fractions tested. Modeling and critical analysis of H_2O_2 diffusive transport and reaction indicated limited H_2O_2 penetration into large GAC particles, which contributed to a decline in MTBE removal. Residual MTBE remaining on the GAC limited the quantity of MTBE that could be re-adsorbed, but no reduction in MTBE sorption capacity resulted from oxidative treatments.

Products

Huling, S.G., E. Kan, and C. Wingo. (2009). “Fenton-Driven Regeneration of MTBE-Spent Granular Activated Carbon – Effects of Particle Size and Iron Amendment Procedures.” *J. Applied Catalysis B: Environmental*, 89, 651–657.



Parameter	> 10	10×16	16×30	< 45
Average radius (mm)	1.0	0.8	0.45	0.18
Total GAC volume (V_T) (mm³)	4.19	2.14	0.38	0.0244
Depth of reaction zone (Δr) (mm)	0.25	0.28	0.25	> 0.18
Volume of reaction zone (V_{RZ}) (mm³)	2.43	1.55	0.342	0.0244
V_{RZ} / V_T	0.58	0.72	0.91	1.00
Thiele Modulus (Φ)	2.14	2.08	1.39	0.97
Effectiveness Factor (η)	0.47 (strong)	0.48 (strong)	<0.76 (some)	0.76 (some)

Conceptual model of H_2O_2 penetration into GAC particles. The H_2O_2 penetration depth was used to estimate the width and volume of the reaction zone.