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Development and Evaluation of a Mn Oxide Adsorbent

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Quarterly Progress Report

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by

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Development and Evaluation of a Mn Oxide Adsorbent

This progress report begins with a summary of work over the past three month period and concludes with a brief discussion of plans for future work. Most of our efforts in the early stage of the project have been directed toward screening and selection of granular activated carbon (GAC) samples for use as the substrate in preparing the composite adsorbent, and evaluating the Mn oxide coating on the GAC surface.

Characteristics supplied by manufacturers were reviewed for approximately 15 different types of GAC. Our objective in this review process was to select test samples with a range of pore volumes and surface areas for further testing. Additional evaluation of GAC surface and bulk properties is in progress, but the current summary of GAC characteristics (Table I) demonstrates a considerable range in surface area and pore volume. Table I includes the results of pH measurements from deionized water extracts of the GAC samples. These results indicate a range of acid and base properties for the solids; we expect this range will play an important role in the adsorption characteristics.

Table I. Summary of GAC characteristics.

	Granular Activated Carbon Sample				
Parameter	Darco	F400	SGL	APC	WVB
Raw Material	lignite coal	bituminous coal	bituminous coal	bituminous coal	bituminous coal
Mesh Size	8 x 30	12 x 40	8 x 30	12 x 40	10 x 25
Surface Area (m ² /g)	625	900 - 1100	900 - 1100	1525	1400 - 1600
Iodine Number (mg/g)	600	NA	900	1265	900
Pore Volume (cm ³ /g)	0.93	0.85 - 0.95	0.85	1.00	1.1
Extract pH	4.4	8.9	8.1	6.4	4.9

The GAC sample identified as APC has been through an initial evaluation of the MnO₂ coating process. Briefly, coatings were prepared by suspending a sample of GAC in a dilute solution of MnSO₄ (14.57 mg Mn / g GAC). Concentrated (4% - 6%) HOCl was added to oxidize the Mn(II), the suspension was agitated for 30 min, the composite adsorbent was washed with DI water, and the solids was dried for 120 h at 60°C. The amount of coating was quantified by extraction for 0, 3, and 24 hr with hydroxyl amine sulfate adjusted to pH < 2 with HNO₃. Results (Table II) indicate that only about 10% of the applied Mn formed a surface coating.

Current tests are using modified coating procedures in an attempt to increase the coating efficiency.

Table II. Evaluation of MnO_2 coating efficiency for three replicates at three different extraction times. The applied dose was 15.6 mg Mn per g GAC.

Extraction Time (hr)	mg Mn / g GAC		Efficiency (%)
	Average	Standard Deviation	
0	1.31	0.08	9.0
3	1.82	0.15	12.5
24	1.22	0.13	8.4

Finally, future work will begin to examine the surface chemical characteristics of the Mn oxide-coated GAC. In initial tests, each of the test GACs will be used to prepare five different Mn oxide-coated GAC composite adsorbents. These composite adsorbents will be evaluated through batch tests to identify the solid with the greatest copper adsorption capacity. This "optimum" adsorbent will be subjected to a series of tests to examine coating efficiency (influence of particle size, effect of multiple coating cycles), evaluate equilibrium and kinetic adsorption behavior, and assess removal and regeneration in column tests.

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