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"Effects of Aging on Treated Activated Carbons"

Submitted by: Energy & Environmental Research Center (EERC)

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PARTICIPANTS

Sponsor	Cost Share
U.S. DOE	$40,870
EPRI	$25,000
SaskPower	$10,000
Otter Tail Power Company	$ 5,000
NDIC	$40,000
Total Cost	$120,870

Project Schedule – 10 Months
Contract Date – 6/19/07
Start Date – 6/1/07
Completion Date – ~~3/31/08~~
Extended To – 3/31/09

Project Deliverables
Status Reports:
9/30/07 (✓); 12/31/07 (✓)
Final Report: ~~4/30/08 ( )~~
4/30/09 (✓)

OBJECTIVE / STATEMENT OF WORK:

EERC proposes to evaluate the effects of storage on activated carbons (ACs) by evaluating the aging effects that might alter the physical or chemical properties of the ACs, which could impact the mercury capture efficiency.

FINAL REPORT SUMMARY

Purpose of the Project: A previous multi-year project headed by the Energy & Environmental Research Center (EERC) showed that halogenated activated carbon (AC) performed very well, with mercury capture rates often ≥90%. However, differences were noted between treated ACs with respect to reactivity and capacity, possibly as a result of storage conditions. In order to further investigate this potential degradation of treated (halogenated) ACs, the EERC-led consortium assessed the aging effects of brominated ACs for the effect that different storage durations, temperatures, and humidity conditions have on the mercury sorption capacity of treated ACs.

Work Accomplished: A significant body of research exists that compares a control batch of activated carbon to several other carbons, both treated and untreated, on the EERC's bench-scale mercury test system. This system allows a simulated flue gas mix of known concentrations to flow through a fixed

bed of activated carbon while a continuous mercury monitor measures the amount of mercury exiting the system. By measuring the initial reactivity of the carbon as well as the point at which the mercury breaks through to 50% of the inlet mercury concentration, comparisons can be made to the performance of the baseline control carbon. Using specially-constructed chambers to control both humidity and temperature, several batches of halogenated carbons were aged and tested for reactivity and capacity on the bench-scale system.

Project Results: No major aging effects on initial capture activity were observed for any carbons or conditions in the investigation. As measured by the 50% breakthrough time, no changes in capacity were observed for commercial control carbon stored frozen and likely none for these samples stored under high humidity conditions. The major aging effects on capacity for the EERC brominated sample were seen as a decrease in capacity during the first week of storage under high humidity conditions. Storage of the control carbon and the EERC 5% brominated samples under low humidity conditions resulted in slightly improved capacity. It appeared that all changes to the carbon for mercury capacity resulted within the first few weeks, after which no significant change was found.

Of particular interest to the project was how bromine and carbon surface chemistry changed as a result of aging under different conditions. Surface analysis using x-ray photoelectron spectroscopy (XPS) showed some migration of bromine to and from the surface occurred during storage, although no net loss of bromine was observed. The migration to the surface in the case of the 15% brominated carbon correlates with the increased capacity observed for this sample. The XPS elemental speciation data for the EERC brominated carbons showed a change in the bromine speciation with time during storage. This was especially great for the carbons that had 15% and the 5% bromine treatment that were stored in low humidity conditions. The carbon speciation data showed generally more oxidization of carbon surfaces with storage, especially formation of carboxylate groups. The observed changes in surface chemistry could be related to the minimal changes in capacity observed, but the factors operate in different directions, so the relationships are complex. High-quality x-ray absorption fine structure spectra were obtained for most samples. The x-ray absorption near edge structure and extended x-ray absorption fine structure spectra confirmed that some changes to bromide occur on storage. No evidence for molecular bromine complexes was found.

Potential Applications of the Project: Since the cost of purchasing the activated carbon is the largest ongoing cost associated with AC injection and this technology is seen as the most promising for reducing mercury in low-chlorine environments, it is important to show that the performance characteristics (reactivity and capacity) of the carbon are stable and consistent under a range of “normal” conditions.