SEPARATION AND CHARACTERIZATION STUDIES FOR UTILIZATION OF UNBURNED CARBON FROM FLY ASH

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Research at FETC has focused on separation of carbon from negative-valued fly ash into valuable end products or feedstocks for further processing. The methods being developed for the separation of carbon from fly ash are dry electrostatic separation (DES) and flotation/agglomeration. In order to understand more about the separation processes and factors that may influence separation, X-ray photoelectron spectroscopy (XPS) has been used to characterize the surfaces of the separated materials.

The characterization studies have examined several aspects of the separation processes, with the hope of understanding why carbon and fly ash behave as they do during those processes and to try to explain unusual phenomena that are observed. In parallel with the surface studies, catalytic screening of carbon concentrates from fly ash has been carried out to demonstrate possible avenues for its utilization.

One goal of the XPS work is to develop a means for easily screening carbon in fly ash in order to predict its potential separability. Surface analysis studies of the parent fly ash and the products of DES have shown that the behavior of carbon during separation depends on the form of the carbon. Two primary classes of carbon have been identified during XPS analysis of numerous fly ash samples. They are an "insulated" carbon, probably in intimate contact with the mineral matter in fly ash and "insulated" from ground during the XPS measurements, and "conductive" carbon, most likely present as individual carbon or carbon-rich particles having a conductive path for electrons to ground. Peaks due to these two classes of carbons appear at different positions on the binding energy scale during the XPS analysis. Examination of the separated fractions produced by DES shows that the carbon-rich fraction is dominated by conductive carbon, while insulated carbon is the major carbon component of the ash-rich fraction.

A commercial fly ash (TVA2) has been studied extensively in order to correlate XPS measurement results of the relative amounts of the two classes of carbon with separability data. Because we are using a surface analytical technique to predict bulk properties of the fly ash, particle size and sample homogeneity issues have been addressed in our studies. It was found that the best correlation between carbon separability and carbon XPS intensities was obtained when the samples were ground to very fine powders before analysis. Unfortunately grinding also seemed to disturb the clear difference in conductivity between the two classes

of carbon observed prior to grinding. This necessitated the use of curve fitting analysis in order to accurately determine the relative peak intensities of the two classes of carbon.

A phenomenon called "particulate schizophrenia," the charge reversal observed on the components of fly ash during DES after the fly ash has been in contact with moisture, was also studied using XPS. The surface compositions of fly ash particles collected closest to the charged plates in a dry electrostatic separator were compared for samples collected during separation of a "virgin" fly ash and also during separation of that same fly ash after it had been wetted and dried. During the separation of the "virgin" fly ash, the carbon-rich fraction is attracted to the negative plate in the separator, but following exposure to moisture it reverses charge and is attracted to the positive plate in the separator. The exact opposite occurs with the ash-rich fraction. Some changes in surface concentrations of minor elements in the two fractions occur during wetting and may be responsible for their change in charging behavior.

Carbon concentrates from FETC fly ash were examined for catalytic activity in hydrodehalogenation of bromine from 1-bromonapthalene. These catalytic reactions are of environmental interest because the carbon catalysts could be used to dispose of waste materials. Catalytic reactivity was compared between the parent fly ash and carbon separated by either DES, wet flotation, agglomeration or a combination of DES followed by agglomeration. Significant differences are observed in the percent conversion for the different materials. Some of those differences can be explained based on the relative carbon concentrations of the separated materials. However there are other factors that must lead to widely different activities observed for concentrates containing the same percent of carbon. We are currently characterizing these samples with the hope that we can further explain the reason for such diverse catalytic activities.