SAMPLE COLLECTION AND PREPARATION METHODS AFFECTING MUTAGENICITY
AND CYTOTOXICITY OF COAL FLY ASH

Judy L. Mumford and Joellen Lewtas

Genetic Toxicology Division, Health Effects Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711

INTRODUCTION

Reports by several investigators describing the biological activity of coal fly ash have presented a variety of results which in some cases (Fisher et al., 1979; Clark and Hobbs, 1980; Kubitschek et al., 1980; Mumford and Lewtas, in press) are conflicting. The biological activity of coal fly ash may differ because of one or more of the following factors: (1) the samples studied were from different sources; (2) the samples were prepared for bioassay differently; (3) the sampling method differed, and, therefore, collected samples were different in chemical or physical properties which affect the biological activity. Several variables involved in coal fly ash studies -- source, sample collection and preparation methods, bioassay method -- are undoubtedly responsible for the diversity of biological effects observed. The objectives of this study were to examine the sample preparation and collection factors which may affect the observed biological activity caused by coal fly ash and to evaluate the mutagenicity and cytotoxicity of fluidized-bed combustion (FBC) fly ash from experimental and commercial units. The bioassays used in this study were the Ames Salmonella plate incorporation test for mutagenicity and the rabbit alveolar macrophage (RAM) system for cytotoxicity.
Worldwide use of coal as an energy source is predicted to increase substantially in the next two decades. The burning of coal by conventional combustion (CC) methods presents a number of environmental problems. Moreover, the addition of new control methods, such as flue gas scrubbing, may not always be economical in conventional plants. Therefore, it has been of great interest to develop alternative coal combustion technologies that are environmentally acceptable and economically feasible.

Of the new coal technologies under development, FBC is closest to large-scale commercialization. A limited number of commercial FBC units are now available. A commercial unit currently in operation at Georgetown University, Washington, DC, was the source of several of the emissions reported here. FBC systems for the production of steam or electricity have several advantages over CC systems:

1. High heat transfer coefficients and volumetric heat release rates permit a reduced boiler size, which, in turn, lowers capital cost.

2. Limestone is used as the bed sorbent material to remove $\text{SO}_2$, thus reducing $\text{SO}_2$ emissions and permitting use of high sulfur coal.

3. The lower FBC temperature range (800 to 900°C, vs. the CC range of 1400 to 1600°C) can decrease NO$_x$ emissions (Fennelly et al., 1977).

The low FBC combustion temperature, however, may decrease the combustion efficiency and increase the emission of mutagenic organics. Kubitschek et al. (1980) and Clark and Hobbs (1980) have reported mutagenic effects of coal fly ash from experimental FBC units. It has been speculated that the lower FBC combustion temperatures increase the emission of polycyclic organic matter (Kubitschek and Williams, 1980).

SAMPLE PREPARATION STUDIES

Two fly ash samples -- one from an FBC source and a reference sample from a CC source -- were used to study sample preparation methods for the mutagenicity bioassay. The CC fly ash sample was collected from a conventional coal-fired power plant burning Alabama Eastern bituminous coal with 1 to 2% sulfur and 11% ash. The combustion temperature was about 1400°C. The sample was collected downstream of an electrostatic precipitator (ESP) by the fabric filter of a high-volume particulate sampler. Sample