Chemical and Mineralogical Characteristics of Flue Gas Desulfurization By-Products and Swine Manure Mixtures after Controlled Leaching Experiments

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The volume of flue gas desulfurization (FGD) by-products is expected to increase because of continued stringent federal and state regulations requiring significant reductions in sulfur oxide and other pollutants, such as mercury. Simultaneously, the agricultural profile of Illinois is changing to meet the demand for more ethanol. Changes in fertilization methods and crop rotation, coupled with environmental requirements to upgrade to clean-burning coal systems, could link the agricultural and power generation markets in the state of Illinois in the form of utilizing FGD by-products as a fertilizer additive. Previous studies have shown that treating manure with coal combustion by-products (CCBs) such as FGD can provide beneficial results in stabilizing manure phosphorus and increasing yields. Many studies have, however, not focused on the mineralogical and chemical composition of FGD byproducts when mixed with manure and the possible environmental impact from the leaching of potential groundwater contaminants.

The main objective of this project was to characterize and compare samples from three separate coal plants in Illinois in order to investigate the mineralogical and chemical composition of different ratios of FGD by-products to swine manure. The mineralogical properties of FGD samples were determined with X-ray diffraction methods. Chemical composition was determined by inductively coupled plasma spectroscopy-mass spectroscopy and whole-rock X-ray fluorescence after the FGD-manure mixtures were subjected to a Standard Test Method for Shake Extraction of Solid Waste with Water. When the samples were exposed to water, bassanite was converted to gypsum. Chemical analysis demonstrated that the ratio of FGD by-product to manure can determine the concentrations of soil nutrients, such as phosphate or calcium, which would have a direct impact on crop variables such as root growth, crop yield, crop health, or growth rates. The concentrations of Al, Cd, Co, Cr, Mo, Ni, Pb, Sb, and Zn in the 18-hour and 26-day laboratory extracts were at or less than analytical detection limits. Arsenic was not detected in any of the extracts. Selenium was present, but in trace amounts near analytical detection limits. The FGD samples contained mercury at levels that were less than that required by the U.S. Environmental Protection Agency for classification as a Low Mercury Waste for land-disposal restrictions. The reaction pH values of the sample mixtures suggested that potential groundwater contaminants would be relatively insoluble. When considering the chemical and mineral characteristics of the FGD-manure mixtures, however, it is still difficult to accurately predict environmental interactions in an open system, which necessitates additional work before FGD-manure mixes can be applied in commercial agricultural practices.