2022 Mid-Continent Transportation Research Symposium
Ames, Iowa
September 14–15, 2022
intrans.iastate.edu/events/midcon2022/

Beneficial Use of Iowa Waste Ashes in Concrete through Carbon Sequestration

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Abstract

Since 2011, hundreds of US coal-fired power plants have been replaced or converted to natural gas burning units and renewable energy sources. While substantially reducing the green gas emission, these new power plant units are still generating many tons of combustion residuals (ashes) per day, which requires for landfill. The present study is to examine the characteristics of some ashes collected from the gas/waste burning power plant units in Iowa, modify their properties through chemical and carbon treatments, and then beneficially use them in concrete materials. The initial research results have shown that due to significant amounts of heavy metals (like zinc and alumina, along with chloride) in the ashes, directly incorporation of raw ashes (as received) could cause significant expansion of cement-based materials, thus leading to visible cracks at very early ages (1 day) and reducing concrete/mortar strength. Water and chemical solution treatments could effectively remove these chemicals and reduce the expansion. Comparing with the bottom ash from the same plant that burns garbage as a refuse-derived fuel (RDF), the RDF fly ash demonstrated a higher reactivity with injected carbon dioxide (CO₂), i.e., a high capability for carbon sequestration. Currently, research is in progress on optimization of carbon curing procedure (pressure, moisture, and time). The researchers will then determine the effects of carbon curing on properties (the surface chemistry, morphology, pore structure, etc.) of the ashes and evaluate the effects of the chemical and carbon treatments on concrete properties (like cement hydration and strength). It is expected that this study can generate profound environmental, economic, and social impacts as overabundant waste ashes in Iowa are beneficially used.