



## PILOT TESTING OF AMINE-BASED SOLVENT AT A LOW-RANK COAL-FIRED POWER SYSTEM

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Carbon capture is being demonstrated at facilities in the United States, but unresolved challenges still need to be addressed in regard to fuel type and plant retrofitting. Lignite coal, especially North Dakota lignite, presents challenges that include the combination of sodium and sulfur content, ash content, NO<sub>x</sub> reduction, and footprint limitations. Fuel chemical makeup is crucial to the behavior of CO<sub>2</sub> capture technologies that may be employed, whether from the buildup of heat-stable salts, aerosol formation, degradation of solvents, or subsequent solvent loss.

The combustion of low-rank coals can produce aerosols that consist mainly of alkali and alkaline-earth sulfates as well as some minor and trace elements. These aerosols and trace elements have the potential to penetrate air pollution control devices and impact the performance of solvent-based CO<sub>2</sub> capture systems. Testing at North Dakota lignite-fired power plants has found that the levels of aerosols on a number basis is on the order of 10<sup>7</sup> particles per cm<sup>3</sup> in the less than 100-nm range in the flue gas that would be routed to the CO<sub>2</sub> capture system. This is in the range of 10<sup>7</sup>–10<sup>8</sup>/cm<sup>3</sup> reported in literature for high emissions of solvent. Coal-fired combustion systems produce aerosols in the form of SO<sub>3</sub> and alkali sulfates that form as a result of the condensation and reaction of flame-volatilized elements during gas cooling. Past testing conducted at the Energy & Environmental Research Center (EERC) has also shown that trace elements, including mercury, selenium, arsenic, lead, cadmium, antimony, and others, are vaporized during combustion. Most of the vaporized elements condense upon gas cooling and concentrate in the aerosol fraction of the ash. Many of these species, in addition to the problematic nature of aerosols on solvent emissions, have the potential to catalyze solvent degradation if they are allowed to build up in the solvent. Determination of the impact of degradation of the solvent and the economics of that degradation are unknowns at this point. Many of the elements that have been shown to catalyze solvent degradation are present in lignite coals and can exacerbate solvent replacement economics.

The project team has conducted slipstream evaluations of Mitsubishi Heavy Industries, Ltd's proprietary KS-1™ solvent in order to address these potential challenges with low-rank fuel. Small pilot-scale testing was performed using the EERC's 0.05-MWe coal-fired combustor in





conjunction with a 1-tonne/day catch-and-release CO<sub>2</sub> capture system over 4 weeks utilizing both Powder River Basin and lignite coal. During lignite firing, the combustor was configured as a cyclone-fired system.

Specific emphasis in this paper will be given to degradation, heat-stable salts, and aerosol formation. Sampling and testing were conducted to identify the presence of nitrite, nitrate, sulfate, thiosulfate, chloride, formate, acetate, and oxalate salts. Additionally, elements such as sodium, magnesium, potassium, mercury, and selenium were analyzed to determine if they are bound in the solvent. Sampling both upstream and downstream of the system was conducted to determine the presence of SO<sub>3</sub> and aerosols.

