Real-Time Aerosol Measurements in Post-Combustion CO2 Capture at National Carbon Capture Center (NCCC)

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Abstract

Around 66% of world's electricity generation is from fossil fuels. Out of the fossil fuels, coal currently accounts for 33% of the electric power generation in the USA. Coal is very carbon intensive and is a major source of CO2 emissions when used in stationary power plants. This released CO2, which is a greenhouse gas, from power generation contributes a significant amount of total anthropogenic CO2. Therefore, there is a major impetus to develop technologies that can effectively capture CO2 from power plants; both existing and new.

Post-combustion CO2 capture using amine-based solvents is a relatively mature technology. Recent test data indicate that amine and its degradation produce emissions in the form of aerosols, which must be controlled for the commercial success of this technology. Real-time aerosols from the CO2 depleted flue gas at a pilot scale facility at the National Carbon Capture Center (NCCC) were measured using an isokinetic probe and a Dekati Electric Low Pressure Impactor (ELPI+TM). The coal-fired flue gas is provided by Unit 5 of the Alabama Power E.C. Gaston Power Plant.

Multiple tests were conducted to quantify the effects of different process changes. The measurements demonstrated sample sensitivity to transient intercooler start-up conditions and absorber beds in operation. The measurements also demonstrated sample sensitivity to dilution gas temperatures, especially above 100 °C. In Unit 5, a new bag house for MATS compliance was installed and began its operation in April 2016. The real-time aerosol characteristics, before and after the bag house installation, are compared. A very significant drop in aerosol number counts has been observed after the installation of the baghouse. It is expected as the hydrated lime that is injected upstream of the air preheaters and baghouse is responsible for the reduction in SO3 which is mainly responsible for the generation of the aerosols. Therefore, a SO3 generator has been successfully installed and operated in different test campaigns during the summer of 2018 to alter the flue gas properties so that a robust aerosol mitigation process can be better understood in a post-combustion CO2 capture system. A direct relationship between SO3 ppm level injection and

aerosol concentration was observed based on the results of these test campaigns, which are discussed in this paper.

The effect of using different collection substrates for the ELPI+TM is also investigated to identify any issue with surface overloading, bounce and blow off effects during the aerosol measurements. The performance of smooth and sintered collection plates during dynamic process changes has been investigated. The aerosol's counter median diameter (CMD) for the normal plates are higher (89–130 nm) compared to the sintered plates (47nm) with a standard deviation of 0.07 nm. This deviation drops to 0.03 nm when the conditions at different pilot plants were controlled based on the process requirements. Details of these findings will be presented within the paper.

Key Words: Aerosol, Carbon Capture ELPI+TM, Pilot Plant