Emissions of Lab-Scale Flares with Entrained Salt Aerosols

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Abstract

Recent field measurements have confirmed that brackish water aerosols are frequently entrained into flare systems at upstream production sites and subsequently combusted. This occurrence has the potential to affect flare emissions; however, the extent to which this may occur is poorly understood. This study examines the degree to which production rates of major pollutants such as NOx, CO, CO_2, and solid-phase species are affected when salt aerosols are entrained into flare gas prior to combustion. Tests were conducted at Carleton University's Flare Facility in which NaCl (5% and 15%) and KCl solutions were aerosolized and entrained into multicomponent flare gas (C1-C7 alkane hydrocarbons plus CO_2 and N_2) representative of typical upstream flare gas compositions. Emissions from a nominal 2 inch diameter flare were captured in a sampling hood and directed to analyzers to quantify gas-phase and particulate emissions. Additional samples were collected for external gas chromatographic / mass spectrometry (GC/MS) analysis to investigate the potential creation of volatile organic compounds (VOCs) and chlorinated-hydrocarbon species. Previous tests have demonstrated that salt aerosols may largely affect soot formation by mixing, both internally and externally, with carbon particles. Thermal optical methods and photoacoustic spectroscopy were used to quantify elemental carbon particulate emissions and thus gain insight into interactions between these salt ions and soot particles in a flame. Repeatability tests were conducted at selected conditions to quantify bias and precision contributions to total measurement uncertainties. Experiments were performed at multiple liquid loading levels to assess the sensitivity of measured emissions to a range of conditions that may be possible in the upstream oil and gas industry.

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