Gaseous Fuel Mixture Effects on Total Soot Yield from Flares

Matthew Johnson, Carleton University
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The emission of fine particulate matter (PM) is a primary environmental concern and has been linked to serious health effects in humans and animals, adverse effects in plants, and environmental damage [US EPA, 2004]. In Canada, emissions of both PM10 (particulate matter less than 10 ?m in size) and PM2.5 (less than 2.5 ?m) are classed as criteria air contaminants (CAC) and are tracked in the National Pollutant Release Inventory (NPRI). Despite the scientific need and legal requirement for characterizing, quantifying, and reporting PM emissions in industry, there are critical gaps in our ability to accurately obtain these data. This problem is especially urgent in the upstream oil and gas sector where the distinct lack of practical, reliable, and accurate approaches for predicting, estimating or even measuring PM emissions from open industrial sources such as flares is a critical issue.

Although it is imperative that we improve our ability to quantify and manage soot emissions effectively, engineers are hampered by the complexity and variability of soot formation in industrial devices.

The formation of soot in a turbulent diffusion flame such as a flare is a complex process that depends on many factors including chemical composition of the fuel, temperature-time history of the fuel and reactant species, and turbulent diffusion and mixing of oxygen and other species in the flame. Unfortunately since the amount of soot produced from a given fuel has a complex dependence on the entire combustion process, there is no single parameter that can define the amount of soot formed per unit weight of fuel consumed [Glassman, 1988]. This simple fact presents an enormous challenge for quantifying and reporting particulate matter emissions from flares. Very limited existing data support the notion that soot emissions should constitute less than 0.5% of the total fuel mass in most flares [Soelberg, 1983; Pohl et al., 1986], however there are currently no accepted science based protocols or data for estimating, predicting, or ultimately quantifying particulate matter emissions from flares in the upstream oil and gas industry.