Measurement of Volatile Organic Compound Emissions from a Vertical Flare

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Abstract

Limited data are available for estimating speciated volatile organic compound (VOC) emissions from flaring, especially with respect to upstream flares burning mixture typical of Canadian operations. In the United States, EPA AP-42 Section 13.5 for Industrial Flares specifies total hydrocarbon (THC) and VOC emission factors of 0.14 lb/10^6 BTU and 0.66lb/10^6 BTU. However, these factors were developed for steam- and air-assisted flares burning propylene-based fuels and are questionably relevant to upstream flares in Canada. Following a request received through its Board of Directors, the FlareNet research team is performing targeted experiments to develop potential VOC emission factors for unassisted flares burning methane-based, multicomponent gas mixtures.

Experiments were conducted at the Carleton University Flare Facility (CUFF) where custom mixtures of fuels of up to nine independent components (C1-C7 hydrocarbons, plus CO_2 and N_2) can be burned in flares up to 3" diameter. The plume is captured into a large (3.14 m included diameter) sample hood and exhaust system, from which samples are drawn for analysis by a suite of gas- and particulate-phase high-precision instrumentation. Additional samples were collected into appropriate cannisters for offsite gas chromatograph / mass spectrometry (GC/MS) analysis according to EPA Method TO-15. Two industry representative, methane-based flare gas mixtures with flow rates between 20 and 260 SLPM were burned in flares ranging from ½" to 3" (ID). The methodology to compute species yields and calculate quantitative uncertainties followed that published by Corbin & Johnson (2016).

For the present experiments on vertical flares in the absence of crossflow (ideal conditions), total VOC and THC emission rates remained below 0.012 lb/10^6BTU and 0.016 lb/10^6 BTU for all test conditions, less than 3% of published EPA emission factors for assisted flares. However, results did show that total VOC and THC emission rates decrease as flow rates and burner exit velocities increase. Further tests are planned to measure VOC and THC emission factors for flares in a turbulent crossflow using the Western University Boundary Layer Wind Tunnel Laboratory as part of upcoming FlareNet research.