A Wind Tunnel Methodology to Measure Efficiency of Flares Subject to Turbulent Crosswinds

Joshua R. Armitage, Darcy J. Corbin, A. Melina Jefferson, Matthew R. Johnson
Energy and Emissions Research Laboratory, Carleton University

Abstract

Flaring in Canada has risen sharply in recent years and is expected to increase further with the venting limits imposed on the upstream oil and gas sector. Data and models to accurately predict flare emissions are critically lacking such that current emission estimation methods used in pollutant inventories and to guide regulation are questionably relevant. Despite evidence that flares subjected to crosswinds can undergo fuel stripping mechanisms that degrade efficiency and lead to emissions of unburned fuel, the majority of published flare experiments have not considered the impact of a crosswind. Worse, no systematic experiments have been performed to determine the effects of atmospheric boundary layer turbulence on flare efficiency. A better understanding of flaring performance under these conditions is necessary for effective methane mitigation strategies and accurate pollutant inventories.

Flaring efficiency over a wide range of atmospheric conditions may only be accurately determined in an environment where the wind speed and turbulence can be controlled. This poster presents a methodology to determine the carbon conversion efficiency and species emission rates of a flare burning in a closed-loop wind tunnel with controlled turbulence levels. The developed methodology is based on solving the unsteady mass balance problem to relate emission rates to measured accumulation rates in the wind tunnel while considering complicating factors such as infiltration of ambient air, exfiltration of gases from the wind tunnel, potential for reburning of products within the wind tunnel, and the presence of inert species in the fuel stream. An accurate methodology to measure flare efficiency within robustly calculated uncertainty limits is a central contribution to the NSERC FlareNet Strategic Network.