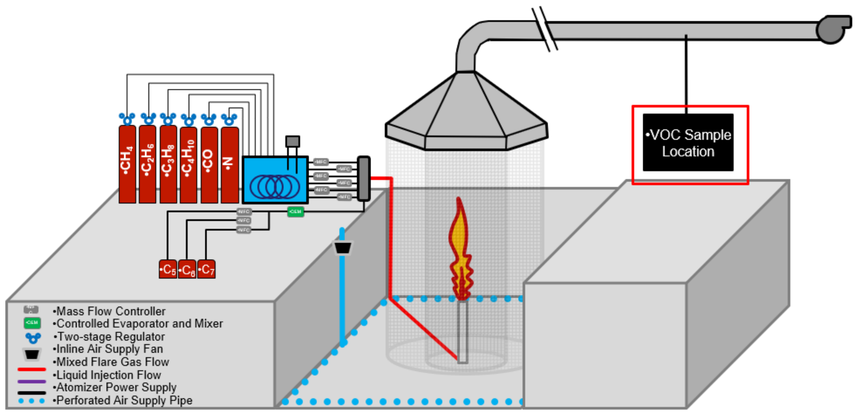
Measurement of Volatile Organic Compound Emissions from a Vertical Flare

Damon C. Burtt*, A. Melina Jefferson**, and Matthew R. Johnson*
*Energy and Emissions Research Laboratory, Carleton University, Ottawa, ON, Canada
**Office of Energy R&D Air Emissions Team, Natural Resources Canada, Ottawa, ON, Canada

Motivation

- U.S. EPA has introduced new VOC emission factors for flares
  - EPA AP-42 Section 13.5 emission factors:
    - 0.14 lb VOCs per 10^6 BTU; 0.66lb THC per 10^6 BTU
  - Developed for downstream steam- and air- assisted flares burning propylene-based fuels
- Questionably relevant for unassisted upstream flares in Canada burning methane-based mixture
- Limited other data available for estimating speciated VOC emissions
- **FlareNet Goal: VOC emission factors for Canada-relevant flares**

Carleton University Flare Facility



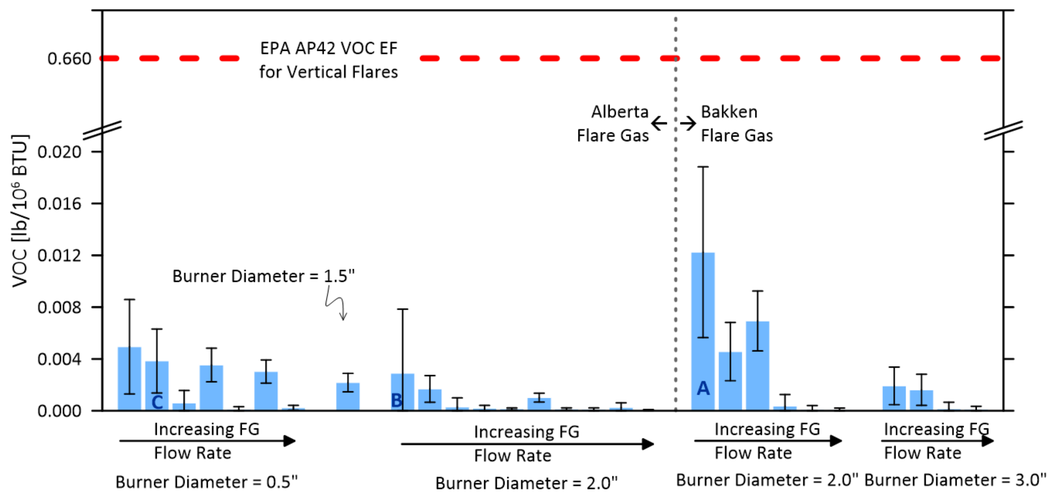
Methodology

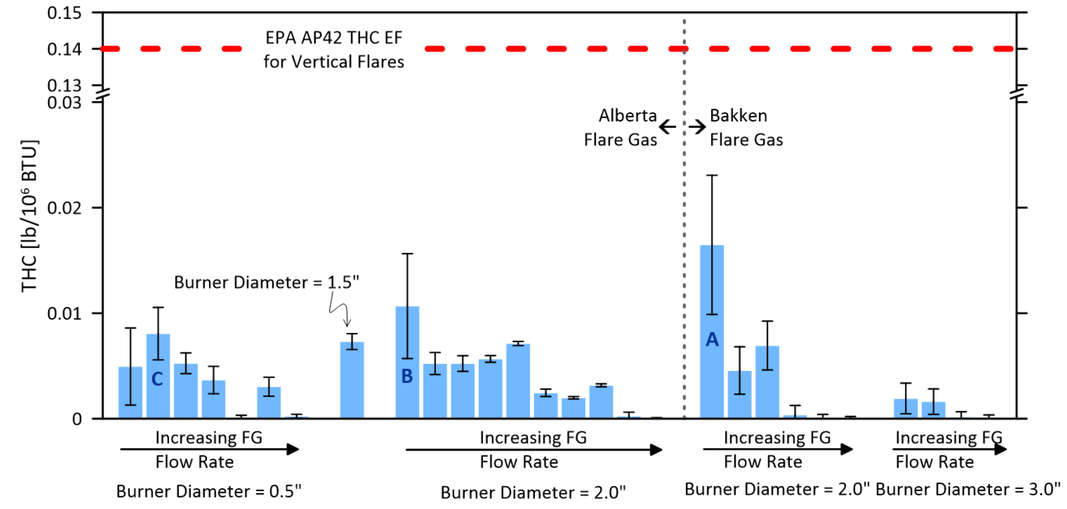
- Measurements on broad range of vertical flares under zero crosswind at Carleton University flare facility
  - Multicomponent (C1-C7, CO_2, N_2) flare gas mixtures relevant to Alberta and Bakken upstream flares
  - Flare diameters of 0.5” – 3” at flow rates up to 260 SLPM
- Flare plume captured into large hood and VOC samples taken from completely mixed 16” ID duct
- Offsite gas chromatograph / mass spectrometry (GC/MS) analysis of speciated VOCs according to EPA Method TO-15
- Methodology to compute species yields and calculate quantitative uncertainties followed that published by Corbin & Johnson (2016)

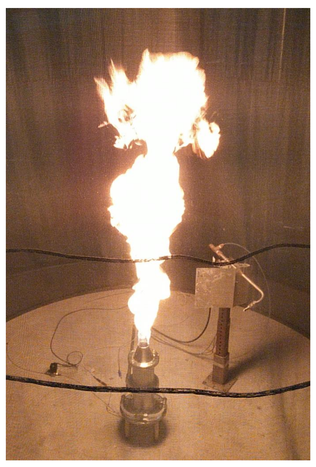
Test Matrix

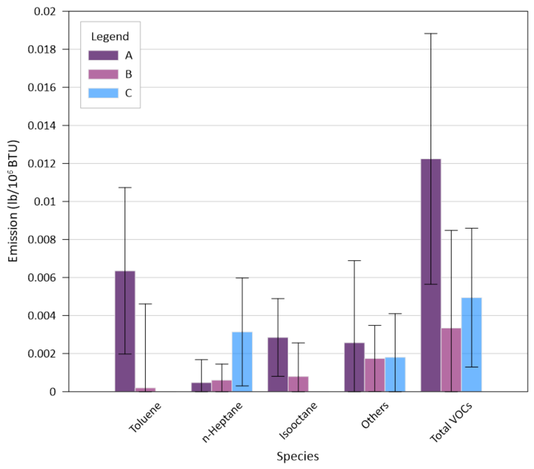
Burner ID [IN.]	Alberta Heavy 9 Mix	Bakken Region
0.5	8 tests, 20 - 65 SLPM	
1.5		1 test, 60 SLPM
2	10 tests, 20 - 260 SLPM	10 tests, 20-160 SLPM
3		4 tests, 25-160 SLPM

Results









Conclusions & Next Steps

- Under ideal (zero-crosswind) conditions, total VOC and THC emissions far lower than EPA emission factors
  - Total VOCs <0.012 lb/10^6BTU for all test conditions (<3% of EPA emission factors)
  - THC <0.016 lb/10^6 BTU for all test conditions (<12% of EPA emission factors)
- Emission rates decrease as flow rates and burner exit velocities increase
- **Further tests planned to measure VOC and THC emissions in a turbulent crosswind at Western University Wind Tunnel Laboratory as part of upcoming FlareNet research**