Remote Detection of Sodium Signatures as an Indicator of Liquid Carry-Over into Flare Flames in the Bakken Oil Production Region

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A Typical Oil and Gas Well Post-Completion

- Liquid/gas separation process can become strained when high volumes of non-hydrocarbon liquid are produced
- Surfactants may contribute to oil-water emulsification
- Can increase quantity & diameter of non-hydrocarbon liquid droplets entering the gas stream and reaching the flare flame
- Limited guidance for operators
- Current regulations simply state that aerosol "droplets larger than 300-600 microns" should be removed from flare systems (API 521/AER D60)
- Some data suggest salt-water aerosols can affect combustion completion and augment particulate emissions

How to detect non-hydrocarbon liquid carry-over into flare flames?

High concentrations of chlorine and sodium are typically found in produced water from Bakken formation (Jefferson, 2017)

Sodium has good atomic emission line strength in visual spectrum (NIST ASD)

Calcium, chlorine, and sodium have high detection potential through atomic emission spectroscopy

Identifying Sodium During Data Processing

- Wavelength and intensity calibrations applied to raw spectra
- Blackbody curve fit to each spectrum to estimate flame temperature
- Goodness of fit and temperature used with intensity filter to select flame signals

Comparison of Measured Emission to Theoretical Na Emission

- Blackbody background is subtracted to isolate potential emission signatures
- Theoretical Na emission peaks at 588.99/589.59 nm are calculated and fitted considering spectrometer resolution

Close correspondence between theoretical and measured signals conclusively identifies sodium in flare flames

Preliminary processing of November 2019 field data have identified flare spectra with a noticeable signatures at 588.99/589.59 nm

- 58% of flares had strong sodium peaks
- 12% of flares had noisy, low intensity, or inconclusive sodium peaks
- 30% flares did not have detectable sodium peaks