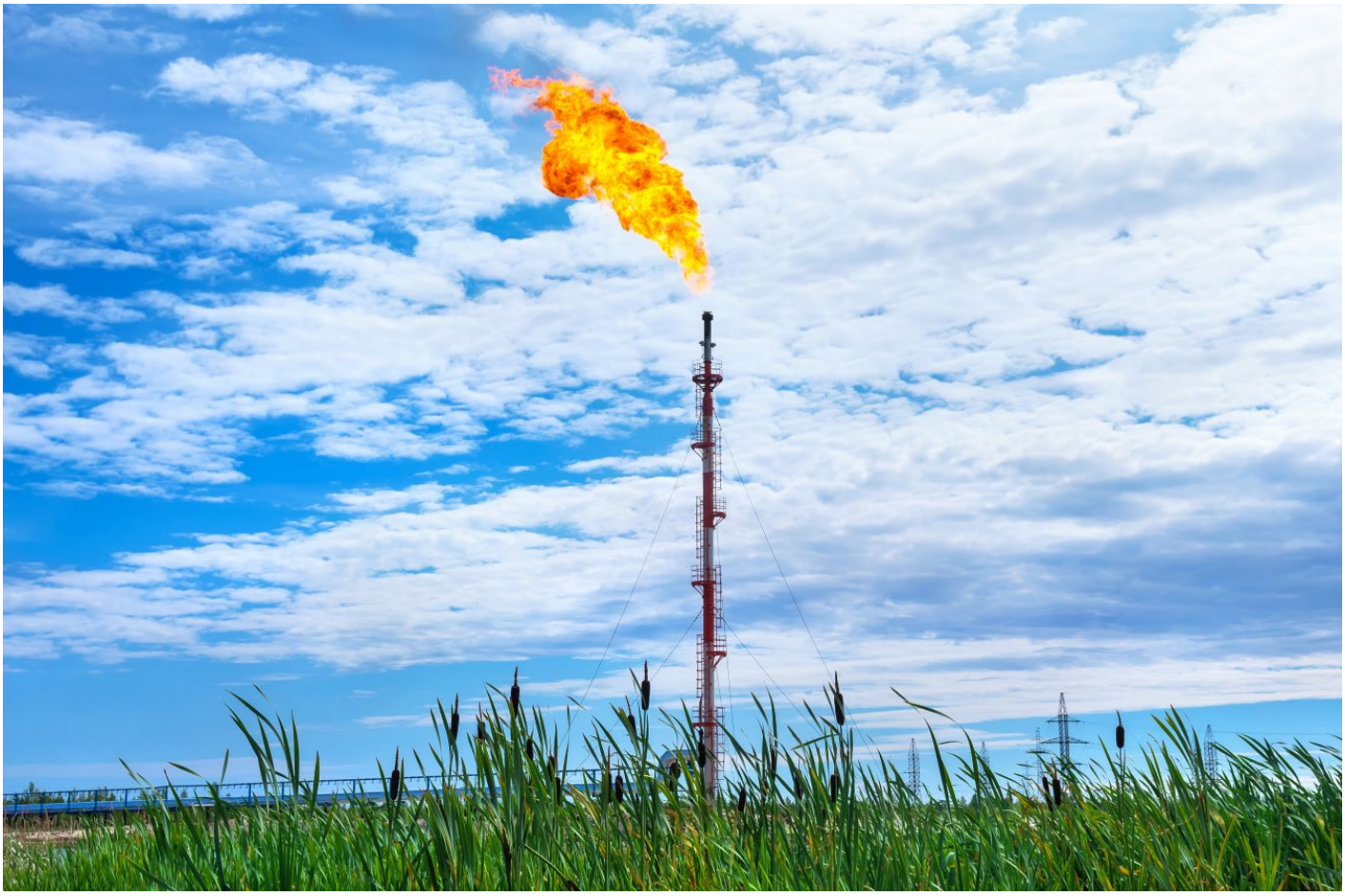
METHANE FROM FLARING TOOLKIT



Measure Efficiency: Passive Fourier Transform Infra-Red and Hyperspectral Spectrometry

Summary

Passive methods use the radiance spectrum of hot gases in the flare to quantify the amount of CO_2, CO and hydrocarbons from which the combustion efficiency can be quantified. They differ from methods such as Differential Absorption (DIAL) in that they do not require an active light source such as a laser, the spectrometer is a receiver only. The Fourier Transform Infra-Red Spectrometry (FTIR) technique is and has been evaluated alongside reference methods. It has been used in a range of flare applications including production and refineries. Measurements are conducted by a specialist operator and require careful calibration which limits long term deployment or use in complex environments.

How it Works

Hot gases in the flare emit radiation in the same frequencies as they absorb. This results in a radiance spectrum which can be converted into absorption spectra and used to determine gas concentrations. There is no requirement for an active source of infra-red light (as used in methods such as DIAL) and can therefore be described as a passive method.

Conventional IR spectrometers operate over spaced spectral bands whereas hyperspectral techniques measure continuous bands. This summary focuses primarily upon the PFTIR method using spaced bands, but is broadly applicable to alternative instrument designs.

Setting up and calibrating the instrument properly is complex and requires a specialist service provider and includes:

Calibration of the spectrometer is critical to accurate measurements. This is achieved primarily by means of a 'black body' calibrator – an IR source of known spectral radiance. The calibrator produces a IR distribution that is predicted by the Planck function providing traceability to the method. The black body has to be positioned at an equivalent distance to the flare, which may place logistical constraints on field deployment, especially offshore. Additional effects including variation in the sky background and atmospheric gases between the flare and spectrometer also have to be accounted for in the final calculation. Setting up and calibrating the instrument properly is complex and requires a specialist service provider.

Determining flare temperature Critical to the measurement is also the need to determine the temperature of the flare as the radiance of the hot gas is proportional to both gas concentration and heat.

Aiming The FTIR should ideally be positioned near the centre line of the plume and one flame length from the flame tip. This is not always possible in field deployments. Strong and variable winds may impact positioning of the instrument.

Data Management The raw data from the spectrometer must be processed to derive individual gas components. A fourier transform is applied to the raw data that converts in interferogram to a single beam spectrum. Here, the interferogram – which is radiance as a function o FTIR scan position is converted in to radiance spectrum (radiance as a function of wavenumber). Once the transform is complete, the flare spectrum can be isolated from interferants (such as atmospheric gases) and then converted in to a absorption spectrum from which concentrations can be derived. In practise, all of these functions are provided by the vendor along with an estimate of uncertainty.

Data is aggregated over short time period – typically per minute, which allows temporal variability in the flare (such as pulsing) to be measured.

Advantages

- ☑ Traceable measurements with an estimate of uncertainty on the quantified value
- ☑

Cover all gas species of interest – CH4, CO and CO_2 from which critical performance ratios can be derived such as combustion efficiency

Quantifies individual components – permitting a direct comparison to the

When in operation provides high frequency output data – typically per minute. This allows rapid changes in flare combustion efficiency, such as oscillations in the flare performance to be measured

Limitations

Requires expert operator

Cannot be permanently installed

Calibration and position of the spectrometer is critical to success. Requires ability to align a black-body calibrator that has to be positioned at an equivalent distance to the flare. For some deployment locations, most notably offshore, this may limit whether the instrument can be used

Full uncertainty requires a thorough understanding of the impact of field deployment on measurement accuracy, precision and bias

Go Deeper

- Vendor website: CleanAir.com
- Research: Use of PFTIR a part of the TCEQ study 2010
- Research: Absorption spectra of methane and other greenhouse gases
- Vendor website: Telops
- Research paper: Savary et al. 2010

Case study

Awaiting copyright approval

Can I measure flare efficiency?

Measure Efficiency: Predictive Feedback and Control

Measure Efficiency: Flare Simulations

Measure Efficiency: Drone equipped with single methane sensor

Measure Efficiency: Aerial measurement of flare efficiency

Measure Efficiency: Extractive method for determining flare efficiency