# Quantifying Methane Flux from Casing Gas Vents and Storage Tank Vents

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## Abstract

Casing gas vents and storage tank vents are important methane emission sources in the upstream oil and gas industry that are difficult to quantify. Typically two separate measurement devices are required to determine methane flux: a flow measurement device that measures velocity [m/s] or bulk flow [m$^3$/hr] (e.g. a diaphragm meter or turbine meter) and an apparatus to take extractive samples that must either be sent to a lab or analyzed on site to determine gas composition. Although this approach is arguably straightforward, it relies on the assumption that the gas composition remains relatively constant between extracted samples. However, gas composition can vary with the age of the well and/or with process conditions -- especially in cases where gas from upstream processes is exiting through a tank vent. Transient flow rates can also vary significantly depending on the site and type of production.

As an alternate approach, we propose using a novel optical sensor which can be connected to sources such as tank and casing gas vents to directly quantify time-resolved methane flux [kg/hr] via simultaneous optical measurements of the gas velocity and methane concentration. This approach would allow both time resolved and time-averaged measurements of methane flux and total gas flowrate providing valuable data to operators that could be used for root cause analysis to determine the driving factors of the emissions. The proposed optical system, known as the VentX, uses tunable diode laser absorption spectroscopy to continuously monitor velocity and vent gas methane concentration, yielding real-time methane flux estimates for the vent being studied. For tank vent applications, an intrinsically safe thief hatch position monitoring system has also been designed that can connect in parallel with the VentX sensor to detect "bump events" where gas might also be exiting the thief hatch. The complete system can be monitored and controlled through an online interface. Preliminary results from controlled testing of the optical system indicate a methane mass flux relative error of 15%, with the largest uncertainty attributed to the velocity component. At the time of writing, an improved design for easier field deployment is currently underway.

## Acknowledgements

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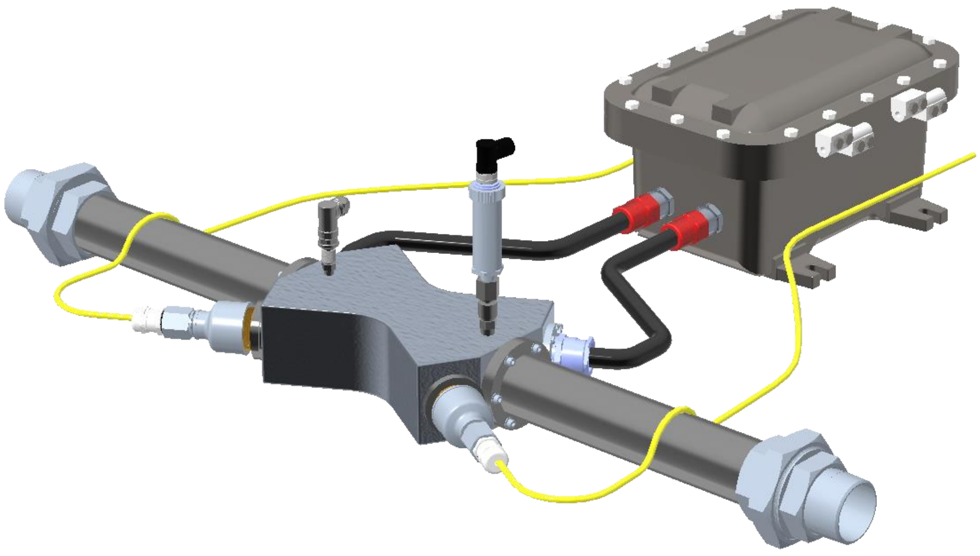

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# Casing Gas, Tank Vent Measurement Design

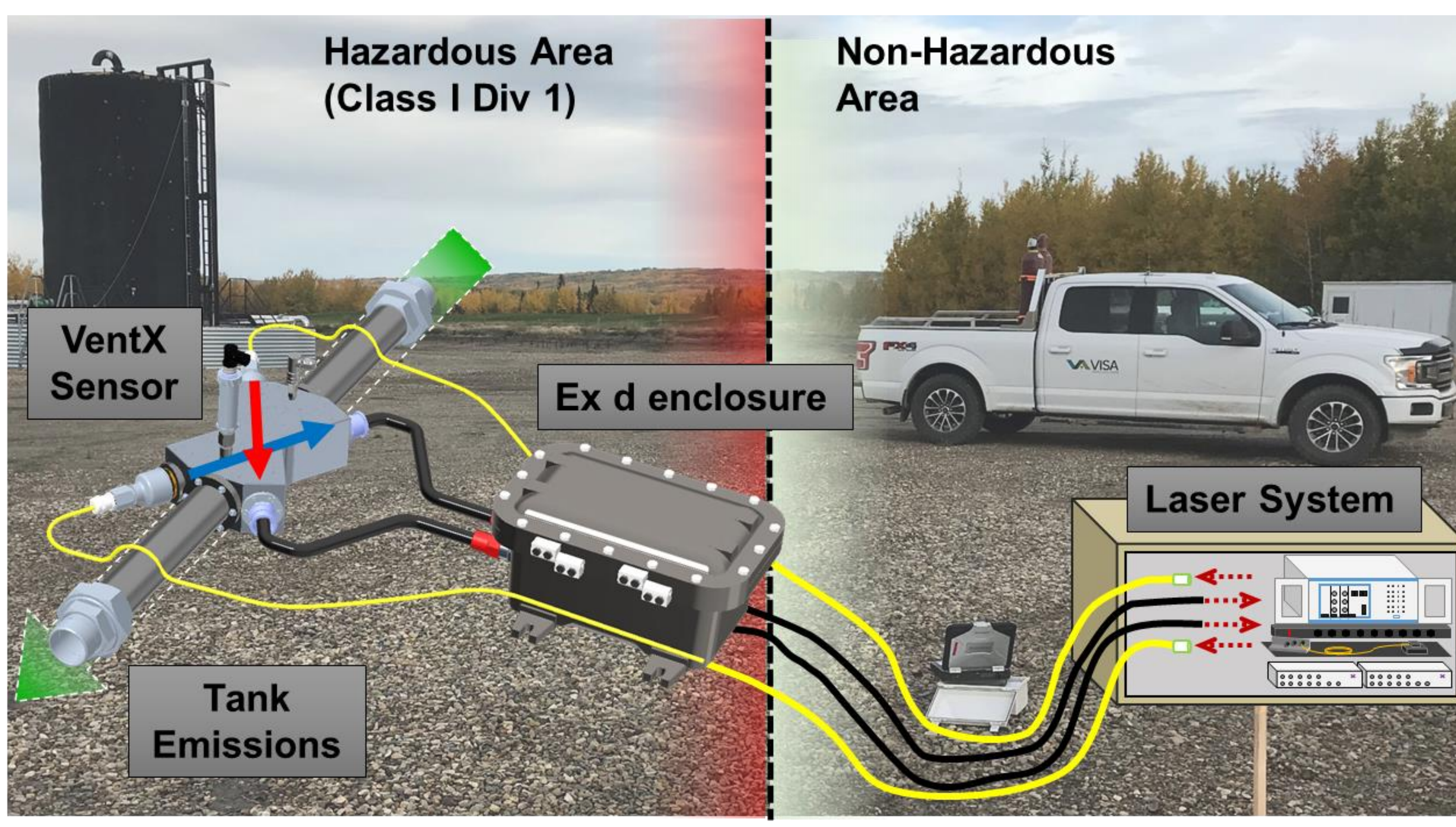
## Motivation

- Two poorly understood, and linked, sources of methane:
  - **Casing gas vents**
  - **Flashing of methane through tanks**
- Common measurements take periodic extractive samples combined with short duration flow measurements

## Solution

- Optical measurement system that measures velocity and methane concentration simultaneously to estimate real-time methane flux [kg/hr]
- **Methane flux critical for:**
  - Proper gas-oil ratio (GOR) estimates
  - Simplified regulatory reporting and compliance
  - Identifying mitigation opportunities
  - Engineered solutions for mitigation

*Well head with casing vent*




*Current layout of the prototype VentX sensor. Final version will place all electronics within the Ex d enclosure which relays data wirelessly.*

## Methods

- Spectroscopic sensor directly measuring methane velocity and concentration
- Compact sensor (10 cm pathlength) attaches to atmospheric vent with near zero back pressure
- Upstream and downstream laser light is Doppler shifted due to the flow velocity
- Methane concentration related to detected laser intensity due to atomic absorption

# Casing Gas, Tank Vent Measurement Performance and Conclusions

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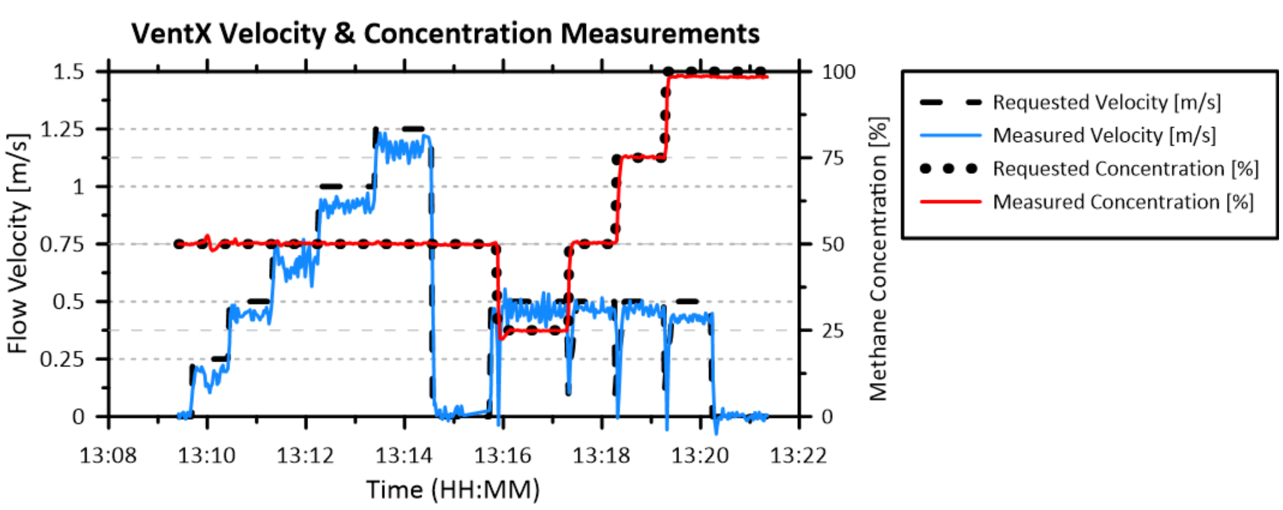
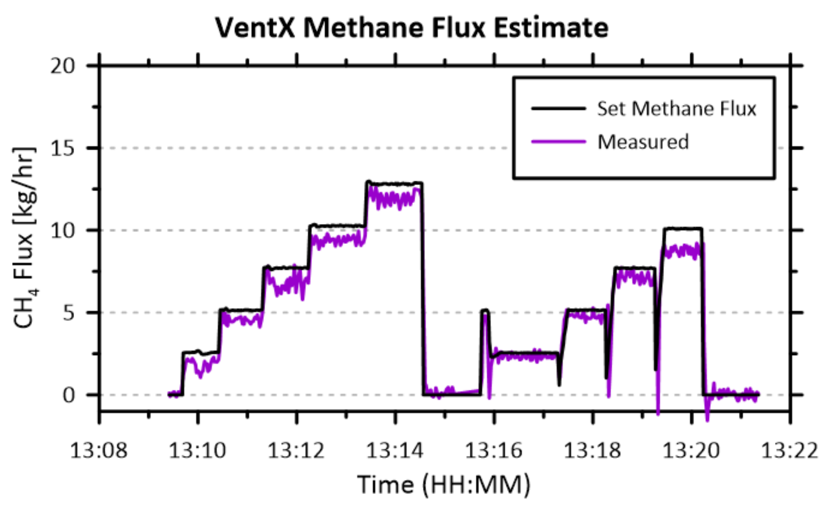
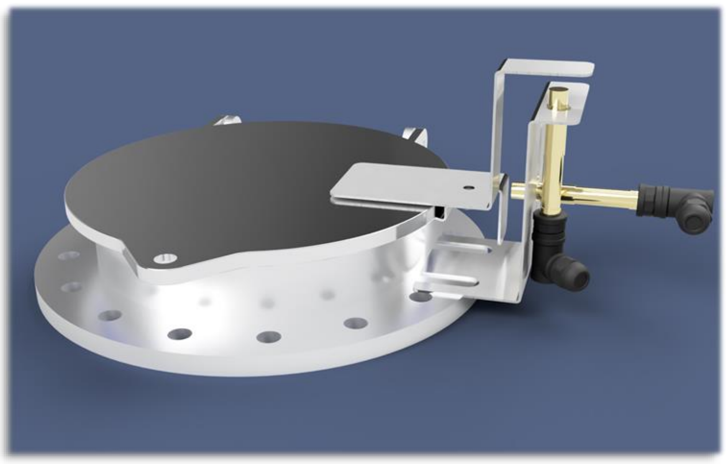
## Results & Discussion




– Concentration relative error of 1.5%
– Velocity relative error of 15%




– Continuous quantification of controlled methane flux release
– Preliminary results indicate a methane flux relative error of 15%, heavily weighed by the error of the velocity data



– Auxiliary sensors include a thief hatch monitoring system which uses two intrinsically safe proximity sensors. These sensors monitor the hatch's position, critical for root-cause analysis of venting emissions

## Conclusions

- Prototype methane flux sensor has demonstrated continuous measurements in a controlled environment
- Next steps are field testing at an active site to assess functionality and performance in realistic setting
- Collected data will guide root-cause analysis of methane venting from oil sites

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