Methane Airborne Detection Solution for the Oil & Gas Industry: Focus on Natural Gas Transmission Lines

Introduction

According to governmental documents, there are more than 300 000 kilometres of natural gas transmission and gathering pipelines in Canada. Pipelines crossing provincial borders are federally regulated (about 73 000 km) while pipelines located entirely within a province are provincially regulated. Despite the fact that pipelines are a safe, reliable, and environmentally friendly way of transporting oil and gas, spills, leaks, and ruptures do happen. In addition, new findings from researchers at Stanford University and the United States Environmental Defense Fund[1] show that gathering pipelines in the Permian Basin are leaking 14 times more methane than Environmental Protection Agency (EPA) national inventory estimates. As new regulation is introduced to increase safety and rapidly reduce methane emissions to slow global warming, there is an emerging need to quickly and efficiently identify leaks.

Over the past several years of research and workshops with scientific and industry leaders, it has become clear that there is no single technology that can survey large areas efficiently and detect emission of all levels. The industry is now leaning toward an array of sensors or a technology toolkit benefiting from the advantages of each sensor to tackle emissions of different sizes. Traditional gas sniffing techniques and optical gas imagers (OGIs) are commonly used to detect gaseous emissions. While these techniques provide strong gas detection capabilities, they can be limited in their ability to accurately identify which gases are present and in what quantities.

The Telops' Methane Airborne Detection Solution is designed to survey an asset efficiently in order to find, identify, and quantify important methane leaks. The system facilitates maintenance plans by providing clear and actionable reports about the locations of methane emissions.

Figure 1. Natural gas transmission and gathering pipelines can be surveyed from an aerial perspective using Telops' methane airborne detection solution.

The Hyper-Cam Airborne Mini

Figure 2. The Hyper-Cam Airborne Mini, a unique, high-performance, thermal hyperspectral imaging camera designed for real-time detection and identification of methane (CH_4) gas leaks and emissions.

The Hyper-Cam Airborne Mini (Figure 2) paves the way towards a striking revolution in infrared hyperspectral imaging.

This lightweight FTIR sensor with a total weight of 24 kg and a volume of less than 2 cubic feet is designed for use in compact aerial platforms without compromising measurement performance (refer to Figure 3). The easy and flexible operation makes the Hyper-Cam Airborne Mini a versatile tool, well suited to meet the requirements of the oil and gas industry and provide efficient methane aerial surveys of production and transmission infrastructures.

Figure 3. The Hyper-Cam Airborne Mini mounted on a Bell 206 helicopter to survey natural gas transmission lines.

TRANSMISSION SECTOR

The flexibility of the methane airborne detection solution allows the user to tailor and optimise parameters based on the application of interest. For the natural gas transmission sector, the system is configured to fly at a height above ground level (AGL) of 350 meters (1148 feet) and a speed between 70 and 80 knots (130 and 150 km/h). This flight profile provides an optimal balance between detection sensitivity and survey speed and efficiency. At this AGL, the footprint of a single pixel is 26 cm leading to a full swath width of 33.6 meters. Because the system is constantly tracking the center of the pipeline, the system is thus able to survey 16.8 m on both sides of the pipeline.

In flight, the system dynamically adapts to the ever-changing flight conditions. Data acquisition is fully automated, requiring minimal to no operator intervention. Detection and quantification reporting is done in real-time, which allows rapid and critical decision making. In addition to the infrared imagery, the system also delivers high-resolution visible imagery with a 12-megapixel embedded camera.

For each of the detections, a detection report is produced in graphical and table format as shown in Figure 4. The report file displays the infrared image overlaid with the color-coded detection results, similar to how the results are presented in the software. Directional information is provided by an embedded compass within the image as well as additional contextual information listed on the left and the gases of interest listed on the right. Pixels containing the detected gas are displayed in colour followed by the number of pixels detected as well as the GPS coordinates of the center of mass of the plume. The detection report shown in Figure 4 provides an example of a methane gas plume (pink pixels) detected during a measurement campaign performed with ASMAN Technology and GRTgaz over the Jonzac-Neulles aerodrome[1]. We can clearly see the cloud detected near the release point located at 45 ° 28' 52.0" N, 0 ° 25' 30.0" W occupying 356 pixels or 21.94 m^2 and containing 9.77 grams of methane in total.

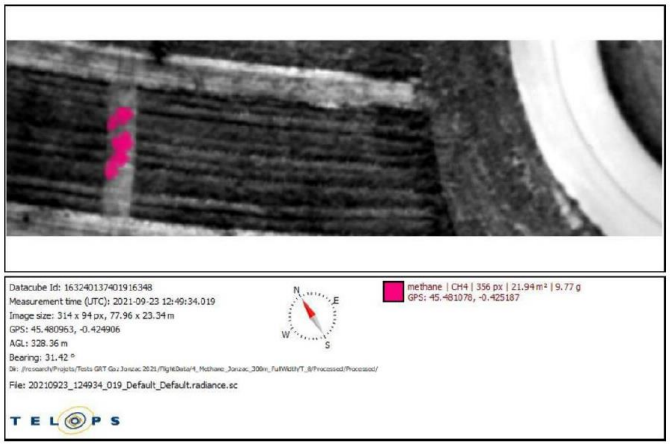

Figure 4. Example of a detection report produced by the system in real time. The methane plume is displayed in pink over the infrared image.

FIELD TESTED AND VALIDATED

The methane airborne detection solution has been extensively field-tested through many controlled-release methane measurement campaigns. The results from the four most recent campaigns are presented in this section.

The gas leak rate or mass flux can be calculated using the gas mass per area calculated by the system and the mean gas flow velocity[1]. The gas flow velocity is approximated by local wind velocity obtained from local weather stations or meteorological models. Figure 5 presents the retrieved leak rate values for positive detections during the four most recent controlled methane release campaigns performed by Telops. In the summary graph, there are 78 datapoints spanning a range of commanded release rate from 3 m^3/h to 54.8 m^3/h. Results show a strong correlation between the calculated leak values and the commanded leak rate values.

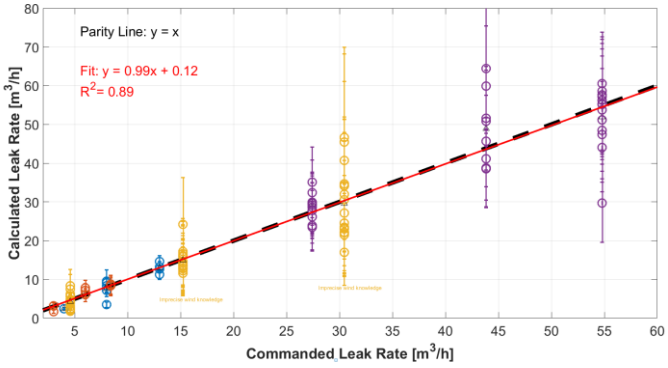

Figure 5. Parity chart of commanded methane leak rates and the corresponding reported calculated leak rate in m^3/h. The y = x parity line indicates perfect quantification. Results show a close linear fit and good agreement between commanded and reported leak rates. The color of the data points indicates to which data collection campaign they belong.

Plume quantification accuracy depends on the wind measurement accuracy but the obtained results indicate that the detection limit of the system is ~3 m^3/h (1968 g/h or 2543 ft^3/day), in good agreement with the theoretical detection limit. However, the detection limit depends on several parameters, such as atmospheric conditions (cloud cover, thermal contrast, humidity level, wind), gas concentration and flight height (AGL). To put this quantification capability into perspective, with such a sensitive detection limit the system is able to detect 90% of the emissions found by Omara *et al.* in 2018[2] and ~100% of those found by Cusworth *et al.* in 2021[3].

Conclusion

Based on the results collected during several controlled methane release measurement campaigns, Telops' Methane Airborne Detection Solution is a highly efficient and sensitive tool for the detection and quantification of methane leaks for the oil and gas industry. The system's flexibility allows for a trouble-free integration into various aerial platforms without compromising performance. The real-time reporting capability is an important advantage allowing rapid decision-making during critical situations. The system facilitates

Figure 6. Methane gas leak observed with the Hyper-Cam Airborne Mini from a distance of 350 m. Methane plume color bar indicates gas concentration levels from low (blue) to high (yellow/white) path length concentration. To protect the privacy of our clients, the detected gas plume does not correspond with the location showed in the image.

maintenance plans by providing clear and actionable reports about the locations of methane emissions.

References

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