Apis headerMonitor Accuracy Report

Background

The purpose of this report is to evaluate the accuracy of Apis headerMonitors deployed at a landfill in Oklahoma. The specific device analyzed was the Apis headerMonitor at the renewable natural gas (RNG) plant, over the course of one year with samples taken, on average, every 3 hours. Apis headerMonitors are fully integrated gas analysis systems that measure CH_4, CO_2, O_2, flow, pressure, and gas temperature. They can be deployed anywhere on a landfill to automatically sample, calibrate, and transmit data to the Apis Cloud dashboard, allowing for frequent, real-time monitoring of landfill gas composition.

RNG plant data, using traditional site gas measurements, were provided by the landfill. This report compares Apis readings against the site-provided plant readings collected from January through December 2024 to quantify device accuracy.

Instrument Overview

The headerMonitor is a fully integrated gas analysis system that frequently measures landfill gas composition, flow, pressure, and temperature. It includes CH_4 and CO_2 sensors using non-dispersive infrared (NDIR) technology and an O_2 sensor using fluorescence quenching. It also features flow, static pressure, and gas temperature sensors, on-board processors, and communication systems to transmit data to the Apis Cloud dashboard. Sensor ranges and accuracy for this unit are summarized in the table below.

Sensor Accuracy:

Parameter	Range	Accuracy
CH_4	0–100 % vol	±0.5 % vol
CO_2	0–100 % vol	±0.5 % vol
O_2	0–25 % vol	±0.1 % vol

How headerMonitors Work

Measurement Process:
The headerMonitor purges the system before and after each sample and uses a closed-loop pump to maintain stable flow to the sensors. Sampling continues until readings stabilize within predefined thresholds, ensuring consistency across measurements. All data is transmitted to the Apis Cloud via cellular connection for remote visibility and analysis.

Calibration Process:
Automated span calibrations are performed using calibration gas at user-defined intervals ranging from twice per day to once per week. Calibration reports are stored in Apis Cloud, providing instant access to current results and past reports on demand.

Maintenance:
Diagnostic sensors monitor flow and pressure to detect system issues in real time. Quarterly preventive maintenance is recommended, typically involving quick on-site filter and calibration canister replacements.

Methodology

To evaluate measurement accuracy, plant headerMonitor readings were directly compared against site-provided plant gas chromatograph readings. For each site reading, the closest-in-time Apis reading was selected to ensure a fair comparison and minimize the influence of short-term variations in gas composition.

For each paired data point, the difference between readings was calculated. Positive values indicate that the Apis device measured a higher value than the plant instrument, while negative values indicate lower readings.

Some data points were excluded due to invalid measurements, such as flagged sensor errors or values identified as outliers through standard interquartile range (IQR) filtering. Of the 2,420 total comparison points, 315 (14.96%) were removed, resulting in 2,105 valid comparisons for analysis. The remaining paired readings were used to calculate average differences across all valid points, providing mean deviation values for CH_4, CO_2, O_2, & time.

Results

Methane readings, one of the most critical parameters for landfill gas monitoring, showed a small average difference of 0.36, indicating strong measurement accuracy. Differences in CO_2 and O_2 were also minimal (-0.08 and -0.13, respectively), confirming consistent and reliable sensor performance across all measured gases.

The average time difference between the headerMonitor and plant readings was 1.66 minutes, demonstrating that data points were closely aligned in time and suitable for precise comparison.

Of the 2,105 total comparison points, approximately 15% were excluded during data cleaning to remove anomalies and ensure a robust dataset. Overall, these results highlight the headerMonitor's high accuracy, stable sensor performance, and ability to provide near real-time data for reliable landfill gas monitoring.

Metric	Average Apis Reading	Average Plant Reading	Average Volumetric Error
CH_4	54.35	53.99	0.36
CO_2	40.56	40.64	-0.08
O_2	0.41	0.54	-0.13

Sensor Drift Analysis:

Apis devices are designed to maintain accurate gas measurements over time, with minimal sensor drift compared to the standard gas parameters of 50% CH_4, 35% CO_2, and 0% O_2. The following analysis evaluates the drift for the plant headerMonitor based on pre-calibration measurements. Sensor drift was calculated as the difference between pre-calibration gas readings and the standard values.

Below is the average sensor drift from standard gas parameters for the plant headerMonitor:

Average CH_4 Drift	Average CO_2 Drift	Average O_2 Drift
0.14	-0.01	0.02

Over the year-long period, the average drift across all devices has remained minimal, demonstrating the reliability and stability of the sensors. On average, the time between calibrations was 3.24 days, which allowed for consistent monitoring and minimal drift. This indicates that Apis devices maintain a high level of accuracy in their measurements, with very little deviation from the expected gas parameters.

Conclusion

Apis headerMonitors provide accurate, reliable, and timely gas measurements for landfill gas management. Methane readings showed an average difference of only 0.36 compared to site readings, confirming measurement precision. Minimal errors in CO_2 and O_2, along with near-zero time discrepancies, further demonstrate strong sensor performance and stability.

The paired-reading analysis, with an average time difference of only 1.66 minutes between Apis and plant measurements, confirms that comparisons were made using closely aligned data points, ensuring a robust and meaningful assessment of device accuracy. Sensor drift over the year remained minimal, and with calibrations occurring approximately every 3.24 days, the headerMonitor maintained consistent measurement reliability with limited intervention.

Overall, these results validate the headerMonitor as a reliable tool for landfill gas management. Its stable, accurate measurements support data-driven operational decisions, optimize methane capture, and provide confidence in system performance, making it an effective solution for modern landfill gas monitoring programs.