Apis smartWell Accuracy Report

Background

This report evaluates the accuracy of Apis smartWells deployed at a landfill in Arkansas. From January through June 2025, 20 smartWell devices were compared twice per month against readings collected using standard handheld instruments. Apis smartWells are fully integrated landfill gas monitoring systems that measure CH_4, CO_2, O_2, flow, pressure, and gas temperature. They automatically sample, calibrate, and adjust wellhead valves to maintain optimal performance, transmitting data to Apis Cloud for frequent, real-time monitoring and control.

Handheld readings were provided by the landfill, while Apis readings were obtained directly from the Apis Cloud dashboard. This report compares these datasets to quantify device accuracy over the six-month period.

Instrument Overview

The smartWell measures landfill gas composition, flow, pressure, and gas temperature on a scheduled cadence. 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 static pressure and 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 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	±0.25 % vol*
Static Pressure	-5 to 5 in H2O	±0.15 in H2O
System Pressure	-135 to 135 in H2O	±0.25% of reading
Gas Temperature	-40 to 257 degrees F	± 1 degrees F

*Newer style Apis O_2 sensors have an accuracy of ±0.1 % vol.

For More Information: 610-229-9069 apisinnovation.com sales@apisinnovation.com

How smartWells Work

Measurement Process:
Each sample begins by purging the system to ensure data accuracy. A closed-loop pump maintains a stable flow to the sensors while readings are collected. Sampling continues until values stabilize within predefined thresholds, after which the data is transmitted to the Apis Cloud via a secure cellular connection.

Automated Tuning:
Following each measurement, the control algorithm automatically adjusts the wellhead valve based on the recorded readings. This closed-loop control optimizes well conditions in real time, improving operational efficiency and overall performance.

Calibration Process:
Automated span calibrations are performed using a calibration gas mixture at configurable intervals ranging from twice daily to once weekly. Calibration reports are stored in Apis Cloud, providing instant access to current results and past reports on demand.

Methodology

To evaluate accuracy, handheld readings were directly compared against corresponding smartWell readings. For each handheld measurement, the closest-in-time Apis reading was selected to ensure a fair comparison and minimize the influence of short-term fluctuations in gas composition.

The difference between each pair of readings was then calculated to assess measurement accuracy. Positive values indicate that the Apis device recorded higher readings than the handheld instrument, while negative values indicate lower readings.

Outlier detection and removal were conducted using the Apis Cloud dashboard to ensure data reliability. Standard interquartile range (IQR) methods were applied to identify outliers across CH_4, CO_2, and O_2 parameters. Data points falling more than 1.5 times the IQR above the upper quartile or below the lower quartile were flagged and excluded from analysis. This consistent approach ensured accurate identification and removal of anomalous data from Apis devices.

After outlier removal, 216 valid comparison points remained across both datasets for analysis. These paired readings were then used to calculate the average differences across all parameters, providing a clear measure of overall deviation between handheld and smartWell measurements.

Results

After filtering and analyzing the data, the following average error metrics were calculated for the 20 Apis devices at the site over the six month period. Some of the numbers are negative as they represent instances where Apis technology measured lower values compared to the manual reading, while positive numbers indicate measurements where Apis technology recorded higher values. These differences can be attributed to variations in instrument sensitivity, measurement accuracy, or environmental factors at the time of data collection. The average time difference between the Apis and handheld reading comparisons was approximately 40 minutes.

For each key parameter, the combined average of all Apis devices and handheld readings was computed. Separately, the average volumetric error was calculated by first taking the difference between each paired reading and then averaging these differences. This metric reflects the overall impact of measurement offsets on system accuracy, even if some individual differences were larger.

Metric	Average Apis Reading	Average Handheld Reading	Average Volumetric Error
CH_4 (%)	51.35	50.52	0.39
CO_2 (%)	35.37	34.94	0.18
O_2 (%)	1.48	1.62	-0.22
Bal (%)	12.29	12.92	-0.34
Diff Pressure (in. w.c.)	0.21	0.18	0.03
Gas Temperature (°F)	84.49	84.37	0.20
Static Pressure (in. w.c.)	-15.32	-14.92	-0.69
System Pressure (in. w.c.)	-45.7	-45.47	-0.24

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 each device 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 20 Apis devices:

Average CH_4 Drift	Average CO_2 Drift	Average O_2 Drift
-0.02	0.05	0.16

Over the six month 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 1.12 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.

Key Insights

Overall Accuracy: The average errors in CH_4, CO_2, O_2, and other critical metrics remained within acceptable limits, demonstrating that Apis smartWells provide accurate and reliable measurements.

Calibration Frequency: Apis devices automatically calibrate more frequently than traditional handheld devices, ensuring consistently reliable and accurate data. At this site, smartWells self-calibrate every 1.12 days, with additional calibrations triggered by significant changes in temperature or barometric pressure to further enhance measurement accuracy.

Outlier Detection & Accuracy: Apis devices effectively identified and removed outliers using robust statistical methods, resulting in cleaner datasets and more reliable comparisons. The calculated average volumetric errors for CH_4, CO_2, and O_2 were minimal, reaffirming device accuracy. All data processing and outlier removal methods are fully documented to maintain transparency and ensure confidence in the results.

Conclusion

The comparison confirms that Apis smartWells deliver highly accurate and reliable measurements, enhancing monthly handheld compliance reads. With frequent calibrations, advanced outlier detection, and consistent sampling, Apis devices deliver a comprehensive and precise picture of landfill gas behavior. By combining highly accurate gas measurements with precise, automated control, Apis smartWells provide operators with actionable, data-driven insights that improve operational efficiency, reduce errors, and maximize landfill gas performance.