Landfill SCADA System: A Next-Gen Prescriptive IoT Solution Engineered To Detect, Transmit, and Mitigate Fugitive Methane Emissions via a Long-Range Supervisory Control and Data Acquisition System (Year 4)

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Landfills are the 3rd largest sources of anthropogenic methane emissions in US. As methane is measured monthly, inadvertent fugitive emissions are undetected, and problems are realized late. So, there is an inherent need to monitor landfill gas (LFG) continuously via “Smart” systems. Goal is to develop a Supervisory Control and Data Acquisition system for real-time LFG detection, prediction, and mitigation. System includes (i) Fugitive Emissions Mitigator with programmable microcontroller connected to gas and environmental sensors (ii) continuous wireless data transmission to cloud using codes (iii) descriptive and diagnostic analytics in interactive dashboard to display historical events, (iv) predictive and prescriptive analytics via Machine Learning (ML) algorithms to forecast methane, and (v) long-distance LFG mitigation. Two aspects (methane generation and transport) that influenced fugitive emissions were studied. Results showed transport rate in saturated soils was 74% lower than dry, indicating methane transport was inversely proportional to soil moisture. However, methane generation was directly proportional to soil moisture content. Predictive and prescriptive analytics were conducted to model this complex behavior. A 5th-order Polynomial ML equation was derived with 86% accuracy provided best curve-fit to explain methane-to-moisture relationship. LFG mitigation was achieved by remotely activating a pump to extract methane. An upgraded modular and extensible PCB prototyping and circuit design was achieved with smaller form-factor. This IoT solution has technology and cost advantages. It helps solve existing and emerging fugitive emission issues via real-time measurements, prediction, and mitigation to reduce 45% greenhouse gases by 2030.

Awards Won:
International Council on Systems Engineering - INCOSE: Certificate of Honorable Mention, a 1-year free student membership to the INCOSE, and free virtual admission to the 2022 International Symposium of the INCOSE