Malodor Detection for FSM Technologies by an Integrated Gas Sensors System

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Summary (max 100 words)

Malodors in and around toilets, and released during fecal sludge management activities remain an important risk factor for adoption of sanitation products and technologies. Many challenges and knowledge gaps exist ranging from identifying odor release points, quantifying odor emissions, adopting designs and best practices that minimize odors, to testing for compliance. One critical need is to develop an instrument that can monitor odor, even crudely, to provide feedback in the event a significant system malfunction. This research evaluated the technical feasibility of using low costs gas sensors and pattern recognition algorithms for an early warning system for malodor associated with FSM.

Introduction, methods, results and discussion (up to 500 words) *

In the past decade, the advent of low-cost commercial off the shelf (COTS) sensors is revolutionizing how we think about environmental and health monitoring. Miniature sensors that react to various chemical species can be found for a few dollars and integrated in devices for wide range of applications including breathalyzer, spoiled food in fridges, or personal health monitoring. Monitoring malodors is particularly challenging in this context for a number of reasons: 1) odor is a sensation and is inherently variable from individual to individual, 2) odorants can cause nuisance at extremely low concentrations (parts per billion), 3) odorants can have synergistic, additive, or antagonistic effects.

Fortunately, while odors from feces and fecal sludge processing are the results of hundreds of compounds, the main nuisance can generally be attributed to only a handful of dominant chemicals: hydrogen sulfide, indole, p-cresol, butyric acid and amines such as trimethyl amine for urine.

In this research, low-cost gas sensors were screened for their ability to respond to exposure to fecal odors. A small and mobile test platform that includes odorous air generation and metering was developed and constructed. The system can be connected to an exhaust or ambient air for field testing. For laboratory experiments, an attachment enables generation of fecal odor air streams. The system allows simultaneous testing of 16 different gas sensors connected to a data logging system.

Four different brands and multiple kinds (H2S, NH3, VOCs, etc.) of sensors were tested for their ability to respond to fecal odors. In parallel, olfactometry was conducted on the air undergoing testing, so that chemical sensor responses could be correlated to olfactometric data.

We expected that no single sensor is able to be a good proxy for odor, indicating that a variable spectrum of chemicals elicits the various malodors experienced in FSM. We also expected a large variability between the different sensors, both in sensitivity to the odorants as well as in their response time. This suggested that advanced data processing is needed to distinguish malodor given the signal from multiple sensors. Computational methods (such as principal component analysis, pattern recognition, neural networks are being explored to better discriminate between presence and absence of a fecal malodor. The most up to date results will be presented at the conference.

Conclusions and implications (up to 200 words) *

This research is an early proof of concept showing that collection of signals from multiple low-cost gas sensors when exposed to malodor can form the basis of an early warning system for process malfunction. Up to date results will be presented and discussed at the conference. Implications for consumer products (toilet monitoring) and large scale process monitoring will be discussed.