

Method to Assess Low-Cost H₂S Monitors for Use in Agriculture

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Background

Agricultural work presents some of the highest risk for occupational injury and illness, yet is one of the least-regulated industries in the United States. Hydrogen sulfide (H₂S) is commonly produced as a byproduct of livestock waste in confined feeding operations and presents an unknown threat to agricultural workers without detection equipment.

Currently, low-cost monitors with electrochemical sensors are used in some industries to comply with confined space requirements. Such monitors could be useful to agricultural work.

Objectives

Compare low-cost H₂S monitors in simulated livestock building concentrations, specifically:

- Assess performance over the manufacturer's advertised "maintenance-free" warranty period.
- Identify calibration needs to recommend to farmers compared to manufacturer recommendations.



Experimental Setup

Hydrogen sulfide test chamber



Methods

Identified low-cost monitors available from farmer-accessible sources.

Selected four low-cost monitors for study based on price, advertised maintenance requirements, and availability.

Compared monitors qualitatively to collect information regarding individual features and manufacturer recommendations regarding the use of each monitor.

Tested monitors at low concentrations of H₂S (0 – 10 ppm) over several months to characterize short-term performance of each sensor:

- Injected 24 ppm gas into gas into an airtight chamber
- Mixed and allowed gas to decay over 1-6 days
- Observed performance of each monitor over time and total concentration exposed to the sensors

Measured actual concentrations with calibrated instruments:

- Calibrated VRAE and MSA Altair 4X: validate and compare test instrument concentrations
- Calibrated ToxiRae was used to datalog chamber concentration throughout each test

Bump-tested (20 ppm) test monitors every 3-6 days, to assess performance: concentration reported, alarm response.

Results

Summary of qualitative information of each monitor

Factor	MSA Altair	Drager Pac 3500	Industrial Scientific T40 Rattler	Honeywell BW Clip
Cost, \$	109	209	220	110
Battery	Lithium	Lithium	AA (1500 hr)	Internal (2 yr)
Replaceable?	No	Yes	Yes	No
Display:				
Concentration?	No	Yes	Yes	No
Alarm?	Lo/Hi	Lo/Hi	Lo/Hi	Lo/Hi
Default low alarm, ppm	10	10	10	10
Default high alarm, ppm	15	20	20	15
Warranty Period	2 yr / 18 hr alarm	2 yr	2 yr	2 yr w/ 2 min alarm/day
Shelf-life	1-3 mo	2 yr	10-11 mo	10-11 mo
Concentration checks, per manufacturer:				
Bump?	Recommend	Recommend	Possible	Possible
Calibration?	Possible	"None needed"	Possible	Recommend if alarmed

Results, continued

MSA Altair and BW Clip:

- Display only time remaining on warranty period
- This can be misleading to users (farmers)

Industrial Scientific T40 Rattler and the Drager 3500:

- Can be shut off when not in use, potentially extending the life of the monitor
- If continuously left on, the T40 Rattler exhibited a comparatively short battery life

In preliminary quantitative trials, the Drager 3500 has:

- Consistently underestimated concentration of H₂S
- Relatively low error at low concentration rising to larger discrepancies with higher (~20 ppm) concentrations

Bench trials have shown increasing response time of MSA Altair to bump tests over exposure time. After 2600 PPM-HR, it no longer alarms consistently at 20 ppm bump tests.

Conclusions

Monitors that display only "remaining sensor time" may be confusing to workers.

Monitors using AA batteries may become expensive: typically last 1 month at 2.5 ppm H₂S (average).

Storage of monitors in the presence of low H₂S concentrations may result in reduced lifespan, based on 10 weeks of bench testing.

Future Research

Continued bench testing will determine effects of long-term exposure of low levels of H₂S on sensor performance. Future studies will incorporate newly-released model of BW Clip (Real Time) that displays concentration.

Further data will be gathered on use and attributes of each monitor as study continues to provide comprehensive information to potential and future users.

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