Finding the Right Fit for Your H_2S Detection Needs

Arizona Instrument LLC

Monitoring hydrogen sulfide (H_2S) levels is critical for air quality, safety and environmental professionals across a multitude of industries. Doing so helps prevent complaints, citations, penalties, corrosion, fires, illness, and even death.

A number of methods have been developed to measure trace levels of H_2S

The most widely used measurement methods include gold film analyzers, SO_2 conversion, colorimetric gas detection tubes, electrochemical detectors, and lead acetate cassette tape gas detectors. This paper will explain the advantages and disadvantages of each in order to assist air quality, safety and environmental professionals alike in selecting the H_2S analyzer that best meets their unique needs.

Main considerations when choosing an H_2S analyzer include desired detection level, accuracy of measurements, potential interferences, and level of maintenance required to ensure the equipment is working properly.

Gold film sensor analyzers offer portable and fixed-point solutions that are both accurate and precise for low-level H_2S analysis

Gold film sensor technology for use in detecting H_2S came onto the scene in the mid-1980s. Developed by Arizona Instrument LLC, the Jerome® brand of hydrogen sulfide analyzers utilizes gold's sensitivity to hydrogen sulfide to detect ultra-low levels of H_2S in air. To take a sample, an internal pump pulls ambient air over the gold film sensor. The sensor absorbs the hydrogen sulfide present in the sample and undergoes an increase in electrical resistance proportional to the mass of H_2S in the sample, allowing the instrument to calculate and display the measured concentration of hydrogen sulfide in parts per million (ppm) or parts per billion (ppb). The most recent gold film hydrogen sulfide analyzer by Jerome, the J605, can detect as little as 3 ppb with a resolution of 20 ppt.

Jerome J605 Portable H_2S Analyzer

Jerome gold film sensor analyzers are rugged, reliable and easy to use. They are available in both fixed-point and portable varieties, making them ideal for a wide range of testing situations including regulatory compliance and permitting, odor control monitoring at landfill and wastewater treatment facilities and scrubber efficiency testing. They are also used in semiconductor manufacturing, control room corrosion monitoring, agriculture and livestock production, geothermal emissions monitoring and paper production.

Jerome 651 Fixed-Point H_2S Monitoring Solution

Unlike other instruments, gold film sensors do not respond to hydrocarbons, carbon monoxide (CO), carbon dioxide (CO_2), sulfur dioxide (SO_2) or water vapor. They are robust instruments that deliver

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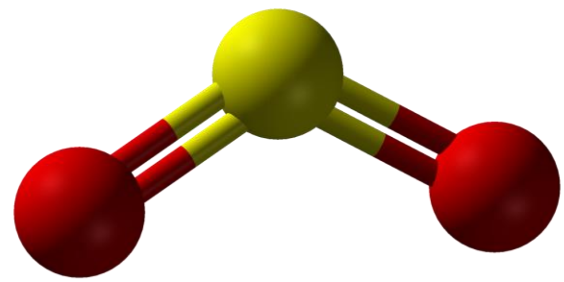
highly accurate and repeatable results whether they are in the lab or in the field. Depending on the model, they can store up to 50,000 samples that can then be exported and further analyzed. They are also available for rent or purchase, making a Jerome an ideal solution to both short and long term H_2S monitoring situations.

Potential interferences with gold film hydrogen sulfide analyzers are rare and most can be eliminated with proper maintenance. Chlorine, ammonia, nitrogen dioxide (NO_2) and most mercaptans can interfere with results. However, specially designed filters can be used to reduce the concentration of chlorine or ammonia gas in the sample before it reaches the sensor, significantly decreasing those interferences.

As far as maintenance goes, calibration is recommended on a yearly or quarterly basis depending on amount of testing and environment in which testing is taking place. If using chlorine or ammonia filters, those should also be replaced at regular intervals depending on frequency of use and the environment in which they are being used.

SO_2 converters are accurate but only available as fixed-point solutions

SO_2 conversion is the EPA recommended method and is useful for low level detection of 0.5 ppb to 10 ppm, but it is in an indirect method of measuring H_2S concentration in air.[13] A collected sample is drawn into the SO_2 converter and any SO_2 that is present in the initial gas stream is removed.[3] H_2S is then turned into SO_2 through a catalytic reaction and the newly created SO_2 sample then passes into a fluorescence chamber where ultraviolet (UV) light excites the molecules.[4] A photomultiplier tube then detects and converts the amount of fluorescence into the SO_2 concentration, which is directly proportional to the H_2S concentration in the original sample.



SO_2 Molecule[20]

SO_2 converters are predominantly used for ambient fence-line monitoring at oil refineries, wastewater treatment plants and landfill facilities.[5] They are only available as benchtop analyzers, not portable, and are usually housed in an enclosure of some sort due to power requirements. Potential interferences include various hydrocarbons, nitric oxide (NO) and water vapor and their lack of portability severely limits their detection capabilities to strictly stationary monitoring.[6]

Colorimetric gas detection tubes are easy to use but results are subjective

Colorimetric gas detection tubes are a well-established method for measuring H_2S in air. They can be used in virtually any industry, are relatively inexpensive for short-term use, and produce results quickly while being simple to operate. To measure the concentration of a given gas, a specific volume of air is pumped through the glass detection tube. Various chemicals inside the tube then react to their target gases by changing colors.[4] Depth and length of the color change are used to determine the concentration of target gas present in the sample.[7]

While the execution of this testing method is simple to perform, there are a number of disadvantages to this type of testing. Because results are based on color change as perceived by the human eye, they are generally considered to be subjective and semiquantitative.[8] Gas detection tubes are portable only and cannot be set to automatically sample. They have a limited shelf life, are sensitive to temperature and humidity during storage and use, and there are a number of chemicals that can interfere with results, such as various mercaptans, hydrogen chloride (HCl) and other acids and bases, isobutylene, hydrogen peroxyl (HO_2) and high concentrations

Colorimetric Gas Detection Tubes[19]

of ammonia.[9] Methyl mercaptan, SO_2 and nitrogen dioxide (NO_2) can also alter the color change, making it more difficult to read the result of the test.[10]

Another thing to keep in mind is that each detection tube is specially designed to detect a specific level of the target gas and that not all detection tubes will have the same interferences. Unless you have a good idea of how much of the target gas you expect to find as well as which interferences may be present and in what concentrations, tube selection may be a challenge.[7] You may need to bring multiple gas detection tubes, which can get expensive, to ensure you are getting a correct reading.

Electrochemical detectors are inexpensive but require frequent calibration

Electrochemical detectors for use in measuring hydrogen sulfide are primarily used for monitoring H_2S at landfill and wastewater facilities as well as for scrubber efficiency testing. They are simple to operate, relatively inexpensive, and can be used as portable or fixed point monitoring solutions for a number of different gases, including H_2S at a ppm level.[11] Electrodes within the electrochemical cells are surrounded by a permeable membrane that allows a sample of air to pass through and diffuse into the cell.[2] When the target chemical is present, an oxidation or reduction reaction occurs and the change in the current is measured and converted to the concentration of target gas present in the original air sample.[12]

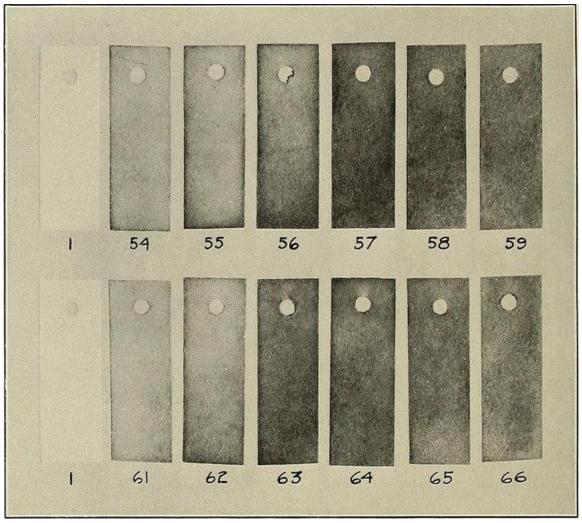
Portable Electrochemical Cell Multi Gas Detector[18]

Although this type of equipment can be effective in measuring H_2S and is available in both portable and fixed-point solutions, it does have its downsides. Electrochemical cell based sensors require very frequent calibration. They are also sensitive to heat and humidity as well as low oxygen environments, all of which can lead to drift and cell deterioration.[2] Other interferences include NO_2, phosphine (PH_3), methyl and ethyl mercaptan, SO_2 and other light hydrocarbons.[11]

Lead acetate tape gas detectors have been around for decades but are susceptible to a number of interferences

Lead acetate tape gas detectors have been around for decades and are still prominent in various industries. It is most commonly used to monitor scrubber efficiency and for fixed-point H_2S monitoring. In the presence of H_2S, the lead acetate tape changes color.[1] Specially calibrated optics inside the instrument are able to determine H_2S concentration by detecting slight variations in the depth of the color change.

Although portable options exist, this type of analyzer is predominantly stationary. The lead acetate tape is prone to interference from SO_2 and both low and high humidity.[13] Dry conditions can cause the instrument to underreport results, while high humidity can cause the tape to become moist and the glass components to fog (humid conditions).[13] When this happens, the color as it is perceived by the optic system is distorted, thus skewing the final test result.



Lead Acetate Detection Strips Circa 1914[17]

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Lead acetate cassette tape gas detectors are on the more expensive side of the spectrum, especially when considering the fact that the cassettes require fairly frequent replacement – every 1 to 4 weeks or longer depending on the amount of tape on the roll, frequency of sampling and the environment in which the sampling is taking place. They also have a set shelf life and must be carefully stored to prevent potential damage from ambient humidity and other factors.

Other methods of H2S analysis exist

Metal oxide semiconductors (MOS), absorption spectroscopy, field olfactometers, sulfur chemiluminescence, flame photometric detectors (FPDs) and sulfur titrators are all valid methods/technologies for detecting hydrogen sulfide. However, due to a number of reasons, they are not discussed in detail in this paper. Reasons may include subjectivity of results, slow response time, special training required, complicated testing procedures, lack of portability or an inability to measure individual sulfur compounds.[1][2]

Field Olfactometer[21]

Choosing the correct H_2S analysis technology is essential

While many types of technology exists to detect hydrogen sulfide, no single method can be said to be the best for all situations. However, some technologies have clear advantages over others. SO_2 conversion is the EPA recommended method, but it is only available as a stationary analyzer. Electrochemical cells can be inexpensive upon initial purchase but require frequent calibrations and have a number of interferences. Colorimetric gas detection tubes are easy to use and inexpensive, but are entirely manual, have many interferences and yield subjective results. Lead acetate cassette tape based analyzers perform H_2S analysis quickly, but are somewhat expensive and require replacement tapes, which adds to the lifetime cost of the unit.

Overall, Jerome gold film sensor H_2S analyzers are the only ones on the market that offer both portable and stationary solutions that are able to produce both accurate and repeatable results for unknown, low-level concentrations of H_2S. They are sensitive enough to ensure compliance with odor and other ordinances and durable and convenient enough for frequent use.

If you would like to learn more about our Jerome line of H_2S analyzers, contact us online at www.azic.com/contact or give us a call at (800) 528-7411.

References:

1) Haydt, D. *H2S Detection and Determination* (Tech.). Retrieved January 10, 2017, from Galvanic Applied Sciences website: http://asgmt.com/wp-content/uploads/pdf-docs/2007/1/020.pdf
2) Benham, B. (2008). *Developing Technologies to Detect Hydrogen Sulfide (H2S) Gas* (Tech.). Retrieved December 30, 2016, from Detector Electronics Corporation website: http://www.det-tronics.com/Documents/74-1002_SAOGE0811Benham.pdf
3) Ecotech. (2015). *Serinus 51 SO2/H2S Analyser.* Retrieved December 29, 2016, from Ecotech website: http://www.ecotech.com/wp-content/uploads/2015/01/M010040-Serinus-51-SO2-H2S-User-Manual-Rev-1.0.pdf
4) Reddy, S. B. (2016, July 25). *Pulsed Fluorescence SO2, H2S, CS Analyzer Working Principle*. Retrieved December 30, 2016, from http://instrumentationtools.com/pulsed-fluorescence-so2-h2s-cs-analyzer-working-principle/
5) Raeco-LTC LLC. (2013). *TLG-837 Tail Gas / Air Demand Analyzer.* Retrieved December 30, 2016, from RAECO-LTC LLC website: http://www.raeco.com/products/gas-analyzers/AppliedAnalytics-TLG-837-Tail-Gas-Analyzer/AppliedAnalytics-TLG-837-Tail-Gas-bro.pdf
6) United States Environmental Protection Agency. (2004, October 14). *Fact Sheet for Trace Level SO2 Monitoring Method.* Retrieved January 10, 2017, from the Environmental Protection Agency website: https://www3.epa.gov/ttn/amtic/files/ambient/pm25/spec/so2sum2.pdf
7) Interscan Corporation. *Detector Tubes and When to Use Them*. Retrieved December 29, 2016, from https://www.gasdetection.com/knowledge-base/best-practices/detector-tubes-and-when-to-use-them/
8) United States Environmental Protection Agency. (2001, February). *Brownfields Technology Primer: Requesting and Evaluating Proposals that Encourage Innovative Technologies for Investigation and Cleanup.* DIANE Publishing. Retrieved December 29, 2016, from the Environmental Protection Agency website: https://www.epa.gov/sites/production/files/2015-04/documents/rfpfinal.pdf
9) RAE Systems. *Gas Detection Tubes and Sampling Handbook.* Retrieved December 29, 2016, from RAE Systems website: http://www.raesystems.com/sites/default/files/content/resources/eBook-gas-detection-tube-and-sampling-handbook.pdf
10) Dräger. (2011). *Dräger-Tubes & CMS Handbook, 16th Edition*. Retrieved December 30, 2016, from Dräger website: https://www.draeger.com/library/content/tubeshandbook_br_9092086_en.pdf
11) Analytical Systems KECO. *Choosing the Right H2S Analyzer for Your Specific Application.* Retrieved January 13, 2017, from Analytical Systems KECO website: http://liquidgasanalyzers.com/choosing-the-correct-h2s-analyzer-for-specific-application/
12) Figaro Engineering Inc. *Operating Principle, Electrochemical Type*. Retrieved December 30, 2016, from http://www.figaro.co.jp/en/technicalinfo/principle/electrochemical-type.html
13) Robert M. Bethea (1973) Comparison of Hydrogen Sulfide Analysis Techniques, Journal of the Air Pollution Control Association, 23:8, 710-713, DOI: 10.1080/00022470.1973.10469832. Retrieved December 30, 2016 from Taylor and Francis Online website: http://dx.doi.org/10.1080/00022470.1973.10469832
14) Ecotech. (2015, January). *Serinus 51 SO2/H2S Analyser.* Retrieved January 13, 2017, from Ecotech website: http://www.ecotech.com/wp-content/uploads/2015/01/Serinus-51.pdf
15) AFC International, Inc. *TixiRae 3 Single Gas Detector for CO & H2S.* Retrieved January 13, 2017, from AFC International, Inc. website: http://www.afcintl.com/toxirae-3-single-gas-detector-for-co-h2s.aspx
16) Honeywell International. (2015, October). *SPM Flex Specifications, Chemcassette® Tape-Based Gas Detector.* Retrieved January 13, 2017, from Honewell Analytics Website: http://www.honeywellanalytics.com/~/media/honeywell-analytics/products/spm-flex/documents/english/ss01138en_spm-flex_specsheet_web_10-14-15.pdf?la=en
17) McBride, R., & Edwards, J.D. (circa 1914). Lead acetate test for hydrogen sulphide in gas [Digital image]. Retrieved January 20, 2017, from https://www.flickr.com/photos/internetarchivebookimages/14776664051
18) FEMA - 38503 - Hazardous materials gas detector in Texas [Digital image]. Retrieved January 20, 2017, from https://commons.wikimedia.org/wiki/File:FEMA_-_38503_-_Hazardous_materials_gas_detector_in_Texas.jpg
19) Draeger Tubes Showing Air Quality Test Results [Digital image]. Retrieved January 20, 2017, from https://commons.wikimedia.org/wiki/File:Draeger_tubes_showing_air_quality_test_results_DSC09470.JPG
20) Sulfur Dioxide 3D [Digital image]. Retrieved January 23, 2017, from https://en.wikipedia.org/wiki/Sulfur_dioxide
21) Pueblo Chemical Agent-Destruction Pilot Plant Odor Monitoring [Digital Image]. Retrieved February 2, 2017, from https://www.flickr.com/photos/acwa/27967249765

Table 1

Detection Technology	Gold Film Sensors		SO2 Conversion	Colorimetric Gas Detection Tubes	Electrochemical Cells	Lead Acetate CassetteTape
Portable/Stationary	Portable	Stationary	Stationary	Portable	Both	Both
Detection Range	3 ppb to 10 ppm	0.003 ppm to 50 ppm	0.5 ppb to 2 ppm	0.2 ppm to 600 ppm *tube dependent	0 to 100 ppm	0.001 ppm to 9.999 ppm
Resolution	20 ppt *range dependent	0.001 ppm *range dependent	0.5 ppb	0.1 ppm, 1 ppm, or 2 ppm *tube dependent	0.1 ppm	--
Accuracy	±1 ppb at 5 ppb, ±3 ppb at 50 ppb, ±0.03 ppm at 0.5 ppm, ±0.3 ppm at 5.0 ppm	±0.005 ppm at 0.05 ppm, ±0.05 ppm at 0.5 ppm, ±0.5 ppm at 5 ppm, ±2 ppm at 25 ppm	--	10% to 20% *tube dependent	--	--
Precision	10% at 5 ppb or lower, 5% at 50 ppb or higher	8% across the range of the sensor	--	±10% to ±15% *tube dependent	--	--
Response Time	12 to 53 seconds	12 to 53 seconds	60 seconds to 95%	15 seconds to 10 minutes *tube dependent	<12 seconds	7 seconds
Data Logging Capabilitiy	Yes - 20,000 tests	Yes - 50,000 tests	Yes	No	Yes - 10 events	Yes - 1500 events
Display Capabilities	ppm, ppb	ppm	mg/m^3, $\mu g/m^3$, ppm, ppb	ppm	ppm	ppm
Operating Environment	0°C to 40°C	-40°C to 55°C	5°C to 40°C	-20°C to 50°C	-20°C to +60°C	0°C to 40°C
Calibration and Maintenance	Yearly calibration recommended	Yearly or quarterly calibration recommended depending on use	Require frequent maintenance and replacement of consumables	Require frequent replacement of consumables	Require frequent calibration	Require frequent maintenance and replacement of consumables
Interferences	Ammonia and chlorine (filters available to offset these), NO_2, most mercaptans	Ammonia and chlorine (filters available to offset these), NO_2, most mercaptans	Various hydrocarbons, water vapor, nitric oxide	SO_2, NO_2, HO_2, ammonia, isobuteylene, other acids and bases, HCl, various mercaptans, temperature, humidity	Heat, humidity, low oxygen environments, NO_2, PH_3, SO_2, methyl mercaptan, ethyl mercaptan, other light hydrocarbons	SO_2, O_2, high and low humidity, temperature, sunlight
Other Limitations	Regeneration needed when sensor becomes saturated	Regeneration needed when sensor becomes saturated	No useable standard for confirming low-end specifications	Subjective, semiquantitative results, tubes have a shelf life	Prone to drift	Tape has a limited shelf life and must be stored carefully
Dimensions *vary by manufcturer	11" x 6" x 6.5" (28cm x 16cm x 17cm)	26" x 25" x 9" (67cm x 64cm x 23cm)	24.4" x 17.3" x 7" (62cm x 44cm x 17.8cm)	Pump: 6.69" x 1.77" x 3.35" (17cm x 4.5cm x 8.5cm)	3.4" x 2.2" x 0.8" (8.6cm x 5.5cm x 2.0cm)	13.2" x 7.2" x 9.5" (33.6cm x 18.3cm x 24.1cm)
Weight *varies by manufcturer	5.4 lbs (2.5 kg)	52 lbs (24 kg)	39.9 lbs (18.1 kg)	Pump: 8.8 oz (250 g)	3.5 oz (99 g)	9.1 lbs (4.1 kg)

-- info not available