

TN 2014:

Calibrating GfG Micro IV instruments equipped with hydrogen fluoride (HF) sensors



Sensors used to measure hydrogen fluoride (HF) are dependable and accurate, but require special care during calibration and functional test procedures.

Hydrogen fluoride (HF) is an extremely toxic, colorless, lighter than air gas associated with a number of industries and industrial processes. HF is highly soluble in water where it forms hydrofluoric acid. HF is highly corrosive, and forms hydrofluoric acid upon contact with tissue. HF is extremely irritating to skin and mucous membranes, can cause blindness by rapid destruction of the corneas, and requires immediate medical attention upon exposure.

Aqueous hydrofluoric acid is a contact-poison with the potential for deep, initially painless burns and ensuing tissue death. By interfering with the body's calcium metabolism, concentrated hydrofluoric acid may also cause systemic toxicity and eventual cardiac arrest and fatality, after contact with as little as 160 cm² (25 square inches) of skin.

Hydrogen fluoride is widely used as a catalyst in the petrochemical industry. HF is used in the manufacture of fluoropolymers such as Teflon® (PTFE), semiconductor materials, aluminum, pharmaceuticals, and refrigerants (e.g. Freon®). HF can also be produced as a combustion by-product of fluorocarbon fire-extinguishing agents, and by the combustion of fluoropolymers.

Hydrogen fluoride exposure limits

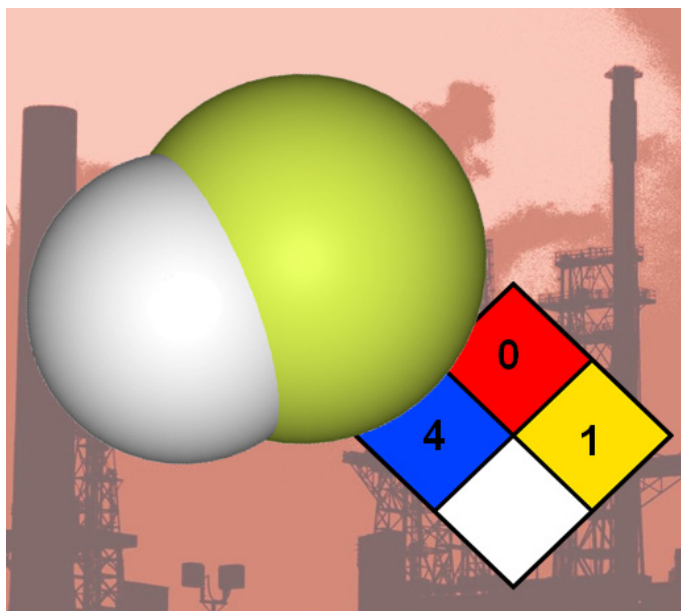
OSHA PEL: The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for hydrogen fluoride is 3.0 ppm as an 8-hour time-weighted average (TWA).

NIOSH REL: The National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) for hydrogen fluoride is 3.0 ppm as an 8-hour TWA, and 6.0 ppm as a 15-minute short-term exposure limit (STEL).

ACGIH® TLV®: The American Conference of Governmental Industrial Hygienists® TLV® is 0.5 ppm as an 8-hour TWA, and 2.0 ppm as Ceiling limit (15-minute).

HF sensor characteristics

GfG uses Sensoric model HF-3E-10-SE substance-specific electrochemical sensors for HF measurement. The linear measuring range is 0 – 10 ppm. The maximum (over-limit) concentration varies by sensor, but is approximately 13.0 ppm. The resolution of the sensor (at 20°C) is ±0.1 ppm. The expected lifespan of the sensor is approximately 18 months. The sensor is warranted for 1.0 year from the date of purchase.



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The HF sensor takes a little longer to reach a final stable reading than other common electrochemical sensors such as those used to measure CO and H₂S. The HF sensor response time at 20°C to 50% of its final stable reading (t50) is approximately 30 seconds. The response time to 90% of its final stable reading (t90) is approximately 90 seconds.

The HF sensor is significantly affected by sudden shifts in humidity, causing momentary shifts or zero reading "transients." However, the sensor rapidly recovers as soon as conditions stabilize. Be careful to avoid breathing on the sensor, or holding the sensor opening against a moist palm or fingers. Give the sensor a few moments to stabilize if you move into an area with a different relative humidity.

The HF sensor responds to a number of acid gases with similar chemistry. The following table lists the relative of some of the most common interfering gases:

HF sensor cross sensitivities at 20° C		
Gas	Concentration applied	HF sensor response
Acetic acid	100 ppm	100 ppm
Alcohols	1,000 ppm	0
Carbon dioxide	5,000 ppm	0
Carbon monoxide	100 ppm	0
Chlorine	1.0 ppm	0.7
Hydrocarbons	Percent (%) range	0
Hydrogen	3,000 ppm	< 1.0
Hydrogen chloride	10.0 ppm	6.0 ppm
Sulfur dioxide	20 ppm	16.0 ppm*

*Short gas exposure in minute range.



Calibrating GfG monitors equipped with HF sensors

1. Calibrating a single-sensor Micro IV instrument:

- Consult the Owner's Manual for complete procedures for fresh air zero-adjusting and span calibrating the Micro IV instrument. You can download a copy of the Micro IV owner's Manual at www.goodforgas.com
- Acid gas sensors such as those used to measure hydrogen fluoride and hydrogen chloride should be activated by a brief exposure to calibration gas prior to the actual calibration procedure.
- Allow at least one full hour after initially turning the instrument on for the sensor to stabilize completely before starting a calibration. A stable sensor should read 0.0 ppm in fresh air without fluctuation.
- If needed, perform a fresh air calibration. It may be necessary to repeat the procedure one or more times.
- After fresh air calibration the monitor must remain stable for at least ½ hour before proceeding to the span calibration step. In all cases allow one hour warm-up after initially turning the instrument on before attempting calibration.
- Connect the gas, regulator, tubing, and Teflon® calibration adapter. Make sure the regulator is designed to flow at a rate of 1.0 lpm (liters per minute) Make sure to use PTFE lined tubing to connect the regulator to the calibration adapter, and use the minimum possible length of tubing to connect the calibration adapter to the regulator.

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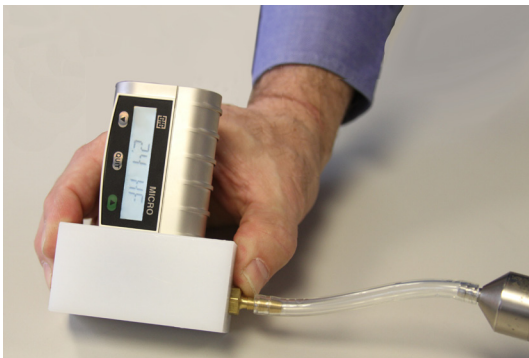
- Remove the protective boot from the instrument, and insert the Micro IV into the Teflon® calibration adapter. Make sure that the Micro IV is inserted so that the sensor is next to the gas inlet in the adapter.



- Start the HCl gas flowing.



- Activation step:** When the reading reaches 4.8 ppm, or has run for five minutes, but not more, turn off the gas flow, remove the instrument from the calibration adapter, and allow the sensor to stabilize in fresh air. Wait at least 15 minutes BEFORE proceeding to the actual calibration step.



- Calibration step:** Insert the instrument into the calibration adapter, and start the HCl gas flowing. When the reading reaches 4.8 ppm, or has run for five minutes, THEN initiate the calibration step. Newer sensors respond more quickly than older and may reach 4.8 ppm, or more, within a couple of minutes.
- The HF sensor has a relative response of about 0.6 to hydrogen chloride (HCl). Use 10.0 ppm HCl in nitrogen calibration gas to calibrate the HF sensor. Make sure the "Cal point" value in the Micro IV is set to 6.0 ppm.



- If the reading does not reach 4.8 ppm within five minutes:
 - Make sure that the regulator has a flow rate of 1.0 lpm.
 - Make sure that the instrument is properly inserted into the calibration adapter, and that the sensor is adjacent to the gas inlet.
 - Make sure that the cylinder contains 10.0 ppm HCl calibration gas, is still within dating, and that the cylinder has sufficient remaining pressure to complete the calibration procedure.
 - Turn the gas flow off, remove the instrument from the calibration adapter, and allow the sensor to recover in fresh air. This may take several minutes.
 - Wait at least 30 minutes, then try again.
 - If the sensor still responds too slowly, or fails to reach a reading of 4.8 ppm, the sensor may need to be replaced.
- If the calibration fails, without turning the gas off, try again.
- If the instrument still fails to calibrate, contact the GfG Service Department for help, or to arrange for the shipment of a replacement sensor.

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