

1.1 DI-8 HYDROGEN SULPHIDE GAS DETECTOR

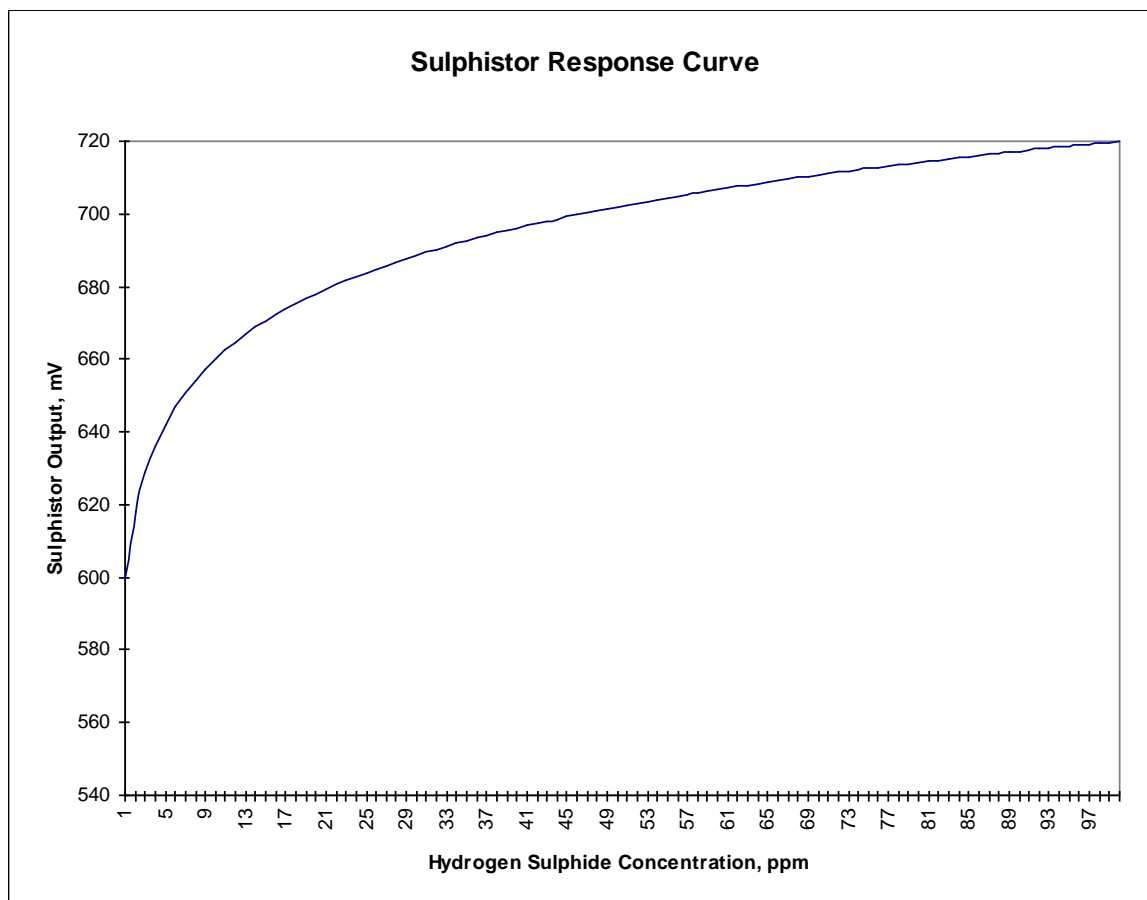
1.1.1 General



The DI-8 hydrogen sulphide gas detector consists of a stainless steel, flameproof enclosure containing Sulphistor gas sensing elements. It is used for detecting hydrogen sulphide in parts per million concentration. It has been in use since 1984 and has been fitted on offshore platforms and petrochemical plants. The DI-8 is normally supplied with the Crowcon standard junction box to which it can be fitted by means of the M20 thread at the top of the detector. The three wires can then be terminated at the connector block in the junction box.

1.1.1.1 Method Of Operation

The Sulphistor sensor is a unique device developed by Detection Instruments Group in association with Brunel University. Its mode of operation is part catalytic and part semi-conductor and its resolution is 1 ppm of hydrogen sulphide in air, reducing to 15 ppm at 100 ppm of hydrogen sulphide (see the graph below). Unlike many other devices it has a fast response and clearing time and does not suffer from the so called "memory effect". The sensor is composed of two elements, one being active and the other passive, which operate in a specialised bridge circuit. When hydrogen sulphide is present, a catalytic reaction takes place which modifies the surface of the active element and changes the conductivity of the material. This change is detected in the bridge, which is located in the body of the detector and is evident as a change in the standing current drain.



1.1.1.2 Certification

The detector head is certified as a flameproof enclosure by BASEEFA. The certification is classified as Exd IIC T6 under BASEEFA certificate EX74085. The certificate number is the same as for the DI-5/6 flammable gas detector since the DI-8 is a variation of this original certificate.

1.1.1.3 Cross Sensitivity

Virtually all sensors for the detection of gases in the ppm range suffer from some form of cross-sensitivity. This relates to sensitivity to gases other than the gas that the sensor is designed to detect. The major cross sensitivity effect with the Sulphistor arises from alcohols. These are often found in paints, degreasing fluids, paint strippers and also in some oils used for mud lubrication. Care should be exercised when using the DI-8 in atmospheres likely to be contaminated with these products.

The cross-sensitivity to hydrocarbon gases is low. For example, methane must be present in concentrations of around 20% LEL to produce a signal equivalent to 10 ppm of hydrogen sulphide.

1.1.1.4 Detector Output

The output of the detector head is not of the traditional pellistor bridge type. In clean air there is a continuous output between the red and yellow leads which, when measured across a 33 Ω resistor connected between these two leads, has a nominal voltage value of 600 mV. When hydrogen sulphide is present in a concentration of 10 ppm, the voltage value will increase by typically 100 mV. The output characteristic is logarithmic so that the response to 100 ppm will be twice that of the response to 10 ppm. See the section on technical notes for further detail.

1.1.1.5 Response Time

Response times are normally quoted as the time for the detector to reach a percentage of the final reading. With the detector connected to a suitable measuring circuit and exposed to, for example, 10 ppm hydrogen sulphide in air then T_{90} is the time for the measuring circuit to record a value corresponding to 90% of the final value, i.e. a signal of 9 ppm. The measured time for the DI-8 is 15 seconds.

1.1.2 Construction

1.1.2.1 Materials

All units are constructed in stainless steel type 316. The sinter fitted to the bottom of the unit through which gas will diffuse to the sensors is also manufactured from stainless steel and has a maximum pore size of 160 μm .

The essential components of the detector consist of the following items:

- Body
- Head top and gland
- Sinter assembly
- Sensor and PCB assembly

After assembly the internal cavity of the detector is encapsulated with Stycast resin. For this reason it is not possible to replace the sensor elements. The sinter unit, however, is replaceable by an authorised agent of Crowcon Detection Instruments Ltd from whom spare sinters are obtainable. When ordering spares it is essential to quote the batch number of the detector head. This is recorded in the form of "S01505 xxx" where "xxx" is the batch number.

1.1.3 Installation

1.1.3.1 Siting Of Detector Heads

The siting of detector heads to provide the greatest probability of detection of a release of gas requires detailed knowledge of plant processes, gases in use, air movements and dispersion characteristics and is beyond the scope of this document. The reader is referred to BS6959, "Selection, installation, use and maintenance of apparatus for the detection and measurement of combustible gases". The following are some very general guidelines.

The head should be located where concentrations of hydrogen sulphide are likely to occur, bearing in mind the following conditions:

- Hydrogen sulphide is slightly heavier than air having a vapour density of 1.19 and will therefore tend to settle low down in still air conditions. However, it also diffuses rapidly into the air and does not behave like a heavy gas such as propane which will form pools. Since the toxic danger from hydrogen sulphide is by ingestion through the mouth or nose, it is reasonable that a proportion of detectors be mounted at approximately head height.
- The detector should be close to any potential source of leakage such as valves, flanges and compressor bearing seals.
- The detector should be positioned pointing vertically downward and be protected with a weatherproof cap if there is any danger of water or dust ingress.

1.1.3.2 Cabling

Each detector head requires a three core cable to connect it to the control equipment. It is permissible to use multi-core cables from marshalling boxes to control equipment, provided that the cross sectional area of each core is sufficient for individual heads. The limitation on cable size is dictated by the resistance per unit length of the core. The generally recommended cable is three core 1.5 mm² SWA.

To avoid cross interference from cables carrying high power circuits, it is essential that cable used should be fitted with some type of screen. In the case of SWA cable as recommended above, the armour is normally sufficient screen provided that it is correctly earthed. As an added precaution detector head cables should not be run in cable trays carrying high power or large currents.

The cable is to be connected to the head via a suitable junction box which should be fitted with an earth plate. The head is supplied with an integral 20 mm threaded gland and sealing washer. The head should be screwed into the junction box until the sealing washer is compressed, an M20 locking nut should then be threaded onto the gland and tightened down so that the earth plate is in good electrical contact with the head and the three wires terminated on the connector block. When connecting the field cable use a suitable gland and ensure that the three cores are connected between the detector head and the control module in the following manner:

Detector Wire Colour	Designation	Circuit
Red	V+	+ve supply
Yellow	V sense	Signal
Black	0	0 Volts

All connections throughout the total circuit must be tight and secure, small changes in resistance due to loose terminals will introduce instability at the control module and may lead to false alarms.

WARNING: It is vitally important that the head is connected as above. If the polarity is reversed the head may suffer irreparable damage.

IMPORTANT NOTICE: Reference should be made to BS5345, Part 3 "Installation and maintenance requirements for electrical apparatus with type of protection 'd' flameproof enclosures".

1.1.4 Commissioning

Head Voltage

It is essential that the head voltage be correctly set as the first step in commissioning. The DI-8 contains within the body of the assembly a voltage regulating circuit, the setting of the applied voltage is not particularly critical but it is essential that the minimum voltage set be not less than 6 V. Ensure that the head voltage control is set to minimum before switching on, making reference to the control card documentation as necessary. At the detector remove the cover from the junction box (observe local safety regulations) and measure the voltage between the red wire (+ve) and the black wire (-ve). Adjust the control at the control module until the voltage measured is not less than 6 Volts. We recommend that the voltage be set to 6.5 Volts.

NOTE: The higher the voltage is set the more power is dissipated in the head regulator circuit and hence the higher the temperature of the head body when thermal equilibrium is reached. Replace the junction box on completion.

Gas Test

Carrying out an accurate gas calibration with hydrogen sulphide requires care and a good understanding of the problems that may be encountered. The following are some general comments that should be carefully read before proceeding to carry out further adjustments.

1. The DI-8 requires a considerable settling in time from first switch on. During this period the zero moves down scale and approaches its final settling point in an exponential fashion, during this period no calibration should be attempted. The length of the period varies slightly from sensor to sensor but in order to ensure that the head is fully settled a period of 24 hours should be allowed between setting the head voltage and carrying out zero and calibration procedures.
2. The Sulphistor sensor requires oxygen to react correctly. It is essential, therefore, that the test gas used shall be hydrogen sulphide in air and **not** hydrogen sulphide in nitrogen or any other inert gas.
3. The ideal concentration of test gas to use is 10 ppm gas in air, as this corresponds to the TLV of hydrogen sulphide and also to the most sensitive part of the response curve of the sensor. Alternatively, a concentration of 20 ppm may be used but we do not recommend concentrations higher than this. It is difficult to maintain low concentrations of hydrogen sulphide in air in containers for long periods without the concentration reducing. This is due to partial absorption of the gas into the walls of the container, it is dangerous therefore to trust implicitly the concentration value written on the container. We advise that before using the gas for calibration its concentration should be measured with a Draeger tube or equivalent. It should be appreciated that if the gas concentration is assumed to be (say) 10 ppm but is in fact only 5 ppm and the head is calibrated on the assumed value, then the sensitivity will be twice the correct value and there will be an increased risk of false alarms.
4. When applying the test gas to the head, care should be taken in the material used for the tubing to carry the gas. Hydrogen sulphide will very readily absorb into many materials and if a long length of natural rubber tubing is used to connect the gas container to the head, then it is quite possible for the concentration at the far end of the tubing to be significantly less than the

concentration in the container. The most reliable material to use for tubing is PTFE, but even so lengths should be kept as short as possible.

Setting Zero

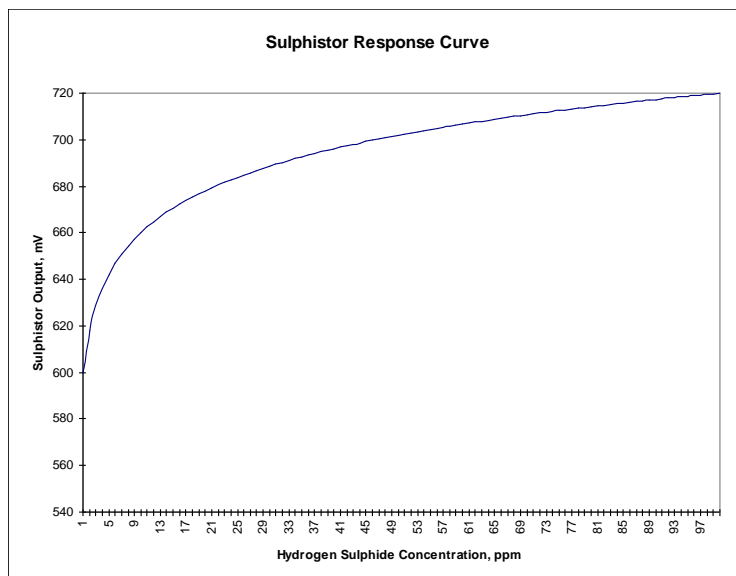
To set a true zero it is essential that the head be in clean air. If there is any suggestion that a type of gas or vapour is present, the head should be capped with the protective cap in which it was originally supplied. The cap should be fitted for at least five minutes before the zero is set. For the procedure for setting the zero control refer to the control module documentation.

Setting Span

Remove the protective cap from the head and fit the calibration cap. Connect the test gas to the calibration cap spigot and flow the test gas at a flow rate of 1 to 1.5 litres per minute. Allow the test gas to flow for at least 30 seconds and then observe at the control module that the meter reading is steady. For the procedure for setting the span control refer to the control module documentation. On satisfactory completion remove the calibration cap and refit the weatherproof cap if relevant.

1.1.5 Technical Notes

1. The Sulphistor sensor has a logarithmic output within the range that it is designed to be used i.e. 0 to 100 ppm. This effectively means that the output in millivolts from the detector for a concentration of 100 ppm is twice the output in millivolts for a concentration of 10 ppm. If a logarithmic curve is drawn it will be seen that the slope of the curve is greater at low values than at high values (see below). This means that in the case of the DI-8 the signal discrimination is better at low concentrations than at high. This is a desirable feature as the TLV of H₂S is 10 ppm and this is the concentration at which the first alarm level should be raised.



2. The basic operation of the detector can be tested quite simply as it already has regulation circuits built into the body. To carry out a simple test on the detector alone the equipment required is:
- A dc power supply capable of supplying a voltage of at least 6 Volts at 500 mA.
 - A 33 Ω ¼ watt resistor.
 - A multimeter.

Connect the equipment as follows:

The 33 Ω resistor must be connected between the yellow and red detector wires. The red wire is then connected to the +ve terminal of the power supply and the black wire to the -ve terminal. It is important to ensure that the polarity is correct otherwise the detector will be damaged. Now connect the multimeter across the 33 Ω resistor and select 1 Volt range. Support the detector such that it is upright with the sinter end downwards and clear of the bench. Switch on the power supply and adjust its output to approximately 6.5 Volts. Observe the reading on the multimeter which should initially read a value in excess of 1 Volt and then rapidly decrease.

3. Assuming that the detector is in clean air the reading will now start to settle towards its zero voltage and the rate of down scale movement will slowly decrease as this zero point is approached. The acceptable reading of the zero voltage in clean air is between 400 mV and 830 mV. It should be apparent within about 30 minutes whether or not the voltage will settle to within these limits.
4. If there is no suitable test gas available, a quick check that the detector is still sensitive can be made by wetting a cloth or tissue with a little alcohol based fluid and holding it just under the detector. A rapid upscale movement of the multimeter should occur.

NOTE: Do not apply the fluid to the sinter as this will cause contamination that may take a very long time to clear.

If test gas is available then the detector can be calibrated in accordance with paragraph 4.2 when it has finally stabilised. To determine if the sensitivity is acceptable using a test gas of 10 ppm hydrogen sulphide in air, proceed as follows:

- 4a) Record the multimeter reading in clean air.
 - 4b) Apply the test gas and when the reading has stabilised (from 30 to 60 seconds) record the multimeter reading.
 - 4c) Subtract reading a) from the reading b) and the result should be not less than 60 mV and not more than 225 mV.
5. If the reading obtained in 4c) above is less than 60 mV then it is possible that the sensitivity will increase if the detector is kept in a powered state for a longer period. This is particularly the case if the detector is new or if it has been kept un-powered for a long time. It is suggested that under these conditions it be left running for 24 hours before carrying out another gas test.
6. If the test gas available is not 10 ppm then it is still possible to determine the correct result by dividing the figure obtained in 4c) above by the logarithm of the test gas concentration. Log tables for typical concentrations are shown below:

Concentration	Log ₁₀
10 ppm	1.00
20 ppm	1.30
25 ppm	1.40
50 ppm	1.70
75 ppm	1.88
100 ppm	2.00

For example: the test gas concentration is 25 ppm, therefore the log of the concentration is 1.40. If the reading obtained (4c) is 87 then the comparative figure is:

$$\frac{87}{1.40} = 62.14$$

With the above calculation 62.14 is greater than 60 so the sensor has sufficient sensitivity.

WARNING: Hydrogen sulphide is a highly toxic gas. When handling it in confined spaces ensure that there is sufficient ventilation and extraction to prevent operators from being exposed to concentrations greater than 10 ppm.

1.1.6 Technical Specification

DI-8 Material: Stainless Steel

Weight: 1.65Kg (includes junction box)

Temperature range: 0 to 65°C

Humidity: 0 to 99% RH non-condensing

Response time: 15 seconds to T90

Certification: Exd IIC T6 **Not ATEX approved**

Baseefa certificate number: EX74085