CO sensing

A submarine is a sealed environment in which the crew are working and living for periods of up to 90 days. As a result the atmosphere needs to be carefully managed to limit exposure of the crew to potentially harmful substances, and to ensure the atmosphere is capable of supporting life when the submarine is submerged.

Sources of carbon monoxide include; cooking, fire, incomplete combustion of the diesel engines, chlorate candles and although less common now, smoking.

The submarine environment is a unique environment which poses a number of problems to standard off the shelf carbon monoxide sensors. The most common type of carbon monoxide sensor is an electrochemical cell, but unfortunately this sensing technology is extremely cross sensitive to hydrogen. This makes it unsuitable for use in the submarine environment, where hydrogen is constantly produced during charging of the submarine batteries, thus providing a constant background level at low concentrations. Most toxic gas electrochemical cells also suffer the added limitation of being very sensitive to changes in pressure, which can limit their suitability on board a submarine. When you add the operating environment into the equation you need equipment that can operate across a range of temperatures and humidity levels as well as through pressure changes.

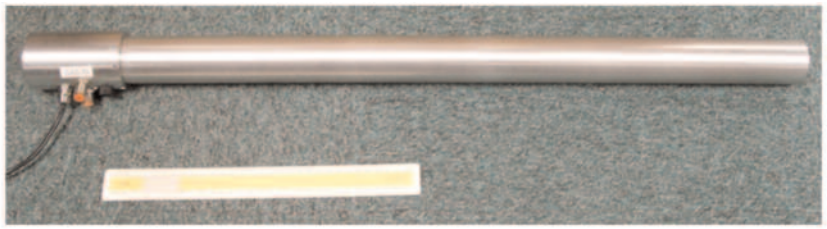
Analox understands the technology challenges associated with using IR sensing techniques at elevated pressures and are able to correct for these effects to produce accurate sensors. Our hyperbaric sensors are well proven in the submarine community where they have been used over the last 14 years at pressures up to 10 BarA, for submarine escape and rescue.

Analox can offer 2 technology options for accurate CO detection on board the submarine.
Both are based on an infra red technique, and as a result neither sensor suffers cross sensitivity to the background levels of hydrogen found on board.

1. The first is based on using standard Non Dispersive Infra Red (NDIR) technology.
2. The second is based on Tunable Laser Absorption Spectroscopy (TLAS), which uses a Quantum Cascade Laser (QCL).

Option 1 - Analox NDIR Sensor

The Analox NDIR CO sensor is a new sensor that has been specifically designed for the submarine community. Drawing upon Analox's expertise in infra red sensing in hostile environments Analox have developed the single path IR sensor for carbon monoxide.



It utilises advanced infra-red detectors and electronics to provide a solid-state IR CO sensor in a mechanically robust package. Unlike competitor units it does not use mirrors, mechanical chopping or other unreliable parts. Power consumption is minimised and the calibration interval has been maximised.
The system comprises a sensor and a separate display unit. They can be mounted independently and may be up to 3m apart. The display unit also contains the gas conditioning system. A pump is used to pull a sample of the submarine air into the conditioning unit where the sample is de-humidified to remove any water vapour. This sample is then presented to the CO sensor, where the concentration of carbon monoxide is determined.

Outline specification

This specification is preliminary, if you have specific requirements please contact Analox to discuss adaptations to the sensor design.

Power supply:
90 to 260V ac, 50 to 60Hz, 10W maximum.
A 24V DC version is available on request.
Power consumption: approximately 16 Watts

Environmental:
Operating temperature range : 0°C to 50°C
Storage temperature range : 10°C to 70°C
Relative humidity : 0 to 99% (non-condensing) operating humidity range
Ambient pressure range : 700 to 1300mbar
Max rate of pressure change : 300mBar/min

Gas measurement:
Gas accuracy is quoted at atmospheric pressure.
Sensor range : 0 to 200ppm CO with 0 to 1000ppm over-range capability
Sensor accuracy : ±10ppm
Temperature sensitivity : ±10% of reading across the operating temperature range
Sensor life is six years with the option of extending life by a further six years with a factory overhaul.

Physical:
Sensor dimensions - Ø60 x 850mm long
Sensor weight - 1.5kg
Display unit dimensions - 210 x 200 x 150mm (W x H x D)

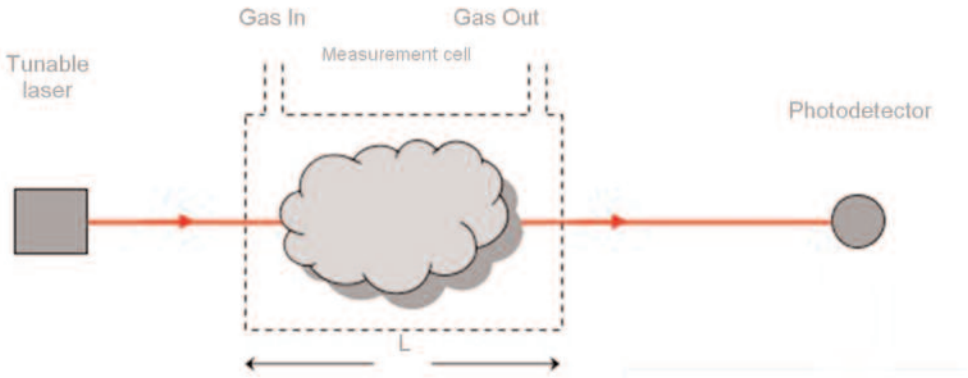
Option 2 – TLAS using a QCL

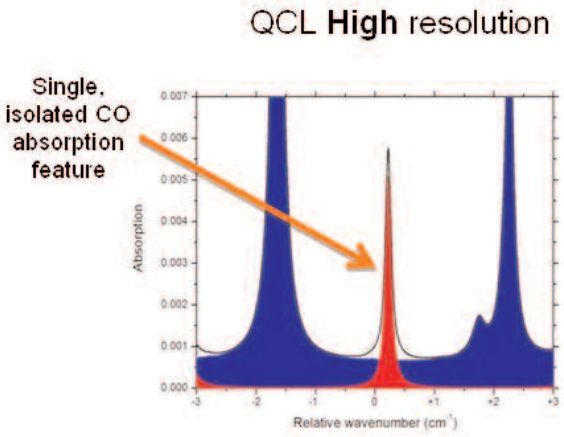
The Analox QCL is based on a Tunable Laser Absorption Spectroscopy (TLAS) approach, which uses a Quantum Cascade Laser (QCL).

TLAS – how it works;

• Laser light is directed through the gas sample and on to a photodetector

• The laser wavelength is tuned across the COabsorption peak





• The photodetector monitors any reduction in laser intensity due to absorption by the CO molecules present.

• Absorption is proportional to the number of CO molecules between the laser and the photodiode, hence sensitivity can be increased by increasing path length.

This technique offers the following advantages;

• The technique is extremely selective, resulting in very good signal to noise ratios, this allows the stable detection of low levels of carbon monoxide concentrations in a demanding environment.
• The laser is very stable over the long term, so calibration periods of at least 6 months are possible.
• Owing to the selectivity, the approach is largely immune to cross sensitivities to other gas species and water vapour. Initial testing has shown no cross sensitivity to hydrogen or water vapour.The unit is ideally suited to monitoring low level, MPC90, CO concentrations typically found on board a nuclear boat. It can be mounted in the central living spaces, and be used to take samples from other boat compartments, or as part of a distributed system.

The QCL is currently a factory prototype that can be used to demonstrate the technology.

Outline specification

Power supply
24V DC (or 18 to 32vDC)
Power consumption : 20Watts

Gas measurement
Sensor range : 0 to 200ppm CO
Sensor accuracy : 0.5%FS + 1% of reading
Zero drift (7 days) : 40ppb
Span drift (7 days) : 120ppb
Temperature sensitivity : Greatest of; 0.05% of reading / °C or 0.025ppm / °C

Environmental
Operating temperature range : 0°C to 50°C
Relative humidity : 0 to 99% (noncondensing) operating humidity range
Ambient pressure range : 700 to 1300mbar
Max rate of pressure change : 300mBar/min
IP54

Physical
Sensor dimensions (approximately) : 480mm (w) x 400mm (d) x 130mm (h)

Performance is tested at standard atmospheric pressure (1013mB)

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