



- COSAMS - carbon monoxide submarine atmosphere monitoring system
- Real time continuous monitoring of CO providing immediate protection of crew when and where it's needed
- The CO monitor can be maintained either on the boat or in the dockyard, thus limiting downtime

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 on board a submarine include; cooking, fire, incomplete combustion of the diesel engines and chlorate candles.

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.

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.

Analog understands the technology challenges associated with using IR sensing techniques over dynamic pressure ranges and are able to correct for these effects to produce accurate sensors.

Analog is offering the new COSAMS unit based on using an infra red sensor which uses a gas correlation filter to minimise cross sensitivity to interfering gases in the environment.

The COSAMS consists of a single enclosure which contains all sensors, pneumatic fittings and display components. The user interface and display are presented on the front face of the enclosure. The whole enclosure is intended to be wall mounted using suitable shock-proof mounts.

A gas sample is drawn from the submarine atmosphere around the enclosure, using the internal sample pump. The gas sample is analysed inside the enclosure before being exhausted to atmosphere.

The unit offers two adjustable audio and visual alarms, a 4 to 20mA output and up to 90 day's continuous data-logging.

Maintenance and calibration is designed to be carried out on board and in the dockyard.

Figure 1
Analog COSAMS



1 Principle of operation

The CO sensor operates by measuring the infra-red absorption of a gas sample within a sample tube. A small pump continuously pumps a sample from the submarine atmosphere into the sample tube to provide continuous, real-time monitoring.

CO exhibits strong infrared (IR) energy absorption in the $4.66\mu\text{m}$ wavelength region of the electromagnetic spectrum. This property can be exploited to determine the concentration of CO present in a gas sample by shining IR light through the sample and on to a suitable detector - as the concentration of CO in the sample rises, more of the IR light is absorbed and the intensity of the light measured at the detector decreases.

Sensor specificity is typically achieved by introducing a narrow band-pass optical filter between the IR source and the detector to restrict the light arriving at the detector to a narrow frequency range centred on $4.66\mu\text{m}$. This also ensures the sensor suffers no cross sensitivity to other gases present in the environment, such as carbon dioxide and hydrogen.

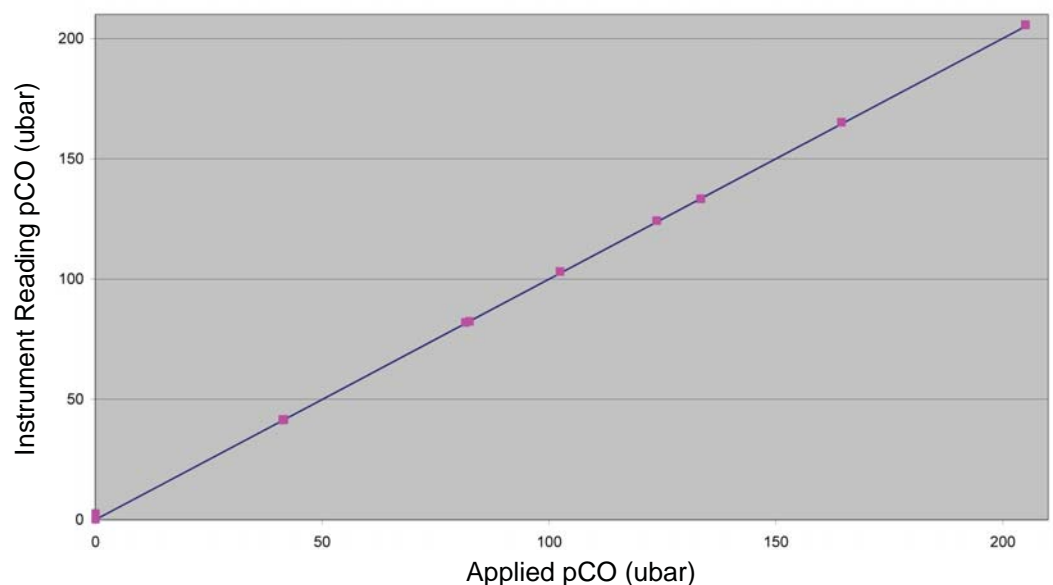
One of the challenges presented by the submarine environment is the high humidity level that may be experienced. Unfortunately, water

vapour also absorbs IR energy in the region of $4.66\mu\text{m}$, albeit to a lesser degree, and therefore its presence will be interpreted as an elevated level of CO.

The IR Gas Filter Correlation (GFC) sensor incorporates a rotating disc containing two transparent, sealed compartments in front of the IR source. One compartment is filled with nitrogen and the other is a high concentration of CO. By looking at the relative IR absorption of the system when the nitrogen compartment is present in the optical path versus when the CO compartment is present, it is possible to reject IR absorption from sources other than CO. This technique allows the sensor to effectively ignore the presence of water and make accurate CO measurements in high humidity environments.

Analox apply their unique temperature correction and pressure correction to each sensor to ensure it is optimised for use on board the submarine. In order to eliminate the impact of zero drift of the sensor, Analox have incorporated an auto zero module into the CO monitor which enables the periodic zero calibration of the sensor to take place automatically.

**Linearity data
COSAMS
CO sensor**



2 System maintenance

The COSAMS has been designed to minimise the level of maintenance overall. Most elements of the system maintenance can be carried out by 'on board' maintenance personnel either prior to deployment, or on an annual basis.

The COSAMS is capable of detecting a number of system faults, giving an alarm and visual warnings when fault conditions are identified. Facility is provided through the built-in user interface to aid diagnostics and trouble shooting. The display module also logs any instances of faults and system events for later download and analysis.

Specification:

Volumetric range:
0 to 200ppm

Accuracy:
 $\pm 5\%$ full scale (equivalent to ± 10 ppm) across normal operating envelope (temp. & pressure)

Repeatability:
 $\pm 0.5\%$ FS + 1 display count at 20°C, 1013 hPa

Span drift:
 $\pm 0.1\%$ FS/week

Zero drift:
 $\pm 0.5\%$ FS/day corrected by auto zero

Operating temperature range:
0 to 45%

Operating humidity:
0 to 80% RH

Operating pressure range:
800 to 1400hPa

Power supply:
115/230VAC or 24VDC

Power consumption:
90W

Size:
479(h) x 280(w) x 175(d) mm

Weight:
<11kg

Shock:
Tested at 22g, 20ms (half sine) without shock isolation

Compliance:
EMC to MIL-STD-461F

Analox Ltd. reserves the right to upgrade, develop or change specifications without prior notice. Full Technical Specifications are available upon request.



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