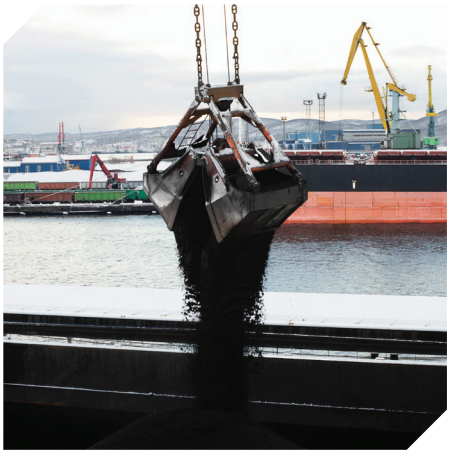
LP Focus

The London P&I Club

November 2018
Issue 8

Carriage of Coal
Gas Monitoring and Ventilation



"Management of coal cargoes and proper use of gas detection equipment are key to preventing coal fire claims"

Gas detection and monitoring equipment

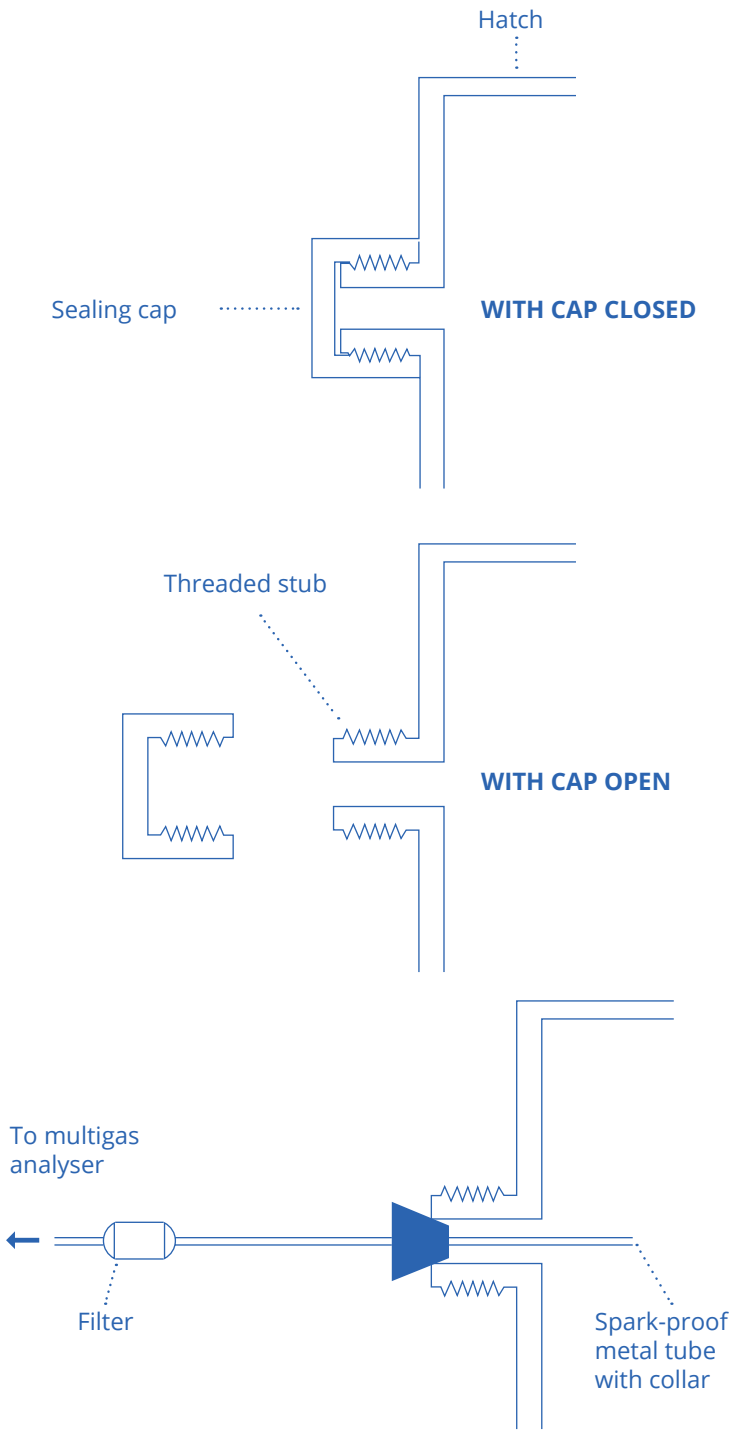
The gas detection and monitoring equipment carried on ships can vary from large units such as the Riken Keiki RX–515 to smaller more portable types such as the BW Gas Alert Max XT II. At Hawkins, we use a range of detection and monitoring equipment, however the most commonly employed electronic device we use is the Drager X-AM 7000.

Ultimately, the key to proper and efficient use of gas detection and monitoring equipment is the crew's full understanding of how the unit works, familiarity with its functions and the proper/prescribed maintenance routines.

Tanker officers, due to the nature of their jobs are more exposed to this type of equipment. In the dry bulk cargo trades we recommend that of the suitable units on the market, consideration is given to selecting the more user-friendly and robust models for service.

The sensors on such gas detectors are fitted into the body of the device and the gases are sampled through a flexible tube and a length of spark-proof metal tubing with a collar. The metal tubing is to make inserting the tube into the gas sample port as easy as possible, the collar is to seal the port opening against the tube.

DIAGRAM OF GAS SAMPLING POINT



Correct insertion of the tube is important to enable a representative sample to be obtained from the cargo hold. Ideally, the gas monitor and/or the tube should incorporate an in-line particle and water contamination filter.

In accordance with The International Maritime Solid Bulk Cargoes (IMSBC) Code, the gas monitor used when transporting coal must be fitted with at least oxygen (O_2), flammable gas (LEL) (with an alarm set to a percentage of the lower explosive limit of methane) and carbon monoxide (CO) sensors. Most of the modern handheld devices will also include a hydrogen sulphide (H_2S) sensor.

The O_2, CO and H_2S sensors are "wet" electrochemical cells, which utilise a chemical reaction inside the cell between the target gas and chemicals (reagents) contained in the cell. Electronics in the cell detect changes in chemistry as the reaction of the wet reagents with the target chemical occur and the generated signal is then translated into a digital display (typically displayed in ppm or percent) on the screen.

Wet chemical sensors which are marketed as being for a particular gas are often not target gas-specific and can exhibit cross sensitivities. These sensors can give a reading, apparently for the target gas, but actually due to detection of another gas (i.e. a 'false reading'). Therefore, it is important to be aware of possible cross sensitivities of your detector sensors to avoid collecting false readings. Such information should be discussed in the instruction manual provided with your gas monitor.

Coal hold

Coal barge

In addition to cross sensitivities, wet chemical sensors are prone to poisoning and saturation. Poisoning occurs when a non-target gas attacks the wet chemicals inside the sensor cell and alters the cell chemistry. Once poisoned, it is often the case that the affected sensors will need to be replaced. Each sensor will have a specified 'range of detection', this range indicates the lower limit of detection of the target gas and also the maximum concentration of the target gas the sensor should be exposed to. Overexposure can cause wet chemical cells to become saturated. A saturated cell may 'clear' in fresh air or after calibration, but that is not always the case as oversaturation may damage a cell to the extent that it would need to be replaced.

LEL sensors can use two different types of sensor technology, the most common and cheapest is the catalytic type, which uses a Pellistor in an electrical measurement circuit known as a Wheatstone Bridge. The working elements of a Pellistor comprise two ceramic beads, both of which encase platinum wire coils. The sensor heats both of the platinum coils to a known temperature and then constantly measures the resistance of the coils. One of the beads (the 'active' bead) is treated with a catalyst which lowers the temperature at which the hydrocarbon gas close to the surface of the bead ignites. The additional heating of the active bead and the wire due to the close proximity combustion of the hydrocarbon gases is detected by the electronic measuring circuit as a change in the resistance of that platinum wire coil relative to that of the wire coil encased in a bead of plain ceramic. The change in resistance is translated to a read-out on the display, normally in % LEL. Pellistor sensors have been used widely and safely for many years, but there are several limitations to the use of them, which are outlined opposite:

- *A pellistor LEL sensor will only operate correctly and produce reliable results if there is sufficient oxygen present (>10%). In an elevated or depleted oxygen environment, LEL readings will become inaccurate.*
- *Pellistor LEL sensors are not able to discriminate between combustible gases and will only provide an indication of a flammable gas (or vapours), be it hydrogen, carbon monoxide, methane, ethane, gasoline or diesel fumes etc. There are different sensitivities for each flammable gas and as such, even if the detector indicates a flammable atmosphere is present, it might not always necessarily be the case. Conversely and more importantly, it is not possible to rely on the detector to confirm whether the atmosphere is safe. It is for this reason that it is important to know what gases are being evolved by a cargo.*
- *LEL sensors are usually based on methane and if another flammable gas is present then the reading given by the instrument will often be incorrect (i.e. either erroneously high or low).*
- *Pellistors are very prone to damage from poisoning from compounds containing silicon, lead, sulphur and phosphates. Therefore, users should exercise caution when dealing with the above compounds and perform regular checks to see whether the sensor has become unreliable.*
- *A pellistor can also be damaged by saturation, i.e. exposure to high concentrations of hydrocarbons.*

Coal loading

So when using a Pellistor LEL sensor, the gas detector will need to be calibrated regularly so that any damaged sensors can be replaced.

An alternative LEL detector technology utilises the infra-red (IR) absorption properties of hydrocarbons. These sensors are typically significantly more expensive than Pellistor detector sensors, but they are not prone to poisoning or saturation. The IR LEL sensors will operate reliably in a depleted oxygen environment as they are not reliant on heat from a combustion reaction as the detection method, but they will not detect hydrogen or acetylene as it does not absorb IR at the frequency used by the sensors.

Good gas monitoring technique

1. *Ensure that the sampling tube is clean and free from condensation, that the metal portion of the tube is spark proof, and that it is completely detached from the gas monitor. Check the inline filter (if fitted) is clean and dry.*
2. *Switch on the gas monitor in clean air (i.e. in the ship's office) and let the unit run for about five minutes before going outside to take measurements.*
3. *Ensure that your gas monitor has been calibrated recently, i.e. it is "in date" and that all of the sensors pass the unit's self-test function, which runs when the unit is switched on.*
4. *Open the cargo hold sampling port. Insert the spark-proof metal tube so that the tube is inside the cargo hold and seal the collar.*
5. *Re-attach the sampling tube to the gas monitor and draw a sample of the atmosphere through the tube, using the aspirator, until steady readings are obtained.*
6. *Log the results on a suitable form which records cargo space, date and time for each measurement.*
7. *Put the sealing cap back on the sampling port.*
8. *Detach the sampling tube and let any condensation drain out by holding the tube vertically (i.e. not coiled).*
9. *Repeat steps 4-8 for each hold to be monitored.*

Caring for your gas monitor

A gas monitor is a sensitive scientific instrument. Read the manufacturer's instructions regarding its use and care.

In general, the gas detector should be kept clean and treated with care. Clean the outer casing with a damp cloth. Never use any chemicals or detergents to clean it. Detach the sampling tube when not in use and hang vertically to let any condensation drain out. Keep the gas monitor charged. Store it in a secure location where it will not be tampered with or exposed to chemicals or fumes. If your gas monitor allows, and you have the equipment, carry out a "bump test" calibration in accordance with the manufacturer's instructions at regular intervals.

The London P&I Club

Ventilation of a coal cargo

Common problems associated with the transportation of coal in bulk include self-heating and generation of flammable gas (i.e. methane).

Self-heating

Self-heating normally occurs in localised hot spots within a bulk cargo, and as such temperature measurements of the atmosphere above the cargo (i.e. taken through the gas sampling ports) are unlikely to identify problems. However, when coal self-heats it produces CO, so measuring the concentration of CO is the most effective method to identify a self-heating cargo. The atmosphere in each cargo hold should be monitored, at least daily, for carbon monoxide (CO), hydrogen sulphide (H_2S), oxygen (O_2) and flammable gas (LEL – methane). If the holds are being ventilated, then ventilation should be stopped at least four hours prior to gas measurements being taken.

When to ventilate

The IMSBC Code requires that the holds are ventilated for 24 hours after loading. However, unless expressly instructed to the contrary, coal cargoes should not be ventilated following this 24-hour period as unnecessary ventilation can cause the coal to begin to self-heat. Once a self-heating reaction has started, further ventilation will provide oxygen, which will worsen the self-heating and could lead to ignition of the cargo.

Only if the LEL levels begin to rise, should ventilation be considered, and **only** for the minimum period necessary to remove any accumulated methane. As detailed in the IMSBC Code, if LEL levels reach 20% or more, then the ventilation should be maintained continuously (except for the purpose of gas monitoring). If the LEL level continues to rise after ventilation has been carried out continuously for a period of 24 hours, or if CO levels begin to rise, then the advice of an expert should be sought as a matter of urgency.

If there is a fire or high levels of CO, the ship should:

- *Close hatches and cease all ventilation to the holds. Seal the holds by closing the ventilation covers and using RAM-NEK tape (or similar) around the hatch openings and ventilation covers.*
- *Ensure all spaces adjacent to the holds are gas-checked prior to entry and that no-one enters confined spaces without confirming that it is safe to do so by testing the atmosphere inside.*
- *Consider boundary cooling of the affected holds and locate the nearest ports of refuge.*
- *Notify Owners and the P&I Club without delay.*
- *Provide Owners and the P&I Club with all temperature and gas monitoring records for the voyage.*

The IMSBC Code provides mandatory requirements for the loading and carriage of coal. Of particular note are:

1. *The cargo declaration should state whether the cargo has a history of self-heating and whether it has a tendency to emit methane (self-heating is almost always encountered when Indonesian coals are carried).*

2. *Coal should not be loaded if its temperature exceeds 55˚C; this is especially important for self-heating coal as a temperature above 55˚C is indicative that the coal is already at an advanced stage of self-heating. Although not required by the IMSBC Code, an infrared thermometer can greatly assist the crew in checking the surface temperature of the cargo prior to and during loading.*

Despite the risks associated with the transportation of coal cargoes, the majority of ships carry coal without incident. Adhering to the requirements and recommendations in the IMSBC Code greatly reduces the risk of fire. Hawkins has many years of experience in assisting Owners and P&I Clubs to prevent an incident from becoming a major casualty. If the Master only allows cargo below 55˚C to be loaded, and regularly checks it during passage, then problems can be identified at an early stage and prevented from escalating to the point where the ship and her crew are potentially in danger.

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Leaders in forensic investigation