SAFE TRANSPORTATION OF SOLID FUELS FOR POWER GENERATION
GAS DETECTION FOR SHIPPING WOODCHIPS AND COAL

The modern maritime industry relies on gas and flame detection for safe operations. LNG, LPG, and refined products tankers carry thousands of tonnes or flammable, volatile hydrocarbons. Bulkers transport grains, cement, coal, and wood chips.

Whilst some of these commodities may at first sight appear less harmful than a cargo of gasoline, coal and wood chips can spontaneously combust as they heat up in the presence of air. Some types of coal release methane during shipping. Wood chips can release carbon monoxide, a poisonous gas.

The hazards of bulk cargoes are not always obvious. It pays to review the best practices, codes and regulations for gas and flame detection.

Cargo hold monitoring system

Poisonous gases from wood chips

In 2002, during the discharge of pellets from MV WEAVER ARROW in the Port of Rotterdam, one dock worker died, and several others were injured after entering a hold where wood pellets had generated CO.

A similar case occurred in 2006 onboard the MS SAGA SPRAY in the Port of Helsingborg, Sweden while the vessel was discharging wood pellets from cargo hold number 9. One seaman was killed, a bulldozer driver was seriously injured, and eleven rescue workers were examined in hospital after entering an unventilated stairway next to a cargo hold. Carbon monoxide (CO) poisoning due to improper ventilation was found to be the cause of the incident. The CO had built up in the hold since the vessel had left port in Canada, less than three weeks before the incident.

Measurements that were taken by the Helsingborg Port Authorities on cargo holds 5 and 6 of MS SAGA SPRAY confirmed that CO had built up to approximately 1,000ppm and the oxygen level had fallen to 15%.

The emission rate of carbon monoxide from wood pellets can be more than 500 mg CO per tonne of woodchips per day. Methanol, formic acid, and formaldehyde can also be released from wood chips.

Coal –the main solid bulk fuel for power generation

Coal is the second most heavily shipped bulk cargo, after iron ore. It is differentiated as steam coal or coking coal according to its quality. It can be shipped either as lumps or powder. The different types and sizes of coal present different hazards. For example, coal powder can liquefy and slosh around in the hold. Additionally, powdered coal may also spontaneously heat up and ignite. Some grades of coal release methane gas during shipping.

Safety at sea

Gas detection can ensure that the risks associated with these hazards can be minimised.

Gas analysis in the cargo hold headspace can be achieved via gas sampling ports. This enables monitoring of the gas composition in the headspace without opening the hatch covers. Oxygen (O2), methane (CH4), carbon monoxide (CO), carbon

Cargo of wood chips

dioxide (CO2) and hydrogen (H2) are gases that may need to be monitored when transporting various bulk cargoes. Below are some examples of why certain gases are monitored and what their composition can indicate.

Oxygen is consumed by self-heating of coal or wood chips. If self-heating is occurring, the gas detection unit should show decreasing O2 levels. To mitigate the risk, an inert gas such as CO2 or nitrogen can be used in the hold. Without oxygen being present, self-heating cannot occur in coal or wood chips.

Carbon monoxide is produced when self-heating or combustion occurs at low oxygen levels. CO binds to haemoglobin in the blood more strongly than oxygen thereby shutting down blood oxygen transport leading to CO poisoning.

Methane is released by some coals, so an increasing level indicates the coal is emitting CH4. If the methane concentration increases to 1% by volume, or 20% of the lower explosive limit (LEL), ventilation is required to reduce the risk of an explosion.

It should be noted that gas detectors that use the catalytic oxidation sensors cannot accurately measure methane or other flammable gases when the background oxygen level is less than around 12%. This is because the sensor relies on the reaction of the flammable gas with oxygen. To ensure an accurate reading, the measurement device may need to be aspirated with fresh air.

International codes and regulations

Gas detection is mandated in maritime applications. Guidelines, Codes, Regulations and Standards must be understood and implemented by ship designers, crews, and dock side teams.

Of general relevance is the SOLAS regulation XI-1/7 on Atmosphere Testing Instruments for Enclosed Space MSC.1/Circ.1485 from January 2015. It states that 'Every ship to which chapter I applies shall carry an appropriate portable atmosphere testing instrument or instruments' and confirms several additional details.

i. The instrument should be capable of remote sampling and detection for all gases that it is designed for, without interference from the atmosphere or other characteristics of the intervening space.

ii. Upon activation, the instrument should perform a 'self-test' which indicates that the instrument is functioning correctly.

iii. The instrument should be capable of measuring and displaying concentrations of the following gases prior to entry into enclosed spaces:

a. oxygen;

b. flammable gases or vapours (% LFL);

c. carbon monoxide;

d. hydrogen sulphide.

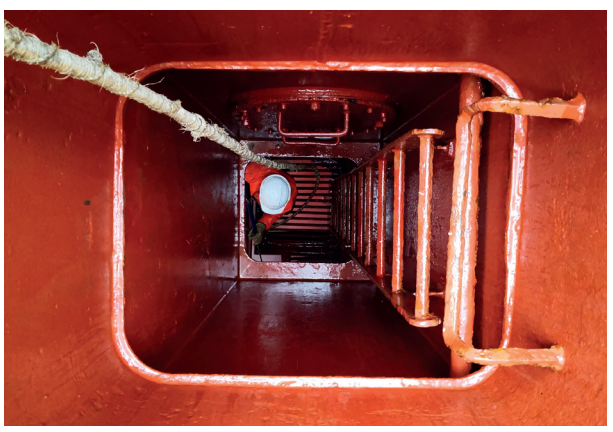
iv. The instrument should clearly and unambiguously show which gas or vapour it is measuring.

v. If the instrument is fitted with an alarm function, it should activate at the appropriate level.

vi. The instrument should be suitably protected, having due regard for the environment & temperatures in which it is expected to operate.

Potential hazards

Enclosed space entry with breathing aparatus



Entering a confined space on board ship

Unloading coal from a bulk carrier

vii. The instrument should be capable of being easily carried.

viii. The instrument should be suitably protected from the ingress of dust and water.

ix. The minimum battery life of the instrument (with fresh batteries of recommended type) should be 10 hours.

x. The instrument should be intrinsically safe.

xi. The instrument display should be readable in all lighting conditions.

xii. Suitable means shall be provided for the calibration of all such instruments.

xiii. Any atmosphere testing should be performed by trained personnel.

IMSBC (International Maritime Solid Bulk Cargoes Code)

The IMSBC lists 450 solid bulk cargoes and describes their characteristics, hazards, required precautions, ventilation, loading and discharging operations. The properties of cargoes are categorised in three main groups.

i. Group A – cargoes which may liquefy if shipped at a moisture content exceeding their Transportable Moisture Limit (TML).

ii. Group B – cargoes which possess a chemical hazard which could give rise to a dangerous situation on a ship.

iii. Group C – cargoes which are neither liable to liquefy (Group A) nor possess chemical hazards (Group B). Cargoes in this group can still be hazardous.

Group B cargoes are those that are most likely to require gas and flame detection equipment. Amongst others, they include the following bulk cargoes.

i. Coal may create flammable atmospheres, heat spontaneously and deplete oxygen. Some types of coal can produce carbon monoxide or methane.

ii. Wood products transported in bulk are listed in a dedicated schedule, 'Wood Products – General'. They include logs, pulpwood, roundwood, saw logs and timber. These cargoes may cause oxygen depletion and increase carbon dioxide gas concentrations.

Regulation 3 confirms the requirement to measure oxygen deficiency.

i. When transporting a solid bulk cargo which is liable to emit a toxic or flammable gas, or cause oxygen depletion in the cargo space, an appropriate instrument for measuring the concentration of gas or oxygen in the air shall be provided together with detailed instructions for its use.

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