

Biomass to power, and biomass gasification to biofuels are driving the demand for white wood pellets. Whilst this cargo may seem benign, there are safety risks inherent in storing and moving bulk shipments of pellets, according to Stephen B. Harrison, managing director of sbh4 consulting

Safe storage and transportation of wood pellets in bulk

Knowing the hazards and how to mitigate them is essential to managing a safe and sustainable supply chain without incurring massive asset losses

The hazards of bulk cargoes are not always obvious. Woodchips may appear to be less hazardous than fuels such as LNG, heavy fuel oil or coal. However, wood pellets can spontaneously combust as they heat up in the presence of air.

Homing in on the hazard

Wood pellets contain unsaturated fatty acids and other volatile organic compounds. These react with atmospheric oxygen to release heat and carbon monoxide (CO). If the heat cannot dissipate, the temperature rises. In turn, this accelerates the oxidation reaction generating more heat.

As the pellets reach around



80°C, the reaction rate increases sharply. As the temperature of the wood pellets approaches 200°C, their auto-ignition point is reached which leads to spontaneous combustion.

Additionally, CO is a poisonous and flammable gas which can accumulate in the cargo hold or storage silo.

The risks are most acute with freshly produced pellets, or pellets that have not properly been dried. In addition to the spontaneous combustion hazard, high humidity can lead to microbial decomposition which also leads to heat.

Wood chips are less

hazardous than pellets because they are of a larger size and air can move more freely between them to cool the stack and dissipate CO build up. However, large stacks of moist woodchips can be equally as hazardous as white wood pellets.

Poisonous gas – the silent killer

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 nine. One seaman was killed, a bulldozer driver was seriously injured and 11 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 five and six 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 CO from wood pellets can be more than 500 mg of CO per

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Pellets loading onto a bulk carrier

tonne of pellets per day. In addition to CO, methanol, formic acid and formaldehyde can also be released.

Detection leads to prevention

Gas analysis in the cargo hold or storage silo headspace can be achieved via gas sampling ports. This enables monitoring of the gas composition in the headspace without opening the hatch covers. For wood pellets, measuring oxygen and carbon monoxide are the key gases to monitor in the hold.

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

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.

It should be noted that gas detectors which use catalytic oxidation type sensors cannot accurately measure a flammable gas such as CO 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.

Regulations at sea

The International Maritime Solid Bulk Cargoes Code (IMSBC) lists 450 solid bulk cargoes and describes their characteristics, hazards, required precautions, ventilation, loading and discharging operations.

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 of the IMSBC confirms the requirement to measure oxygen deficiency with such cargoes.

Of additional relevance is the SOLAS regulation XI-1/7 on Atmosphere Testing Instrument for Enclosed Spaces. It explains the situations under which a ship must carry a portable atmosphere testing instrument and confirms additional details, such as:

- 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. Any atmosphere testing should be performed by trained personnel. ●

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