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CARGO VENTILATION[1]

1. INTRODUCTION

Ventilation, in its most basic form, is the supply of fresh air into a space. On bulk carriers, this generally means the provision of fresh air into the cargo holds, which is achieved through either natural or mechanical means. In broader terms, ventilation is understood to be all the steps taken to prevent damage to cargoes from condensed moisture within the cargo holds.

1.1. Reasons for Ventilation

The primary purposes of ventilation are to minimize damage to the cargo and to ensure the safety of the crew and vessel. This is achieved by:

- minimizing the formation of sweat or condensation, prevention of sweat is the most common reason for ventilating.
- removing hazardous or fumigant gases,
- preventing excessive heating of the cargo

The requirements on ventilation for dry bulk cargoes are governed by SOLAS II-2 / Regulation 19/3.4.3 and as well as the relevant IMO circulars IMSBC Code. SOLAS Regulation II-2/19.3.4.3, natural ventilation shall also be provided if there is no provision for mechanical ventilation.

From a regulatory perspective, the reasons for ventilating are purely safety based, with the following objectives:

- The occurrence of an explosive atmosphere in cargo holds shall be avoided.
- Toxic gases and vapours shall be removed from the cargo holds as far as possible.
- Toxic gases, vapour and dust shall be kept away from accommodation spaces.
- Special attention shall be paid to oxygen-depleting cargoes.
- Self-heating properties of cargoes shall be considered when applying ventilation.

2. TYPES OF VENTILATION

The cargo holds of most dry cargo ships have either natural or mechanical ventilation systems.

2.1. Natural Ventilation System

A natural ventilation system, as the name suggests, is based on nature's law of air circulation. The ventilation is usually surface ventilation, with air flowing over the surface of the cargo from ventilators.

[1] W 25 / 2021 (Entire Chapter)

The hinged-door type ventilators are often fitted on the sides of the hatch cover. These can then be opened depending on the relative wind direction to provide adequate surface ventilation within the cargo hold.

2.2. Mechanical Ventilation System

Mechanical ventilation means ventilation systems which incorporate mechanical fans. All type of fans can be present in cargo holds (exhaust, supply or reversible). With some systems, it is possible to vary the speed of the fans to further control the ventilation.

The capacity of a ship's hold ventilation fans is normally expressed in the number of air changes that can be achieved in an empty hold per hour. When cargo is carried, the number of air changes per hour increases, as there is less air in the hold.

Mechanical ventilation is to be provided for cargoes liable to emit flammable gases or vapours in an amount which can form an explosive atmosphere with air (IMSBC Code subsections 3.5.1 and 9.3.2.1.3, same reproduced here).

3.5.1 Unless expressly provided otherwise, when cargoes which may emit toxic gases are carried, the cargo spaces shall be provided with mechanical or natural ventilation; and, when cargoes which may emit flammable gases are carried, the cargo spaces shall be provided with mechanical ventilation.

9.3.2.1.3 Cargoes liable to give off vapours or gases which can form an explosive mixture with air shall be stowed in a mechanically ventilated space.

For cargoes with self-heating properties, mechanical ventilation should only be applied in special circumstances. In no case shall the ventilation be directed into the body of the cargo (IMSBC Code subsection 3.5.6 and Appendix 1).

2.3. Ventilator Maintenance

Every ventilator should have a positive means of closing. The closing mechanism could be in the form of a weathertight door or a ventilator flap.

It is essential that the closing devices are maintained and in a good condition, which includes being greased as needed and inspecting the gaskets to ensure an effective seal, especially in the case of a fire or shipping spray in the vicinity of ventilator intakes.

Ventilation ports and fan spaces must be checked for possible loose rust or paint chips that might fall onto the cargo, causing contamination. Prior to any loading operation, the fans for mechanical ventilation should be checked to ensure they are in operation.

It is recommended that the ventilators are prominently and permanently marked with the space (that is being serviced by the vent) and that it is indicated whether the shut-off is open or closed with the direction of the damper mechanism.

3. CARGO SWEAT AND SHIP SWEAT

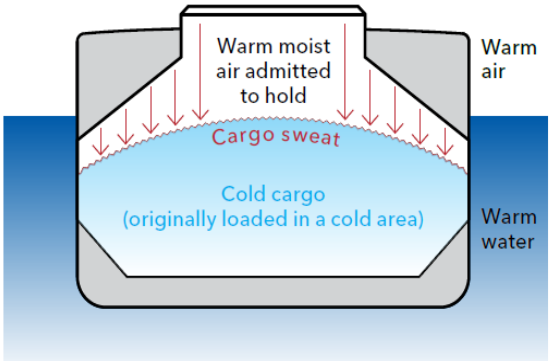
Sweat is condensation that occurs when the dew point has been reached. When this condensation materializes on the cargo, this is known as cargo sweat, and when on the ship's structure, it is called ship sweat. Cargo or ship sweat is the most significant cause of cargo damage resulting in cargo claims.

If sweat is allowed to form without any effective attempt to check it, cargo wetting, and expensive claims, can result. It may not always be possible to prevent the damage by correct ventilation; however, if correct ventilation has been carried out, and recorded, it should be easier to defend the resulting claim.

The risk of sweat on a voyage from a cold to warm climate is low, but on a voyage from a warm to cold climate, there is a high danger of ship sweat occurring during carriage. Ventilation may be necessary to replace the moist air inside the cargo hold with drier outside atmospheric air.

3.1. Cargo Sweat

Condensation forming directly on the cargo. Cargo sweat occurs when warm moist air is introduced into cargo holds and comes into contact with cold cargo. This usually happens when cargo is loaded in a cold climate, and the vessel then sails to a warmer climate. The cargo holds are ventilated, and warm air is introduced into the holds. Example would be steel products loaded in northern Europe in a vessel bound down south for West African ports.



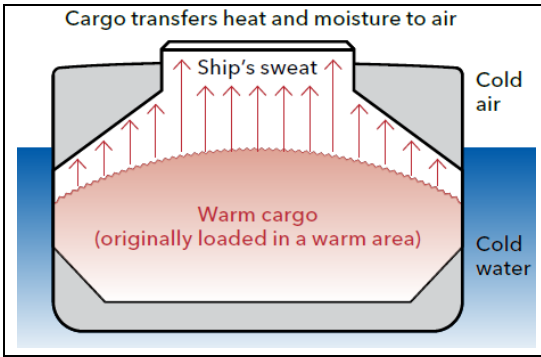
Cargo Sweat

Surface rust due to cargo sweat

3.2. Ship Sweat

Ship sweat is the condensation on the ship's structure that occurs when warm air in the cargo hold comes into contact with the cold steel structure in the hold. This typically occurs when cargo is loaded in a warm climate and the vessel then sails on a voyage to a colder climate.

In such cases, cargo may get damaged by overhead drips or by contact with sweat which has formed on the ship's sides or by condensed water which may accumulate at the bottom of the hold.



Ship sweat

Sweat on ship structure

3.3. Relative Humidity, Dew Point and its Measurement

Relative humidity tells us how much water vapor is in the air, compared to how much it could hold at that temperature. It is shown as a percent. For example, a relative humidity of 50 percent means the air is holding one half of the water vapor it can hold. A reading of 100%, it means that the air is 100% saturated with water vapor. It is incapable of holding any more water vapor.

The amount of vapour that can be held in air varies with the temperature of that air. The higher the temperature, the higher the amount of vapour that can be held. Equally, the lower the temperature of that air, the lower the amount of vapour that can be held in the air. Thus, relative humidity is the ratio of water vapour in the air to the maximum amount of water vapour that can be held in the air at a given temperature.

As warm air can hold more water vapour, the relative humidity as a percentage will decrease as the temperature increases, and vice versa, even though the actual or absolute amount of moisture remains the same.

Dew point is the temperature at which the air becomes saturated and condenses (100 percent relative humidity). It is dependent on only the amount of moisture in the air. Relative humidity is the percent of saturation at a given temperature; it depends on both moisture content and temperature.

Dew point can be measured by a number of methods and instruments. The traditional method is to use a wet-bulb/dry-bulb thermometer combined with a dew point table.

The wet-bulb/dry-bulb thermometer on the bridge wing would not provide the temperature and dew point in the cargo holds or on the deck and thus a whirling psychrometer (a hand-held device containing a wet-bulb/dry-bulb thermometer) was traditionally used but it is not safe to get the reading inside the cargo space.

Now a days **electronic psychrometers and hygrometers** are used. For steel cargoes only, some operators, for reasons of efficiency and general convenience, use "multi-channel wireless hygro-thermometers". The transmitters are fixed to magnets and then placed on the bulkhead low in the cargo hold. Using these thermometers is simple: crew members simply walk up the deck with a remote sensor, wait for the right channel to be received (remote sensors send a signal every one to two minutes) and take a reading. The dew point can then be calculated using dew point tables.

4. WHEN TO VENTILATE

Prior to ventilating the cargo a number of factors need to be considered. Failing to adhere to correct requirements may cause cargo damage and result in substantial claims. The decision to ventilate should be taken after consultation between the Master and CNO and reviewed as the weather changes, or sea state changes and after considering the following factors:

- Instructions contained in the charter party or voyage order
- Temperature, nature and requirements of the cargo
- Temperature, relative humidity and dew point of air inside and outside the hold
- Sea temperature, as it may lower the temperature of the hold steel adjacent to or in contact with the sea, resulting in condensation forming on the shell plating (ship sweat)
- Vent opening should not be exposed to sea spray

A review of all of these factors can predict the risk of sweat, and therefore, broadly speaking, it can be decided whether ventilation is necessary or to be prevented.

Some hygroscopic cargoes, particularly FERTILIZER and SALT, when carried in bulk, should not be ventilated during the voyage if they are in a sound state at the time of shipment, as ventilation could increase the risk of moist sea air entering the cargo hold, increasing the moisture content of the cargo.

In general, there are two ventilation rules which the Master should check and confirm when voyage orders are received. If these instructions are at odds with what he would expect for his vessel, he is advised to be prudent and clarify instructions before execution.

- No ventilation is to be carried out without informing office (Ship Management and Operations departments) and charterer.
- Any ventilation after fumigation will be carried out strictly as per the written instructions provided by the fumigator.
- Ventilation required to remove the vapours from the surface of the cargo, the instructions as provided in the IMSBC Code for the cargo are to be complied.

4.1. Dew Point Rule

- **Ventilate** if the dew point of the air inside the hold is higher than the dew point of the air outside the hold.
- **Do not ventilate** if the dew point of the air inside the hold is lower than the dew point of the air outside the hold.

The practical problem associated with this rule is that entry in the hold is required to find out the dew point of the air in cargo hold. This may be impossible, particularly if the hold is completely full. Even when it is physically possible, it may **very well be unsafe** due to cargoes that are liable to oxidize (causing oxygen depletion inside the hold) or to emit toxic/hazardous/flammable gases.

A closed cargo hold should never be entered until proper entry into enclosed space procedures have been carried out and office approval has been obtained. If there is even the slightest doubt, do not attempt to enter in cargo holds.

4.2. Three Degree Rule

Ventilate if the temperature of the outside air is at least 3 °C below that of the cargo temperature (taken at loading), so long as factors such as heavy spray do not prevent ventilation, but do not ventilate when outside air is at a similar temperature or warmer.

This rule does not require anyone to go into the holds during the voyage. and relies on the fact that the temperature of the cargo mass, except at the boundaries, only slowly changes during a voyage.

In order to apply the rule, it is necessary for the ship's crew to take a number of cargo temperature readings during loading. Hand-held infrared thermometers are ideal for this task.

Generally, on a voyage from cold to warm regions, no ventilation is required; but from warm to cold regions, surface ventilation is required.

4.3. Recordkeeping

It is Master's responsibility to ensure that ventilation is conducted in accordance with voyage instructions and that entries are made accurately in the logbook concerning items which could affect the condition of cargo, as this will later assist in documenting the case in the event of a cargo claim. Ventilation should be recorded by the CNO in the Deck Log book.

The following should be recorded from the time of arrival at the port of loading, throughout the voyage, and up to completion of discharge:

- Outside air temperature and dew point
- Hold air temperature and dew point (where electronic psychrometers and hygrometers provided)
- Sea temperature

- Hold bilge soundings
- Weather conditions (wind speed and direction, sea conditions, precipitation)
- Times when hold ventilation started and stopped
- Times when hatches are opened and closed
- Any incidence of rain during cargo operations
- Moisture levels of cargo during loading
- Photographs taken during loading
- Times when hold bilges are pumped out
- Results of hatch cover weathertightness tests before loading
- The event of cargo being exposed to rain ashore stockpile or in barges during loading

If ventilation is impossible due to inclement weather or adverse sea conditions, it is of utmost importance that the times of interruption of ventilation, together with all relevant aspects of weather and sea conditions, are logged. Always file Form 2.3.13, when ventilating cargo[2].

[2] W 07 / 2024