

Carefully to Carry

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Fishmeal cargoes – self heating and fires

If an insufficient quantity of antioxidant is added at the time of production, oxidation will start at some stage... this can result in carbonisation and/or fire

Fishmeal products manufactured from oily fish, principally anchovies and sardines, normally contain about 8-10% fish oil unless specially defatted. The standard products are classified as hazardous cargoes and are covered by entries in the IMDG Code, 2000 edition. The relevant entries are in Class 4.2 (Spontaneously Combustible) or Class 9 (Miscellaneous) UN Nos. 1374 and 2216.

The original fishmeal trade involved products now falling into the Class 4.2 category. The basic requirements for the carriage of cargo of this type were that it was bagged and aged for a period of not less than 28 days between production and loading on the carrying ship. Stowage was by the double strip stow method, that is, the bags were stowed longitudinally in the cargo spaces with transverse channels every two bags. Cargo stowed in this way was to be ventilated throughout a voyage, weather permitting. There were also requirements in terms of maximum oil content, maximum and minimum moisture contents and temperature at the time of loading. Strict adherence to these conditions permitted generally uneventful carriage of fishmeal over protracted voyages. It will be appreciated, however, that the stowage requirements resulted in a high stowage factor and were expensive in both labour and materials (dunnage).

It has been known for many years that heating of fishmeal to the point of fire is due to aerial oxidation of reactive chemical sites on fish oil molecules. All oxidation reactions are associated with the product of heat. Thus, the rationale behind the practice discussed briefly above was that the most reactive material was oxidised during the aging process and the residual oxidisable material reacted with atmospheric oxygen at a rate at which the heat produced could be removed by ventilating air under the conditions of stowage stipulated. It followed that if some procedure could be found which would either eliminate or drastically reduce the rate of oxidation it would be possible to carry oily fishmeal products as bulk cargo, or as bagged cargo in block stow.



“The carrier shall properly and carefully load, handle, stow, carry, keep, care for and discharge the goods carried.”

Hague Rules,
Articles iii, Rule 2

Carefully to Carry Advisory Committee

This report was produced by the Carefully to Carry Committee – the UK P&I Club's advisory committee on cargo matters. The aim of the Carefully to Carry Committee is to reduce claims through contemporaneous advice to the Club's Members through the most efficient means available.

The committee was established in 1961 and has produced many articles on cargoes that cause claims and other cargo related issues such as hold washing, cargo securing, and ventilation.

The quality of advice given has established Carefully to Carry as a key source of guidance for shipowners and ships' officers. In addition, the articles have frequently been the source of expertise in negotiations over the settlement of claims and have also been relied on in court hearings.

In 2002 all articles were revised and published in book form as well as on disk. All articles are also available to Members on the Club website. Visit the Carefully to Carry section in the Loss Prevention area of the Club website www.ukpandi.com for more information, or contact the Loss Prevention Department.

Certain shipowners approached the problem by the use of inert gas. Special ships were built which were equipped with onboard inert gas producing equipment, similar to that used on tankers, and had hatchcover systems which were substantially airtight. This system works satisfactorily provided the number of loading and discharging ports served on a single voyage is limited. It will be appreciated that each time a hatchcover is opened the inert atmosphere is replaced by air and the inerting operation must be repeated again when the hatches are closed.

The fishmeal industry sought to resolve the problem by modifying the product to render it inert or less susceptible to oxidation. This was achieved by the addition of antioxidant during the production of the meal. Fishmeal suitably treated with antioxidant was included under Class 9 (Miscellaneous Dangerous Substances) in the IMDG Code. Antioxidant-treated oily fishmeal, conforming to the requirements of the Code, can be carried either as a bulk cargo or in bags in block stow. This permitted relaxation of both stowage and ventilation requirements during ocean carriage. Introduction of antioxidant-treated fishmeal on a large scale roughly coincided with drastic fall in the annual production of fishmeal on the west coast of South America. However, sufficient cargo was shipped for it to be apparent that the process could give a stable product for carriage in bulk or block stow.

In 1982 there was a series of incidents involving serious heating, sometimes to the point of fire, in fishmeal cargoes shipped from Chile on various long ocean voyages. In 1987 similar problems were encountered with fishmeal loaded at Peruvian ports. A number of cases involving Peruvian cargoes are currently the subject of litigation and cannot be discussed in this article. However, some facts of general interest have emerged during investigations.

Fishmeal is produced by cooking the fish and extracting oil and aqueous fluids mechanically. The cake which is produced is then dried and milled. The milled meal is cooled and treated with antioxidant (ethoxyquin), usually by spraying the meal as it passes through a trough.

As indicated earlier, heating of fishmeal is due to atmospheric oxidation. The chemical process is complex and involves a series of reactions. The amount of heat produced by these reactions varies. The reactions producing most energy are those towards the end of the series. Antioxidant stops the reaction chain before these later reactions can occur.

Antioxidant is used up as treated fishmeal ages. If an insufficient quantity is added at the time of production, it will be used up before the condition of the fishmeal

has been stabilised. As a result, at some stage after production, oxidation will start, producing substantial quantities of heat and the risk of a serious rise in temperature in the affected meal. However, this will not be evident for some time after loading. This was the case in shipments from both Chile and Peru mentioned earlier in this article.

When serious heating occurs, this can result in carbonisation and/or fire. Many small isolated pockets of bags may be involved. During investigations, these pockets were found in regions of maximum ventilation and also in the interiors of large block stows. It follows that the primary cause was the intrinsic reactivity of the contents of a few bags rather than unsuitable stowage or ventilation.

Bagged fishmeal

Bagged fishmeal presents the majority of problems.

Documentation

The master should have onboard a copy of the latest IMDG Code, 2000 edition. Entries for fishmeal are on pages 58, UN No. 1374 for unstabilised fishmeal and pages 103, UN No. 2216 for stabilised (i.e. anti-oxidant treated) fishmeal. He should also have a copy of the *IMO Code of Safe Practice for Solid Bulk Cargoes* (IMO BC Code) 1998 edition, where the entry for stabilised fishmeal can be found at pages 80 and 81.

The master must ensure that he obtains and retains certificates for antioxidant treated fishmeal as required by the Code, covering all the cargo loaded; that these certificates give all the information required; and figures given conform with the requirements set out in the special provisions at page 189, Section No 907, Volume 2 of the Code.

Since de-regulation of the fishmeal trade in Peru, certificates may be issued by a person or company recognized by the Government of Peru, the competent authority. Certificates for Chilean fishmeal, which very rarely gives problems, are issued by IFOP.

Action to be taken by the ship or surveyors acting for the ship during loading

The temperature of the contents of as many bags as possible should be measured. Where these do not comply with the requirements under special provision 300, page 188 of the Code, the relevant bags must be rejected. If high temperatures are being observed it may be necessary to stop the loading of the relevant parcel to allow more extensive temperature checking. Any wet or water-stained or caked bags should be rejected. It must be appreciated that fishmeal cargoes packed in black woven polypropylene bags with

staining are not readily detectable. Thus again it may be necessary when such staining is observed that loading of the relevant parcel is suspended or slowed to allow a proper examination. Torn bags should also be rejected.

Stowage

Standard stowage practice for bagged cargoes should be adopted, i.e. use of double dunnage on decks and tank tops and provision of a spar ceiling or adequate dunnage to prevent the cargo coming into contact with the ship's sides, pipes and bulkheads especially those which are liable to become heated.

Details of stowage precautions for fishmeal can be found at pages 321 and 322, Section 7.1.10.3, of Volume 1 of the 2000 edition of the IMDG Code. For UN 1374 fishmeal, where loose bags are carried, double strip stowage is recommended, provided there is good surface and through ventilation. For UN 2216 fishmeal, where loose bags are carried, no special ventilation is required for block stowages – IMDG Code, Volume 2, page 103. Flammable materials such as paint should be removed from storerooms immediately above or adjacent to cargo spaces loaded with bagged fishmeal.

Installation and operation of temperature sensors

The IMO requires that the temperature of cargo in each hold is monitored. This can only be satisfactorily performed by installation of remote reading sensors. The Committee specially recommends that installation is not performed by the ship's crew as they should be solely engaged observing loading operations.

The BC Code requires that the temperature of cargo in each hold is monitored throughout the voyage. This can only be satisfactorily performed by the installation of remote reading sensors which are normally connected to a switch box which also has a connection for a read-out meter. The installation is normally carried out by a specialist survey organisation who are employed by the shippers or charterers. The Committee specifically recommends that installation is not performed by the ship's crew as they should be solely engaged observing loading operations. It is common to install sensors at two or three levels in a lower hold and one or two levels in a tween deck depending on the depths of the relevant spaces. Between four and eight sensors are distributed at each level depending on the cross sectional area of the cargo spaces.

The master should obtain a drawing from the installation operator indicating the locations of sensors in each cargo space. At completion of loading, for preference, but in any event when all sensors have

been installed, the master or chief officer should check the temperature as indicated by each sensor in the presence of the installing operator. This will ensure that the ship's command is conversant with the equipment. It will also show whether each sensor is functioning correctly. Abnormally high or low figures will indicate malfunction from the outset of the voyage. At this stage it is impractical to replace sensors and such an operation should not be attempted. The installing operator should be asked to sign the entry covering the first set of recordings which should be entered, as read, in a bound book. Subsequently, the figures for each sensor should be read and recorded in the book each watch for the first few days of the voyage. If they are more or less stable they may subsequently be read at eight-hourly intervals as required under *Special requirements (2)* in the BC Code entry. If some temperatures in a space start to rise, temperature reading should revert to four-hourly intervals for all sensors in the space.

From experience, it is known that there can be some increase in temperature (possibly up to 34°C) as recorded from some sensors, at the outset of a voyage after which the temperature stabilises. This situation need not give rise to concern. If, however, the temperature of one or more sensors exceeds 40°C and continues to rise, the master should take timely steps to seal the relevant hatchcovers using sealing tape and if necessary plastic or foam sealant or cement. Consideration should be given at this stage to sealing ventilation openings; owners and charterers should be informed of the temperature figures and their advice / instructions sought. Members of the Committee are on occasions requested to advise owners or charterers when this situation arises and advice is normally given on the temperature trends over a time period. Hence when a master is forwarding information he should ensure it is clear and the temperature figures for each cargo space are always reported in the same sequence.

In any event, the instructions in the BC Code entry *Special requirements (3)* should be followed, i.e. if any temperature sensors indicate a cargo temperature in excess of 55°C, the cargo space and any interconnecting cargo space should be sealed effectively and ventilation restricted. If self-heating continues, then CO₂ or inert gas should be injected as stipulated in the fire fighting manual provided by the installers of the system. The injection should take place slowly over a 24-hour period. It is basically undesirable to inject less gas than is recommended in the manual, even though this means that only a few cargo spaces can be so treated.

It should be appreciated that any cargo heating results from an oxidation process. This means that the oxygen

concentration in a hold is depleted and the concentration of nitrogen (an inert gas) increases. Hence, in a sealed hold, cargo heating tends to be self-quenching. It is therefore of paramount importance that the master has all necessary materials onboard to allow very efficient sealing of cargo spaces in order to minimise atmospheric interchange. Very efficient sealing may be a time-consuming operation, but should never be skimped.

Technically, provided that hold sealing is adequate, it would be possible for a ship with cargo heating in all her holds, to sail safely across the Pacific Ocean with her CO₂ supply exhausted (assuming a sufficient reserve for the engine room). However, such action would only be recommended if sealing efficiency could be guaranteed. Under normal circumstances, where there is obvious progressive heating, a ship would be recommended to go to a port of refuge to obtain adequate CO₂ supplies. This often involves fitting a bulk tank containing several tonnes of CO₂. If considered necessary, further sealing should be performed whilst the ship remains in port.

Unless special circumstances prevail, sealed hatchcovers should not be opened until the first discharge port for that hold is reached. An accurate assessment of the situation in any cargo space can be obtained by measuring the oxygen concentration via a pipe connected to an oxygen meter which is introduced ideally via dedicated points of access or alternatively by slightly opening an access manhole. The manhole should be closed and secured immediately after measurements have been taken. Although some ships have oxygen meters onboard and have crew conversant with their use, it is generally recommended that, where possible, measurements of oxygen levels are made by surveyors. If they are made by the ship, the instrument should be checked immediately before use by checking the oxygen concentration of the external atmosphere (20.8%). When oxygen levels are below 10% heating is greatly restricted. Even without use of CO₂, this situation may be achieved in a few days where hatches are effectively sealed and there is a substantial quantity of cargo heating in a hold.

Discharge

Heating cargoes (if any) should be discharged first. However, where this is not practicable, the rate of spread of heating in a cargo space can drastically be reduced by maintaining a low oxygen concentration. This is done for preference by the use of CO₂ or when supplies are not available by keeping the holds sealed. It must be appreciated, however, that once the holds are opened for discharge and the oxygen concentration is allowed to rise to at least 20%, which is necessary for safe working in the hold, heating will

resume at an accelerating rate. Hence attempts should be made to discharge pockets of heating cargo as soon as possible. On some occasions this can be achieved without difficulty. However, on occasions smoke generation becomes excessive, preventing manual operations. There are then several options for dealing with this problem and the choice depends on the circumstances prevailing.

The first option is to reseal the hold and inject CO₂, the minimum quantity injected being that recommended by the installers of the ship's CO₂ system. Again this operation should take place over a 24-hour period. The hold should then be left sealed for at least four days. The oxygen concentration must again be allowed to rise to 20% before labour is allowed into the space to resume discharge. This option, when successful, results in the minimum amount of cargo damage but extends the discharging period. It may be considered impractical if it has to be repeated several times.

The second option is to control smoke evolution by the use of water sprayed through a fine spray directly onto the smoking cargo, whilst discharge proceeds. This procedure, if properly used, results in limited water damage to part of the cargo. However, excessive water is often applied, particularly when the local fire service intervenes, and the amount of cargo wetted can be substantial.

Very occasionally, the cargo will actually ignite. Flames should be extinguished with a water spray.

The third and last option which should only be used when other methods have failed is to use a water spray to control smoke evolution or fire and discharge heating pockets by grab. The procedure obviously results in more cargo damage.

Members of the Committee have had experience of fires in fishmeal igniting flammable cargo in adjacent spaces with disastrous results. Hence the earlier advice that flammable materials should not be stored in storerooms adjacent to or above holds loaded with fishmeal.

Damaged and apparently sound cargo should always be separated at the time of discharge. However, even badly heated cargo has feed value and can be incorporated in cattle feed. Hence, cargo should never be left onboard to be dumped at sea.

Bagged fishmeal carried in containers

Bagged stabilised (i.e. UN 2216, Class 9) fishmeal may be carried in freight containers as indicated in Volume 1 of the IMDG Code at page 322. It is probable that containers will be delivered alongside already sealed.

However, if the master is in a position to see the containers being stuffed he should ensure they are clean and that the maximum quantity of bags are placed in each container. In any event he should ensure that the container doors and other openings are properly tape-sealed to minimise possible air ingress.

On the voyage, the temperature of the outsides of containers, if stowed in accessible positions should, if possible, be checked regularly by feeling them (in any event, as indicated in Volume 1 of the IMDG Code at page 322, 7.1.10.3.2.2 *“Temperature readings in the hold should be taken once a day early in the morning during the voyage and recorded”*). If any container becomes hot they should be cooled using water; *“...consequent risk to the stability of the ship should be considered.”* 7.1.10.3.2.3. If smoke is seen issuing from a container, a hole should be punched in the side at the top of the container, a hose nozzle fitted and the container flooded.

It is self-evident that masters must ensure there is reasonable access to any containers stowed under deck.

Fishmeal carried in bulk

This matter is covered in the IMO BC Code pages 80 and 81.