Chapter 47 – Fishmeal Cargoes

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

Fishmeal is a product made from fish, as well as bones and offal from processed fish. It is a brown powder or cake obtained after cooking, pressing (particularly important for oily fish, to extract as much oil as possible), drying and then grinding the fish trimmings. It is nutrient rich and high in protein, and primarily used in the diets of domestic animals. Four or five tonnes of fish are needed to manufacture one tonne of dry fishmeal.

In some areas of the world where industrial processing plants are not available, fish are simply dried out in the sun before grinding them into fishmeal. However, the end product is poor in comparison to modern methods. Fishmeal can be made from almost any type of seafood but is generally manufactured from wild-caught, small marine fish that contain a high percentage of bones and oil, and are therefore usually deemed not suitable for direct human consumption. The fish caught solely for fishmeal purposes are termed 'industrial'. Virtually any fish or shellfish in the sea can be used to make fishmeal, although rare/poisonous species are avoided.

The standard products are classified as hazardous cargoes and are included in the IMDG Code (Reference 19) in Class 4.2 (Substances liable to spontaneous combustion) or Class 9 (Miscellaneous dangerous substances and articles), UN numbers 1374 and 2216.

Figure 47.1: Small fish, deemed unsuitable for human consumption, ready to be processed at a fishmeal processing plant.

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, where 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. However, the stowage requirements resulted in a high stowage factor and were expensive in both labour and materials (dunnage).

47.1 Self-heating

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 production of heat, so in the double ship stow method the most reactive material was oxidised during the aging process prior to loading and the residual oxidisable material reacted with atmospheric oxygen at a rate at which the heat produced could be removed by ventilating air.

Certain shipowners approached the problem of reducing the rate of oxidation by using inert gas. Special ships were built, which were equipped with onboard inert gas producing equipment similar to that used on tankers and with hatch cover systems that were substantially airtight. This system works satisfactorily provided the number

of load and discharge ports served on a single voyage is limited. However, each time a hatch cover is opened, part of the inert atmosphere is replaced by air and the inerting operation must be repeated 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 treated with antioxidant is categorised under Class 9 in the IMDG Code (Reference 19). 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 has 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 provide a stable product for carriage in bulk or block stow.

Fishmeal is produced by cooking the fish and extracting oil and aqueous fluids mechanically. The cake that is produced is then dried and milled. The milled meal is cooled and treated with antioxidant, usually by spraying the meal as it passes through a trough. Antioxidants used are ethoxyquin, BHT (butylated hydroxytoluene) or tocopherols.

Heating of fishmeal is due to atmospheric oxidation, but the chemical process is complex and involves a series of reactions. The amount of heat produced by these reactions varies and those producing most energy are those towards the end of the series. The addition of an antioxidant stops the reaction chain before these later reactions can occur.

As treated fishmeal ages, the antioxidant additive is used up. If an insufficient quantity is added at the time of production, it will be depleted before the condition of the fishmeal has been stabilised. As a result, and 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 until some time after loading. This was the case in shipments from both Chile and Peru during the 1980s.

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

47.2 Bagged Fishmeal

Bagged fishmeal presents the majority of problems.

47.2.1 Documentation

The Master should have on board a copy of the latest edition of the IMDG Code (Reference 19), which includes entries for unstabilised fishmeal and for stabilised (ie antioxidant treated) fishmeal. The Master should also have a copy of the International Maritime Solid Bulk Cargoes Code (IMSBC Code) (Reference 17), where there is an entry for stabilised fishmeal.

The Master must obtain and retain certificates for antioxidant-treated fishmeal, as required by the IMDG Code, covering all the cargo loaded. These certificates should include all the information required to ascertain that the product conforms with the requirements for temperature, weathering and packing, as set out in the special provisions in Volume 2 of the Code.

Since deregulation of the fishmeal trade in Peru, certificates may be issued by a person or company recognised by the Government of Peru, the competent authority. Certificates for Chilean fishmeal, which very rarely gives problems, are issued by the Instituto de Fomento Pesquero (IFOP), the Chilean Institute of Fisheries Development, a government agency that supports the sustainable development of the country's fishing and aquaculture resources.

47.2.2 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 the IMDG Code, the relevant bags must be rejected. If high temperatures are observed, it may be necessary to stop loading the relevant parcel to allow more extensive temperature checking. The Code states that fishmeal *"shall not be transported if the temperature at time of loading exceeds 35°C or 5°C above the ambient temperature, whichever is higher."* Any wet, water-stained or caked bags should be rejected. It may be difficult to detect staining when fishmeal cargoes are packed in black woven polypropylene bags, so it may be necessary when such staining is observed to slow or suspend loading to allow a proper examination. Torn bags should also be rejected.

47.2.3 Stowage

Standard stowage practice for bagged cargoes should be adopted, ie 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, particularly those that are liable to become heated.

Details of stowage precautions for fishmeal can be found in the IMDG Code (Reference 19). 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 of bagged cargo. Flammable materials, such as paint, should be removed from store rooms immediately above or adjacent to cargo spaces loaded with bagged fishmeal.

47.3 Bagged Fishmeal Carried in Containers

Bagged stabilised fishmeal (ie UN 2216, Class 9) may be carried in freight containers as indicated in Volume 1 of the IMDG Code (Reference 19). Containers will usually be delivered alongside already sealed. However, if the Master is in a position to see the containers being stuffed, he or she should ensure that they are clean and that the maximum quantity of bags are placed in each container to restrict the free air space to a minimum. In any event, the Master 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 be checked regularly by feeling them, in any event as indicated in Volume 1 of the IMDG Code: *"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, it should be cooled using water; *"... and the consequent risk to the stability of the ship should be considered."* 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.

Masters must ensure there is reasonable access to any containers stowed under deck.

47.4 Installation and Operation of Temperature Sensors

The IMSBC Code (Reference 17) 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 that are normally connected to a switch box that also has a connection for a readout meter. The installation is usually carried out by a specialist survey organisation employed by the shippers or charterers. It is generally recommended that installation is not performed by the ship's crew as they should be solely engaged in observing loading operations. It is common to install sensors at two or three levels in a lower hold and one or two levels on 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, once all sensors have been installed, the Master or chief officer should check the temperature as indicated by each sensor, in the presence of the installation 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 installation operator should be asked to sign the entry covering the first set of recordings, which should be entered, as read, in a 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 the *Carriage* requirements for UN 2216 (stabilised fishmeal) in the IMSBC Code (Reference 17). 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 at the outset of a voyage (possibly up to a value of 34°C) as recorded from some sensors, 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 steps to seal the relevant hatch covers 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. Expert advice should

be requested to advise owners or charterers when this situation arises and advice is normally given on the basis of temperature trends over a time period. Therefore, when a Master is forwarding information, they 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 under *Ventilation* for UN 2216 in the IMSBC Code (Reference 17) should be followed, ie 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 stopped. If self-heating continues, CO_2 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 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. Therefore, in a sealed hold, cargo heating tends to be self-quenching.

It is of paramount importance that the Master has all necessary materials on board to allow very efficient sealing of cargo spaces to minimise atmospheric interchange. 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 with her CO_2 supply exhausted (assuming a sufficient reserve for the engine room). However, such an action would only be recommended if effective sealing could be guaranteed. Under normal circumstances, where there is obvious progressive heating, a ship would be best advised to go to a port of refuge to obtain adequate CO_2 supplies. This often involves fitting a bulk tank containing several tonnes of CO_2. If considered necessary, further sealing should be performed while the ship remains in port.

Unless special circumstances prevail, sealed hatch covers 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. This 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 on board 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 measuring the oxygen concentration of the external atmosphere (20.8%). When oxygen levels are below 10%, heating is greatly restricted. Even without the use of CO_2, oxygen concentration may drop to this level in a few days where hatches are effectively sealed and there is a substantial quantity of cargo heating in a hold.

47.5 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 be drastically reduced by maintaining a low oxygen concentration. This is preferably by the use of CO_2 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 20.8%, which is necessary for safe working in the hold, heating will resume at an accelerating rate. Therefore, attempts should be made to discharge pockets of heating cargo as soon as possible. This can sometimes be achieved without difficulty. However, on occasion, smoke generation becomes excessive and prevents manual operations. There are 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 CO_2, the minimum quantity injected being that recommended by the installers of the ship's CO_2 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 20.8% before personnel are 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 applied through a fine spray directly onto the smoking cargo, while discharge proceeds. This procedure, if undertaken properly, 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 then be substantial.

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.

If the cargo ignites, the flames should be extinguished with a water spray. Fires in fishmeal may ignite flammable cargo in adjacent spaces with disastrous results. It is reiterated 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.

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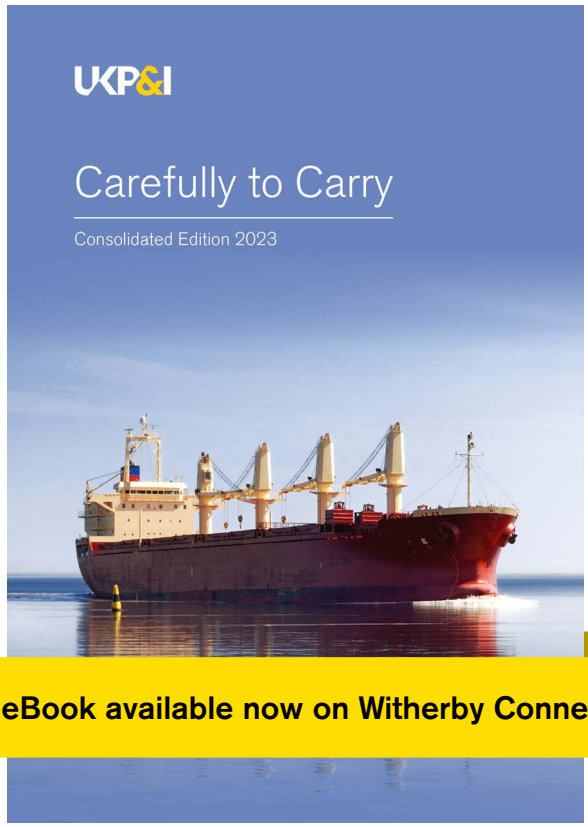

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