UK P&I CLUB

Carefully to Carry

Scrap metal (borings, shavings, turnings, cuttings, dross)

Ferrous materials in the form of iron swarf, steel swarf, borings, shavings or cuttings are classified in the IMO Code of Safe Practice for Solid Bulk Materials as materials liable to self heating and to ignite spontaneously.

Turnings are produced by the machining of steel, turning, milling, drilling, etc. When produced the turnings may be long and will form a tangled mass but they may be passed through a crusher or chip breaker to form shorter lengths. Both forms of turnings are shipped and shipments are frequently a mixture of short and long chips. The density of the short chips is of the order of 60 pounds per cubic foot, twice the density of the longer chips as they tend to compact more readily.

Borings are produced during the making of iron castings. Because of the nature of the parent metal, borings break up more readily than turnings. They tend to be finer and the bulk density is greater than turnings.

Turnings and borings may be contaminated with oils - cutting oils for instance - used in the manufacturing processes. Oily rags and other combustible matter may also be found among the loads.

Iron will oxidise, (rust) and iron in a finely divided form will oxidise rapidly. This oxidation is an exothermic reaction, heat is evolved. In a shallow level mass of turnings this heat will be lost to the surrounding atmosphere. However in large compact quantities as in a cargo hold this heat will be largely retained and as a result the temperature of the mass will increase. This oxidation process is accelerated if the material is wetted or damp, contaminated with certain cutting oils, oily rags or combustible matter.

The turnings may heat to high temperatures but will not necessarily exhibit flames. In one incident temperatures in excess of 500°C were observed six feet below the surface of the cargo. Temperatures of this order may cause structural damage to the steelwork of the carrying vessel. Flames are frequently seen in cargoes of metal turnings but these flames are usually the result of ignition of the cutting oils, rags, timber and other combustible materials mixed with the turnings.

Spontaneous heating of metal turnings has caused several major casualties. In the incident mentioned above spontaneous heating was detected, the vessel was moved from port to port in attempts to agree discharge. After weeks of delay all the holds were eventually flooded to reduce the heating for safe discharge of cargo. Following discharge of the turnings the vessel loaded a cargo of conventional scrap. During the subsequent voyage rough weather was encountered, cracks developed in the shell plating, the holds flooded and the vessel was lost with 29 lives.

In another incident heated turnings formed a solid mass in the hold which had to be mechanically broken into pieces before discharge by grab. In a further incident, following a normal passage it was not possible to discharge the cargo by grabs. The surface of the stow had crusted to a hard mass. Bulldozers were used to loosen the surface of the cargo and several hours later fire was observed in all of the holds.

"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.

The *IMO Code of Safe Practice for Solid Bulk Cargoes* has special requirements for the loading of turnings and borings which include:

1. Prior to loading, the temperature of the material should not exceed 55°C. Wooden battens, dunnage and debris should be removed from the cargo space before the material is loaded.

2. The surface temperature of the material should be taken prior to, during and after loading and daily during the voyage. Temperature readings during the voyage should be taken in such a way that entry into the cargo space is not required, or alternatively, if entry is required for this purpose, sufficient breathing apparatus, additional to that required by the safety equipment regulations, should be provided.

   If the surface temperature exceeds 90°C during loading, further loading should cease and should not recommence until the temperature has fallen below 85°C. The ship should not depart unless the temperature is below 65°C and has shown a steady or downward trend in temperature for at least eight hours. During loading and transport the bilge of each cargo space in which the material is stowed should be as dry as practicable.

3. During loading, the material should be compacted in the cargo space as frequently as practicable with a bulldozer or other means. After loading, the material should be trimmed to eliminate peaks and should be compacted.

   Whilst at sea any rise in surface temperature of the material indicates a self-heating reaction problem. If the temperature should rise to 80°C, a potential fire is developing and the ship should make for the nearest port.

   Water should not be used at sea. Early application of an inert gas to a smouldering fire may be effective. In port, copious quantities of water may be used but due consideration should be given to stability.

4. Entry into cargo spaces containing this material should be made only with the main hatches open and after adequate ventilation and when using breathing apparatus.

It will be noted that compacting the cargo as loaded with a bulldozer is recommended. This will tend to form a dense mass, pushing the short turnings into the bundles of long turnings, tending to exclude air from the stow. However some authorities argue that compacting the stow tends to break up the long turnings, creating greater surface areas for the oxidation process. However shorter turnings should compact more readily than the longer forms and thus reduce the area exposed to oxidation.

The reference to trimming level ensures that there is less cargo surface exposed to the air than cargo in a peaked condition. Furthermore, theor-etically air will pass across the top of a level trim, but can pass through the stow if loaded in a peaked condition creating a 'chimney' effect, thus accelerating the heating process.

The requirements for entry into cargo spaces are very important, many lives have been lost by officers and crew-members entering a hold to inspect a heating problem without taking adequate precautions. Oxygen is essential for the oxidation process and in a sealed space the oxygen is reduced by the heating reaction of the turnings or borings. The concentration of oxygen in air is 20.8%. Exposure to an atmosphere of 16% oxygen concentration causes an impairment of mental and physical state.

Concentrations of 10% will cause immediate unconsciousness and death will follow if not removed to fresh air and resuscitated. The symptoms which indicate an atmosphere is deficient in oxygen may give inadequate notice to most people who will then be too weak to escape when they eventually recognise the danger. Ventilation of the hold and testing the atmosphere or use of breathing apparatus is essential for safe entry to a hold which is loaded with these cargoes.

Surface temperature reading

Metal dross and residues

Aluminium dross

Aluminium dross is formed during the recovery of aluminium from scrap and in the production of ingots. Dross may constitute about 5% of the metal where clean mill scrap is involved but will constitute greater quantities where painted or litter scrap is recovered. The main components of dross are aluminium oxide and entrained aluminium. Small amounts of magnesium oxide, aluminium carbide and nitride are also present.

The dross is recovered and re-melted under controlled conditions to provide aluminium metal which is then treated to remove hydrogen and other impurities including trace elements. Storage or transport of aluminium dross should be conducted under carefully controlled conditions.

Contact with water may cause heating and the evolution of flammable and toxic gases, such as hydrogen, ammonia and acetylene. Hydrogen and acetylene have wide ranges of flammability and are readily ignited.

Aluminium dross, aluminium salt slags, aluminium skimmings, spent cathodes and spent potliner as aluminium smelting by-products are included in the IMO Code of Safe Practice for Solid Bulk Cargoes.

The Code recommends that hot or wet material should not be loaded and a relevant certificate should be provided by the shipper stating that the material was stored under cover or exposed to the weather in the particle size in which it is to be shipped for not less than three days. The material should only be loaded under dry conditions and should be kept dry during the voyage. The material should only be stowed in a mechanically ventilated space. In our opinion the ventilation equipment should be intrinsically safe.

Zinc dross

Zinc dross, zinc skimmings, zinc ash and zinc residues are all materials obtained from the recovery of zinc. The zinc types may be recovered from galvanised sheets, batteries, car components, galvanising processes, etc. Zinc ashes are formed on the surface of molten zinc baths, and whilst primarily zinc oxide, particles of finely divided zinc will also adhere to the oxide. The various types of zinc are treated by processes to produce pure zinc metal.

The ashes, dross, skimmings and residues are all reactive in the presence of moisture liberating the flammable gas hydrogen and various toxic gases. The materials are also listed in the IMO Code for Solid Bulk Cargoes which states that any shipment of the material requires approval of the competent authorities of the countries of shipment and the flag state of the ship.

The Code recommends that any material which is wet or is known to have been wetted should not be accepted for carriage. Furthermore the materials should only be handled and transported under dry conditions. Ventilation of the holds should be sufficient to prevent build up of hydrogen in the cargo spaces. All sources of ignition should be eliminated which would include naked light work such as cutting and welding, smoking, electrical fittings etc.

We have knowledge of one incident where the cause of an explosion in a hold containing zinc ashes was said to be a lamp used to warm the sealing tape used to seal the hatch-covers. The flame of the lamp was stated to have ignited hydrogen gas leaking from the hold. The flame flashed back into the hold to ignite an explosive concentration of hydrogen/air. The explosion lifted the hatchcovers and collapsed a deck crane.

Unfortunately there was also loss of life. The hydrogen had been generated by reaction of the zinc ashes with water, zinc ashes which had been loaded in a damp condition. The zinc ashes were discharged and later spread on the quayside in a thin layer to dry. Seven days later hydrogen was still being evolved to the atmosphere, as proved by tests with a hydrogen gas detector.

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