Cargo | **Iron Ore Fines**

Liquefaction of Iron Ore Fin

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Graham Charlton joined Burgoynes in 1984 and has worked since in their offices in the UK and Hong Kong specialising in fire and explosion investigation. He has undertaken a wide variety of investigations on marine craft ranging from yachts to large commercial ships such as general cargo; container ships and tankers of various types.

'FINES' IS A GENERAL TERM used to indicate the physical form of a mineral or similar cargo and, as the name suggests, such cargoes include a large proportion of small particles. The transportation of iron ore fines by sea from the Indian subcontinent has proved problematic in recent years when the moisture content has been too high at the time of loading. As a consequence the solid cargo has behaved as a liquid, sometimes with alarming results. This phenomenon is called liquefaction and leads to stability problems whereby the cargo can shift at sea under the influences of the motion of the vessel and the effects of vibration. Shifting can be sudden or progressive and lead to a ship developing a severe list, sometimes resulting in a capsize.

Cargoes from the Indian sub-continent have been particularly prone to this phenomenon in the monsoon season (June to September) because the fines are stored outside very often with no protection from heavy rain. Also, cargoes transported long distances by rail from mines to ports are prone to similar exposures. However, as explained below, such problematic cargoes would never have been loaded if properly sampled, tested and assessed before loading commenced. It is worth noting also that stockpiles can remain moist if left out in the open after the monsoon season. As such, care needs to be taken at all times and close attention paid to preloading test procedures. Liquefaction can occur in a cargo that outwardly appears dry on the surface or essentially so; it does not have to be 'running wet' with water for it to have the propensity to liquefy.

Liquefaction

In a dry, granular, well-trimmed cargo the individual particles are in contact with each other such that frictional forces prevent them sliding over one another. However, if there is enough moisture present then there is the potential for the cargo to behave like a liquid. This is because settling of the cargo occurs under the influences of vibration, overstowage and the motion of the ship. As such, the spaces between the particles reduce in size with an accompanying increase in water pressure between the particles. This results in a reduction in friction between the particles and can allow the cargo to shift suddenly.

Photograph of iron ore fines showing spatter on the side of the hold caused during loading by excess moisture in the cargo.

Testing the Fines

Obviously, before a cargo is loaded the owners and charterers need to be satisfied that it is safe to carry. The International Maritime Solid Bulk Cargoes Code, published by the IMO in 2009, addresses this by requiring that the shippers ensure it is properly sampled, tested and assessed before it is loaded. Cargoes that are capable of liquefaction are classified Class A cargoes. The Code is mandatory under the provision of the SOLAS Convention from 1 January 2011, but may be applied on a voluntary basis until then but with the recommendation that it be adopted by governments before 1 January 2011.

The Code requires that the cargo be assessed by determining a property known as the flow moisture point (FMP). This is the lowest moisture content at which the material under test begins to exhibit flow (liquefaction). The Code requires that whatever the value of the FMP, it is reduced by 10% so as to incorporate a safety factor. This lower figure is then adopted as the Transportable Moisture Limit (TML) for the cargo; TML = 90% of FMP.

As such, tests to determine the actual moisture content of the cargo must then be carried out on a representative sample before it is loaded. If the moisture content is at the TML or exceeds it then the cargo should be declared unsafe and rejected. It is important to note that the moisture content determination on the cargo to be loaded must be carried out no more than seven days before the loading commences. Moreover, if there has been significant rain between the time of testing and loading then further tests must be conducted to ensure that the moisture content of the cargo is still less than the TML (Section 4.5.2 of the IMSBC Code).

The IMSBC Code sets out at Appendix 2 the proper Laboratory Test Procedures, Associated Apparatus and Standards. The test should be carried out by a competent laboratory, although in India there is currently no accreditation scheme. As such, Masters

es from India

should be wary of the provenance of test results. It is understood that the Indian Authorities are currently looking at developing an accreditation scheme, in light of the recent problems.

Documentation and Checking by the Master

The IMSBC Code requires that the shipper shall provide certification to the Master to confirm the TML and actual moisture content of the cargo before loading can commence. Only if the cargo has a moisture content that is less than the TML can it be offered for safe carriage by sea (IMSBC Code Section 7.3.1). Masters should be vigilant and ensure that cargo is inspected for any signs that it may be above the TML. For example, free-standing surface water, or spattering of cargo as it lands in the holds with resulting run marks are clear warning signs.

The IMSBC Code states that a Master may undertake his own check test, often referred to as the 'can test'. If he considers that the cargo may not be as dry as is being claimed then he can adopt a complementary test procedure as outlined in Section 8.4 of the Code.

Section 8.4 states that the test is to check for **"approximately determining the possibility of flow on board ship or at the dockside by the following auxiliary method: Half fill a cylindrical can or similar container (0.5 to 1.0 litre capacity) with a sample of the material. Take the can in one hand and bring it down sharply to strike a hard surface such as a solid table from a height of about 0.2m. Repeat the procedure 25 times at one- or two-second intervals. Examine the surface for free moisture or fluid conditions. If free moisture or a fluid condition appears, arrangements should be made to have additional laboratory tests conducted on the material before it is accepted for loading."** It is worthy of note that if the result of the **'can test'** is negative this is not proof that the cargo is below the TML.

Summary Advice for Masters

- Follow the IMSBC Code 2009 requirements in relation to Class A cargoes.
- Ensure that certification showing the moisture content of the cargo and the TML are presented before loading commences.
- The cargo shall only be accepted if the moisture content is below the TML.
- Confirm that the certification is from a reputable laboratory and that the moisture content determination was carried within a week of the start of loading. If it has rained in that intervening period then further laboratory tests should be carried out to establish the moisture content of the fines to ensure that it is still below the TML.
- Be vigilant during loading and watch out for any signs of wetness in the cargo. If unsure of the state of the cargo undertake a 'can test' which may assist in determining whether the cargo is at or above the TML. If any doubts remain then the Master should seek advice from the responsible person ashore.
- Once a cargo is on board it will be difficult to discharge at the load port as it will almost certainly be regarded as having been exported from India.

BASIC FACTS

per 1 April 2010

Protection & Indemnity (including Charterer's Liability)	
Number of vessels	1,303
Average age	11.0
GT (million)	40.8
Freight Demurrage & Defence	
Number of vessels	665
Average age	8.6
GT (million)	26.0
Hull & Machinery	
Number of vessels	1,378
Average age	10.6
GT (million)	55.4
Loss of Hire	
Number of vessels	428
Average age	8.5
GT (million)	19.5

NEW MEMBERS

Angel Shipping (Hong Kong) Co Limited	China	PI, FO
Brightoil Shipping Limited	Hong Kong	HM
CR Power Marine Transportation (Tianjin) Co	China	PI
CSIC-IMC Shipping Ltd	China	PI, FO
Da Sin Shipping Pte Ltd	China	TL, FC
DS Tankers GmbH & Co, KG	Germany	HM, LH
EE Shipping AB	Sweden	PI
Farglory Shipping Singapore	Singapore	PI, FO
Fortune Ocean Shipping	China	PI
Fujian Lucky Sea Shipping Ltd	Hong Kong	PI, FO
GC Tankers Ltd	Singapore	TL
Genoa Maritime S.A.	Greece	PI, FO
J. Lauritzen A/S	Denmark	HM, PI, FO
Larvik Shipping AS	Norway	HM, LH
Minelco AB	Sweden	TL
Northstar Maritime S.A.	Greece	PI, FO
Omniblue Shipping Inc.	Greece	LH
Orion Bulkers Gmbh & Co KG	Germany	HM, PI, FO
Parsam Shipping & Shipmanagement Ltd	United Arab Emirates	HM, PI
Phoenix Bulk Shipping Ltd	China	TL
Reederei J. Ohle KG	Germany	HM, PI, FO
Reederei M Lauterjung GmbH	Germany	HM, PI
Seatrek Trans Pte Ltd	Singapore	TL
South Ocean Shipping Co Ltd	China	PI, FO
TDM Carriers Ltd	Greece	PI, FO
Transcenden Global Pte Ltd	Singapore	TL
Wah Shun Shipping Co Ltd	Hong Kong	PI, FO
Winson Oil International (HK) Ltd	Hong Kong	PI

FC = Charterer's Freight Demurrage & Defence
FO = Freight Demurrage & Defence
HM = Hull & Machinery
LH = Loss of Hire
PI = Protection & Indemnity
TL = Charterer's Liability