



# LP Bulletin

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## Bulletin 631 - 4/09 - Direct Reduced Iron (A) (Hot Moulded Briquettes) - Novorossiysk - Russia

### **DIRECT REDUCED IRON (A)** – Hot moulded briquettes

This product is included in the IMO Code of Safe Practice for Solid Bulk Cargoes as a material hazardous in bulk (MHB) and Group B a cargo which possesses a chemical hazard which could give rise to a dangerous situation on a ship.

In a recent case which resulted in the cargo heating and giving off hydrogen the description of the cargo given to the ship was found to be suspect which gives serious concern re cargoes loaded from this port.

The Cargo Declaration:

*'Name of the cargo' stated: - Briquettes of Iron Ore (Briquettes, Hot-Moulded).*

However in the same document under the title, 'Cargo information'

*The cargo's name under the B.C.Code (IMO) is stated as: Direct Reduced Iron (A) Briquettes Hot Moulded Length 110 mm, Width 50mm, Thickness 35mm, Fines under 4mm, not more than 5%.*

It is unusual for a cargo of DRI (A) to heat to a dangerous level or produce dangerous levels of hydrogen.

### **INCIDENT**

The vessel loaded 47,000 mt of cargo in Nos.1, 3 and 5 Holds in Novorossiysk. The temperature of the cargo as loaded during the period 11/13-2-2009 was reported to be within the range of 10C to 21C. The vessel sailed for Xingang on 14-2-2009 and on that day the temperatures of the cargo had increased to within the range of 20 C to 54 C.

On 17-2-2009 the temperature of the cargo in Nos.3 and 5 Holds had risen to 77 C and 64 C respectively. The temperature in No.3 Hold rose to 95 C on 18-2-2009 and increased to 100C on 20-2-2009. It was then learned that the hydrogen content in Nos.3 and 5 Holds was in excess of 2%. The lower flammable limit of hydrogen in air is 4% thus immediate ventilation of the hold spaces was advised.

The voyage continued with daily ventilation of the cargo holds through the ventilation windows on the hatch covers and the hatch accesses at the fore and after ends of the cargo holds. However heavy weather around 7-3-2009 prevented ventilation of the hold spaces and the hydrogen level increased from 0.16% to 0.95% vol. Weather conditions improved the following day which allowed ventilation of the holds and clearance of the hydrogen again. In view of this continued hydrogen generation and the possibility of further heavy weather preventing hold ventilation it was suggested that inerting of the holds in a suitable location should be considered.

Favourable weather conditions were forecast for the planned route and the voyage continued with good weather and conditions which permitted continuous ventilation of the cargo spaces and no build up of hydrogen concentrations to flammable or explosive concentrations occurred. However a further short spell of inclement weather, with seas over the deck, forced closure of the ventilation system once more with the resultant increase of hydrogen in the cargo holds.

## OVERVIEW

Direct Reduced Iron, hot moulded briquettes are normally considered a relatively safe cargo to ship. The iron is in a densely moulded form, moulded at a temperature of 650C and has a limited surface area exposed to oxidation and water reaction. **However when the briquettes are broken there is an increase in surface area of reactive iron exposed to oxidation to evolve heat and react with water to release hydrogen.**



The attached photograph shows the degree of breakage of the briquettes in this case and in particular the vast quantity of fines present. The fines offer an increased surface area exposed to oxidation and reaction with any water or moisture present in the hold atmosphere. In a marine environment any water or moisture would have a salt content which would accelerate the rate of oxidation and hydrogen evolved.

**At discharge it was estimated that the undamaged portion of the cargo was 25%.** Thus 75% of the cargo consisted of broken briquettes and fines creating a vast increase of fresh surfaces exposed to oxidation and reaction with water present in the cargo. There had been water present because bilge records indicated that 178.873 metric tonnes had been pumped overboard. Furthermore because of the practice of almost continuous ventilation of the holds to free the generated hydrogen, moist sea air would have been taken into the holds and would have condensed to run over the cargo and accelerate the oxidation of the HBI and liberate hydrogen.

## CONCLUSIONS

Direct Reduced Iron (B) in the form of lumps, pellets and cold moulded briquettes is a substance of open structure which readily reacts with water and air to release hydrogen and heat. The recommended form of carriage by sea includes an inert atmosphere, oxygen content less than 5% in the cargo holds throughout the voyage.

Direct Reduced Iron (A) is moulded at a temperature in excess of 650C, producing a heavy dense product which is less reactive to water and air than the (B) form. Thus provided that the fines content (less than 4mm) is less than 5% and the temperature at time of loading is not in excess of 65C an inert atmosphere is not essential for safe carriage. The Description of Direct Reduced Iron (A), according to the IMO Code of Safe Practice For Solid Bulk Cargoes includes – ‘Fines (under 4mm) not to exceed 5%’.

Prior to this incident we have no record of a DRI (A) cargo heating to a dangerous level or reacting to produce dangerous levels of hydrogen. It would appear that the presence of a high level of fines and broken briquettes and reaction with the water in this cargo resulted in the heating observed and the release of hydrogen.



**Masters should be extremely vigilant when loading this type of cargo and if in doubt as to the extent of breakages, possibly from loading remnants etc, the Club's correspondent should be contacted immediately.**

It should be stressed that it is not always possible to guarantee favourable weather conditions on a long sea voyage when it is safe to open hatch access covers and ventilation covers.

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