Heat damage in soya bean cargoes - the importance of inspections

An increasing number of soya bean cargoes are reportedly loaded in a "bin-burned" condition. Important visible signs that fall under the phrase “apparent condition” can reveal at an early stage soya bean parcels that can be liable to self-heat.

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Gard has this year (2016) seen many claims relating to heat damage in soya bean cargoes loaded in South America, particularly Brazil and Uruguay, mostly for discharge in China. Due to the relatively high value of soya beans and the fairly large quantities shipped, the disputes have in some cases involved multi-million dollar claims.

The problem is related to microbiologically induced self-heating, which is caused by a combination of elevated moisture content and cargo temperatures in parts of the cargo at the time of loading. The prolonged time that the beans in some instances have remained on board the vessels before discharge also contributes to the problem, and exacerbates the self-heating and microbiological deterioration.

It is reported that parts of the 2016 crop (in Brazil at least) were affected by rain during growth in the field and at the time of harvest. It is believed overly moist beans went into storage and were later exported. Spores of storage fungi are always present on all soya beans and other agricultural commodities, irrespective of whether they are dry or wet and these are impossible to detect with the naked eye. They are dormant at normal bean moisture levels but will start to proliferate when the humidity in the stows are above certain critical levels. The growth is initially very slow. It is only when the proliferation have progressed to the point that temperature increases show in the accessible stow, the beans differ in appearance from the yellow or pale colour of normal beans, or mould has become manifest, that Masters can recognise that an abnormal cargo is being, or has been, loaded. It is these symptoms that trigger substantial cargo claims at discharge ports.

An additional but unrelated problem involves complaints received in China relating to beans of a distinct red/purple appearance. This condition was due to an infection in the field by a specific species of mould that could not have developed during the voyage, and the receiver later withdrew the claim with regard to this phenomenon.

Loading Before loading the Masters will be provided with the bulk cargo shipping form which lists the bulk cargo shipping name, e.g. soya beans, but will usually contain no specific information relating to the moisture content of the cargo to be loaded apart from its maximum allowed specification level stated in the cargo declaration. However, the maximum moisture level is purely a trade reference for the maximum amount of valueless water to be tolerated under a sale contract. The contractual limits for the moisture content of South American soya beans, e.g. 14 per cent maximum for Brazil, 13.5 per cent maximum for Argentina, are often well above what would be recommended for safe storage. In other words, many cargoes may be loaded within the sale contract specification but still be at significant risk of self-heating during carriage.

As mentioned above, the two main factors causing self-heating are moisture content and cargo temperature at the time of loading, where variation in moisture content, and particularly the portions of the shipment with the highest moisture values, has major importance. At 14 per cent moisture and 21°C (70°F) the safe storage time is 45 days, which is the typical length of a voyage carrying soya beans from South America to China. In other words, at those moisture and temperature levels, the length of storage before shipment and voyage delays may have a significant influence on heating. Detailed parcel by parcel moisture data necessary for evaluating the safe storage capacity is only available to cargo interests and not to the carrier. To a Master, beans at 13 per cent and 15 per cent moisture will look exactly the same. The control of the moisture content falls outside Masters' responsibility during loading, with the exception of obviously wet cargo. A Master therefore accepts a cargo in good faith and is in the hands of the charterers/shippers in so far as the safe storage on board, i.e. its own capacity to withstand ordinary carriage, is concerned.

However, although Masters do not know the moisture characteristics of the soya beans to be loaded, experience has shown that there can be important visible tell-tale signs that fall under "apparent condition" which can reveal parcels that are liable to self-heat early on and of which vessel's crew should be particularly aware.

Case study – self-heating In the following example one of our Members loaded soya beans in Brazil in July 2016. The Master stopped the loading when an abnormal presence of blackened beans became apparent in the loaded stow. The Member sought advice from grain scientists and it became clear that the blackened beans (see photographs below) was due to the so-called "bin-burned" phenomenon.

From the photographs below it is clear that the blackened bin-burned beans stand out when compared to the unaffected normal yellow or pale brown beans. The bin-burn phenomenon occurs when over-moist beans are put into storage without sufficient aeration for long periods of time. The process starts as microbiological self-heating but, as the organisms causing microbiological metabolic self-heating die due to the effect of 'self-pasteurization', it is followed by oxidative heating of the oil contained in beans to produce the high temperatures necessary to produce the blackened bin-burned beans. Where such deterioration occurs, farmers and silo operators may break-up the affected, severely heat-damaged cargo to mix it with sound cargo delivered to the export terminals at the ports. Modern sale contracts typically allow for some 1 per cent of burnt beans. The incidence of blackened beans for the Paranagua cargo in question was significantly above this level. It rendered the affected parcels clearly out of conformity with the "normal good order and appearance" condition of soya beans that Masters expect. The presence of the distinct areas of excessive black beans was considered to present a significant risk of claims in China, which was the destination for the shipment. The photograph introducing the article illustrates how bin burned cargo can appear at the time of discharge. The Master rejected the affected parcels although they were already on board and requested they be replaced with beans in apparent good order and condition.

Grain experts advised that the extensive presence of bin-burn was potentially indicative of a wider problem of general over-moistness in the parcels of beans within the shipment. During the time it took to reach an agreement with the charterers to replace the affected bin-burned parcels, the cargo temperatures in all holds were checked regularly and within a couple of weeks noticeable increases in temperature were found in the accessible surface areas of the stows.

Any temperature variation in the cargo at loading would be expected to be relatively small. Consequently, the marked variation seen demonstrated that self-heating was underway in parts of the cargo that had previously been loaded as visually sound soya beans. Since the nature of microbiological self-heating is such that the extent of damage will only increase and accelerate with time, and despite the fact that the genuine damage in all likelihood was small at the time of the loading, it was predicted that it would increase during the voyage. Chinese receivers of the cargo were likely to present a claim for damage upon arrival in China; a claim over which our Member had no responsibility nor control.

The Member negotiated a special agreement with the charterers for the carriage of the beans which changed the destination from China to a port in Europe and held the Member harmless for any cargo deterioration due to self-heating plus any consequences thereof. The vessel eventually completed that voyage and discharged the cargo without claims being incurred, although self-heating damage was apparent at discharge.

It was the alertness of the Master who initially spotted that abnormal quantities of black beans were loaded, in combination with the temperature monitoring regime that was undertaken, that averted a significant claim in the above case. It is not easy for a vessel's crew to take accurate cargo temperatures. However, where delays in loading or delays in the voyages are involved, e.g. delays between two or more loading ports or at discharge ports, , a regime of proper temperature measurements is helpful in revealing signs of self-heating in cargoes. These should be carried out when safe to do so, bearing in mind fumigation, and sea and weather conditions.

Case study - purple beans An unrelated matter involving soya beans is the presence of purple beans. A Chinese receiver initially raised allegations of losses caused by the vessel. Please see below photographs showing affected beans. Gard obtained advice from grain experts to the effect that red/purple soya beans are caused by a fungal disease (*Cercospora* leaf blight) due to field infection by the *Cercospora kikuchii* fungus. Affected plants produce beans that show a

prominent purple stain over part of the outer hull. However, the fungus does not develop after harvest in storage - neither in silos nor in vessels' holds. It follows therefore that the red/purple beans found in the cargo were already present at the time of loading and the condition of the beans was unrelated to the transportation by sea.

The receiver in question dropped his claim. The infection is not thought to affect the quality of the oil or the protein, but soya bean meal produced from red/purple beans may take on an abnormal "purple" colour. Members and clients should therefore also be alert to abnormal presence of red/purple coloured beans.

General loss prevention guidelines It is important to remember that there is an obligation in law, under the relevant cargo carriage liability regimes, to inspect the cargo's apparent order and condition at loading, to enable the Master to ensure that the bill of lading is accurate in its description of these items. The same regimes oblige the Master and his crew to properly care for the cargo once loaded. The following recommendations are therefore provided with a view to assist Members and clients involved in the transportation of soya bean cargoes with cargo care and loss prevention:

- The Master and crew should be vigilant during loading and monitor the visual condition of the cargo so far as practicable, using breaks in the loading for closer inspections.

- Soya beans are pale yellow/brown by appearance (see photograph below). Although contracts allow for admixture of several percentage points of damaged and discoloured beans, including often 1 per cent burnt beans, seek advice if portions of the cargo visibly differ from normal with parts of discoloured or black beans.

- Cargo temperatures should ideally be taken during breaks in loading and, for the purposes of ventilation, on completion of loading. If significant temperature variations (say 5 to 10°C) and/or elevated temperatures are noted, this may be indicative of self-heating already underway.

- Once on board, in loading port(s) and during voyages, soya beans should be cared for like any other grain, i.e. kept dry at all the times and properly ventilated in accordance with normal maritime practice, following the shipper's prescribed fumigation periods (if any). Although natural ventilation as found on board many bulk carriers is not effective in controlling spoilage deep within the hold, and cannot prevent self-heating caused by inherent cargo conditions, it is nevertheless important that the ventilation practice is recorded accurately in the log book in case a party should challenge the vessel's cargo care regime. It should specifically include the times when ventilation is not conducted and reasons for not ventilating.

- During voyages, the crew should check the drain valves of the hatch covers for presence of condensation. Condensation may be unavoidable in cold regions but if individual hatches stand out, it may be indicative of self-heating. If condensation forms and the vessel is ventilating, this should be noted in the vessels' log book in order to document that it occurred despite the crew's best efforts in cargo care.

- The crew should inspect the cargo at for example weekly intervals within the normal restrictions of vessels at sea. It is not advisable that crew enter cargo holds, but inspections may be possible via the access ways on deck. Any abnormalities found such as sweat should be noted and logged.

- Voyage delays may give the opportunity for better inspections by opening the hatch covers, if safe to do so. When delays cause normal voyage periods to be well exceeded, the Association should be advised. If cargo temperatures information can be safely obtained that can be communicated to charterers/cargo interests so that mitigating steps can be considered.

If the Master at any point in time during loading or voyage are in doubt about the condition of a soya bean cargo, or in the event of cargo complaints at the discharge port, Gard should be contacted immediately. Advice can then be sought from cargo experts regarding the nature and extent of the damage and how to best mitigate the loss.

PHOTO 1: Sound cream coloured Brazilian soya beans.

PHOTO 2: When sound cream coloured soya beans are heated the beans become darker, brown or even black.

PHOTO 3: Small lumps of heat damaged soya beans dispersed sporadically throughout the cargo is consistent with the soya beans having undergone self-heating prior to loading or 'bin-burn'.

PHOTO 4. Pre-shipment heat damage (or bin-burned) soya beans in the foreground, with sound beans in the background, all loaded in a single hold.

PHOTOS 5 and 6: Examples of purple beans on plants affected by the Cercospora kikuchii fungus in the field.

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