Loss Prevention for Soya Bean's Self-heating Damage in China

I. What is heat damage?

Soya beans are the world's most important oilseed as a source of vegetable oil and animal feed (soya bean meal). According to China General Administration of Customs, 63,340,000 metric tons of soya beans have been imported to China until August within year of 2017[1], most of which were sourced from South America. Soya beans in bulk are usually loaded in apparently sound conditions but in several cases from South America these cargoes undergo self-heating and deteriorate during the voyage.

Sound soya beans are normally of a cream and pale colouration but self-heating and elevated temperatures can give rise to a deterioration of the cargo condition resulting in discoloured, darkened and mouldy beans.

Furthermore, self-heating and mould growth can impact the quality of soya beans with an increase in the level of free fatty acids (FFA) in the crude oil and a decrease of protein digestibility in the soya bean meal. FFA are linked to the rancidity of the oil, affecting flavour, aroma and other oil characteristics and hence the crude oil must be refined prior to human consumption. Extensive self-heating and heat-damage of a cargo translate into higher concentrations of FFA and consequently to higher refining costs and yield losses of the soya oil.

Elevated cargo temperatures can also affect the colour of the oil and the meal. Additional costs are associated with the discolouration treatment and refinery for the oil. Especially in China, the price of soya bean meal is dictated by colour, with paler colouration being preferred by Chinese buyers. Although not necessarily of lower quality, in China a darker colouration of the meal is perceived to be of lower quality and can result in financial losses.

Heat damaged cargoes should not be considered a 'total loss' because crushing plants can process such damaged beans, producing edible oil and animal feed, albeit with some extra processing. Importantly, mould *per se* is not an issue for crushing plants because moulds are typically killed by heat (steam) at the beginning of the process. In China, however, local health and safety regulations allow a maximum of 1% mouldy beans in a soya bean cargo. In theory, above this threshold the local China Inspection and Quarantine (CIQ) officers can enforce the law and prevent a cargo from being transported to the destined crushing plant. In the worst scenario, a cargo with more than 1% mouldy beans can be destroyed under the supervision of CIQ, thus amounting to a total loss plus additional incineration and handling costs. CIQ, however, do not always get involved in such disputes and soya bean cargoes containing more than 1% mouldy beans are often processed and used.

The most common and cost-effective strategy used by crushing plants for processing a heat-damaged cargo is to blend it with beans of higher quality. In so doing, the average quality of the

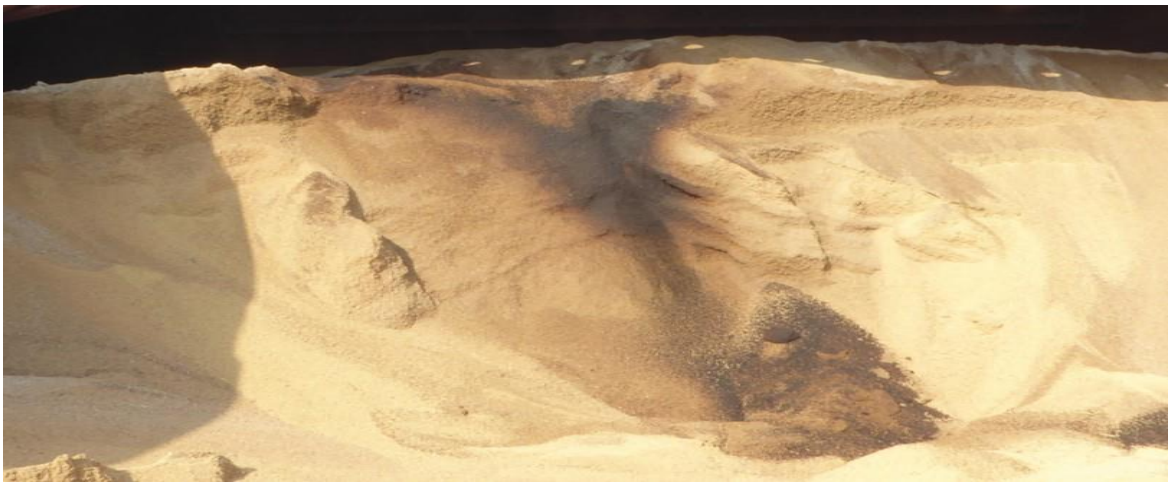
[1] http://www.customs.gov.cn/customs/302249/302274/302276/733978/index.html

damaged cargo is increased up to the plant's specifications for the quality of the target oil and meal.

Extra refining costs during the production of soya oil and meal along with yield losses for the sound beans used during the blending process of a heat-damaged cargo typically comprise the final claim in cargo disputes.

In the event of excessive self-heating with temperatures sometimes up to about 100°C, the quality is so degraded that a cargo cannot be used for the production of meal and oil for food consumption. Alternative end uses for a severely heat damaged cargo can however be sought, such as 'acid oil' for paints and varnishes, biofuel and fertilizer, in order to avoid destruction, and thus total loss.

The destruction of a cargo is always something to be avoided because handling and incineration of damaged soya beans typically incur in extra costs, with the final claim thus exceeding the total value of the cargo.



Severely Self-heated Soya Beans

II. Causes

Every soya bean is covered in dormant mould spores (storage fungi) that can begin to grow and subsequently deteriorate a cargo under certain environmental conditions.

The propensity of a soya bean cargo to spoil and the ensuing extent of deterioration are determined by the inherent properties of the cargo, such as moisture content, temperature and the duration of storage.

At sufficiently elevated moisture content and temperature, a cargo of soya beans is said to be 'microbiologically unstable' because it is prone to mould growth and thus self-heating. As mould grows, it forms long filaments that intertwine among the beans, resulting in the visible formation of cohesive and caked layers of cargo. Mould growth generates heat, which causes a cargo to increase in temperature and ultimately to deteriorate.

At a temperature of about 25°C, soya beans with a moisture content below 13% are generally regarded as safe for carriage but the risk of deterioration increases at moisture contents above this limit. Because of the heterogeneity of soya bean cargoes, moisture content values reported on cargo quality certificates at load ports are usually an average for the entire shipment, which means that portions of a cargo are loaded above the stated contractual value. Furthermore, the contractual limits for moisture content of South American soya beans (e.g. 14% maximum for Brazil and 13.5% maximum for Argentina) are often above the recommended value for safe storage. In other words, many cargoes may be loaded within sale contract specifications but still be microbiologically unstable, with therefore a significant risk of self-heating during an about 8-week sea voyage to China.

In addition to elevated moisture content and cargo temperatures, other parameters can affect the propensity of a soya bean cargo to self-heat, such as age, storage history, presence of foreign matter and pre-shipment conditions. Therefore, the rate of cargo spoilage can be accelerated by these additional parameters, even when a cargo is loaded at a relatively low moisture content and cargo temperature. Prolonged storage periods prior to loading can drastically reduce the safe storage life of a cargo, allowing moulds/fungi to grow, albeit slowly, during the storage period and then to accelerate their growth and proliferation when on board a vessel.

Ventilation

Soya beans are hygroscopic, meaning that they can absorb and give off water. During a voyage from a warm and humid port, a vessel can encounter cold climates and waters. In this instance, warm and humid air can rise from the bulk of a cargo, reaching the cooler steelwork of the hold. This moist air can then condense on the cooler underside of the hatch covers and coamings, subsequently dripping down on the cargo. The beans on the cargo surface will then absorb this liquid water, thus creating the suitable conditions for mould to grow rapidly and fruit, i.e. generation of spore-producing structures. This type of damage is referred to as ship's sweat and its associated damage presents itself as stripes of mouldy cargo on the surface of the cargo mirroring the underside of the vertical structures of the hatch covers and coamings.

The damage due to ship's sweat is minimal and affects only the uppermost surface of a cargo. On the other hand, the damage due to self-heating can extend throughout a hold, depending on the location of the more microbiologically unstable parcels of a cargo at loading. It is therefore straightforward in many cases to discriminate between the patterns of damage caused by self-heating and ship's sweat.

Natural ventilation conducted adequately on board a bulk carrier can help alleviate or prevent the damage associated with ship's sweat by replacing moist air in a hold headspace with drier air from outside. The ventilating air does not penetrate the bulk of a cargo but only affects its top surface. It should be noted that no amount of shipboard ventilation will prevent ship's sweat in cases of a considerably strong self-heating cargo.

In China, a lack of or inadequate ventilation regime is often alleged by cargo receivers as the major cause of cargo damage at outturn, although ventilation cannot control self-heating within a cargo hold.

Other alleged causes of damage

Another common allegation by claimants concerns heating of the cargo from fuel oil tanks (FOTs). However, this type of damage is localized only to the beans in close proximity to the steelwork adjacent to the heated FOT because soya beans are poor conductors of heat. This type of damage, therefore, does not extend to other beans located approximately a metre away from the heated FOT, depending upon the location of the FOT.

Cargo damage may also result from a leakage in the hatch cover seals. The ingressed water (seawater or rain water) descends vertically in the holds, and a portion of this water is then absorbed by the beans, causing mould growth and spoilage. The remaining ingressed water will continue to descend, forming a vertical column of wetted and caked cargo. Therefore, damaged portions of a cargo within the bulk of a hold due to self-heating cannot be ascribed to water ingress from a leakage in the hatch covers.

III. Precautions

During loading, a Master should ensure that the cargo reflects the description in the Bill of Lading and is only responsible for the readily apparent condition of a cargo, such as abnormal presence of blackened beans, mouldy beans and foreign matter. Soya beans at either 12% or 15% moisture content appear visually the same and only a laboratory test can determine the exact moisture content. Therefore, with the exception of obviously wet parcels of cargo, the control of the moisture content of a cargo is not a Master's duty during loading.

A long-standing issue in the trade of soya beans is the fact that quality certificates issued at loading ports do not relate to the quality of the beans but are only contractual specifications. Critical properties of a cargo, such as FFA and protein solubility, are not present in these certificates. Buyers are essentially interested in the water content of a cargo, because financially water is of no value for the end purposes of soya beans. This has caused and is still causing major issues at discharging ports because soya bean cargoes loaded within (contractual) specifications can still self-heat and spoil during a sea voyage for the reasons explained earlier.

Owners should not get involved in matters related to the quality of a cargo. If ship owners take samples during loading and then find that the loaded cargo is within contractual specifications, it will be difficult for owners to defend their position if the cargo self-heats during the voyage. As explained in the previous section, even cargoes loaded at relatively low moisture contents and temperatures can self-heat during a sea voyage because mould growth can be caused by other factors, such as age and storage history of a cargo. Therefore, the general advice is not to routinely take samples of a cargo during loading, unless something unusual is encountered.

The following actions can be taken by the vessel to care for the cargoes prior to and during the voyage:

- Prior to loading, ensure that the holds are clean and the hatch covers are weathertight.
- During loading, the crew should monitor the apparent condition of the cargo and cargo temperatures can be taken in several locations both during temporary interruptions and at the completion of loading. The vessel should refuse to load a soya bean cargo once indication of excessive temperature or visibly wet beans are found during loading operations.
- During the voyage, ventilation should be carried out day and night, whenever permitted by the weather, and in accordance to the 3-degrees rule, e.g. ventilate only when the outside air temperature is at least 3 degrees less than the cargo temperature, as measured during loading.
- During the voyage, the crew in the engine room should be made aware of the properties of the cargo in order to avoid overheating the fuel oil tanks in way of the cargo in the holds.

Sound Beans

Visibly Mouldy and Wetted Beans

Caked and Burned Beans

IV. Claim and Defence

In consideration of the attitude of courts in China and that soya beans are a valuable commodity, it is not rare to see receivers claiming against ship owners for cargo damages amounting to millions of USD. We hereby briefly introduce examples of typical claim and defence focusing on disputes of heat damaged soya beans in Chinese jurisdictions.

Claims

As mentioned above, CIQ may enforce to destroy a soya bean cargo through incineration or burial once the mouldy beans are more than 1%. In this scenario, cargo receivers will not only claim for the amount of total loss, but also the treatment, storage and transportation fees as well as other expenses related to a cargo's incineration/burial.

If cargo receivers take delivery of a damaged cargo, they may process it directly or by mixing it with sound cargo for oil and meal production. Under these circumstances, the main items of damage submitted by cargo sides are mainly the following:

- Yield loss of refined oil from the refining process of a heat damaged cargo, as a portion of the crude oil will be lost for instance during removal of FFA.

- Additional cost for crushing/refining a heat damaged cargo, such as extra clay, caustic soda, active carbon, phosphoric acid, electricity/steam, etc…
- In some cases, indirect loss with large claims due to the suspension of factory's production to wait for the arrival of sound soya beans from another vessel for blending with the damaged cargo; this additional financial loss and the resulting claim are typically justified as a necessary step for loss mitigation.

According to the Code of Maritime of China (CMC), generally the amount of indemnity for the loss of cargo shall be calculated on the basis of the CIF value of the lost cargo, while that for the damage to a cargo shall be calculated on the basis of the difference between the value of the cargo before and after the damage or on the basis of the expenses for the damage 'repair'. Moreover, the expenses reduced or avoided as result of the occurred loss or damage shall be deducted at the time of compensation.

Defence

According to CMC, ship owners shall exercise due diligence to make the ship seaworthy before and at the beginning of the voyage to properly and carefully load, handle, stow, carry, keep, care for and discharge the cargoes carried. Ship owners shall not be liable for cargo damage occurred during the period of carrier's responsibility arising or resulting from the nature or inherent vice of a cargo (such as self-heating of soya beans loaded at elevated moisture content and temperature). However, ship owners bear the burden to prove the same. To prepare for the defense against any potential claim of cargo heat damage, the following actions are suggested to be taken prior to and during the voyage:

- Keep the holds clean and the hatch covers to be weathertight in material time. All relevant certificates and documents should be carefully preserved.
- Prior to loading, obtain information/documents on the origin and storage history of the cargo to be loaded such as cargo quality certificate/test report/test standard at loading port. However, depending upon where the cargo is loaded, this information/documents can be often difficult to obtain.
- During loading, the crew should monitor the apparent condition of the cargo, stopping loading operations and notifying ship owners, the Club in the event that portions of a cargo are visibly different from the normal appearance of soya beans.
- During loading, the crew should take photographs of the cargo to obtain evidence of the cargo condition both during and at the completion of loading. The presence of dust during loading can often prevent the crew from taking photographs of the cargo, however it is advisable to take a photograph to prove the presence of excessive dust. Abnormal parcels of cargo could be loaded when the visibility is poor and a crew could then be accused for not noticing it, being a readily apparent condition of the loaded cargo.
- During loading, cargo temperatures can be taken in several locations both during temporary interruptions and at the completion of loading. The ship owners should be alerted if significant temperature variations and/or elevated temperatures are measured throughout loading because the hottest parcels are more prone to self-heating during a voyage.

- During the voyage, ventilation should be clearly and accurately recorded in the relevant logbook, along with instances and the associated reasons when ventilation was not conducted.
- During the voyage, the drain valves of the hatch covers should be checked for the presence of condensation, which is an indication that a cargo is undergoing self-heating. In this event, the presence of condensation should be noted down and reported to ship owners.
- During the voyage, the temperatures of fuel oil tanks adjacent to cargo holds should be recorded properly.
- During the voyage, record bilge soundings to check for the presence of water in the holds, which can be an indication of a leakage in the hatch covers or from an adjacent ballast tank.
- At the discharge port, take photographs of the cargo at the opening of the hatch covers to obtain evidence for the surface cargo condition at outturn.

Regardless of the above points, it is challenging to persuade Chinese courts to hold that heat damaged soya beans were caused by the inherent nature of the loaded cargo. Nevertheless, the dispute will continue even in case of defeat in China, ship owners could then claim against other concerned parties, such as Charterers, to recover the losses occurred. Therefore, it is very important for ship owners to take all the proper steps and precautions to avoid potential losses when carrying soya bean to China.

V. Additional precautionary measures

At the discharge port, in the event of a complaint, inform the P&I Club who may then consider appointing proper surveyors/lawyers/experts immediately. The team can assist with the assessment of the nature and extent of the damage and on how to mitigate the resulting loss and avoiding potential risks. Importantly, the team can also plan sampling operations of the cargo and assist with the subsequent laboratory tests to quantify the damage to the oil and protein fractions of the damaged cargo. These laboratory results and the expert's opinion on the causation of damage will be crucial for future disputes through lawyers in case of a claim.

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