An expert's view on the carriage of soya bean cargoes from Brazil to China

Soya beans are big business and Brazil has now become the world's leading producer, surpassing the United States. We looked to consultant scientist, Dr Stephanie Heard for insight into carriage of soya beans in bulk between Brazil and China and some of the problems that may be encountered due to moisture content at loading.

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Gard has seen many claims arising from soya bean cargos transported from Brazil to China for damage and alleged damage at discharge. The claims are made by receivers and/or cargo insurers under bills of lading against the vessel and often involve very large security demands. These claims are often passed to charterers, particularly when the Interclub agreement terms have been incorporated in the charterparty. We would like to understand more about the trade, the cause of the damage and some advice for mitigation of losses where damage is established.

Dr Heard, before we discuss the cause of the damage, can you provide some background about production of soya beans in Brazil?

The soya bean planting season begins as early as September in some of Brazil's central growing regions. Once the fields have flowered and set pods, growers will leave the plants to dry in the field. When 90 to 100% of the pods are brown in colour they are ready to be harvested. Most farmers aim to harvest soya beans with a moisture content of 13%; however, monitoring is usually assessed by pod colour which, as a subjective assessment, may not always be as accurate as using moisture meters. More sophisticated harvest operations use combine harvesters equipped with moisture meters which allow constant measuring of pod moisture content during harvest. If drying is required, it may occur either at the farm or at cooperatives where drying machinery is shared.

From the beginning of January, Brazilian growers start to harvest soya beans growing across an estimated 36.9 million hectares of land, a production area larger than Germany. Transporting the harvested beans from field to ports remains a challenge in Brazil where the transport and crop storage infrastructure has failed to keep pace with ever-increasing production. Soya beans are routed hundreds of kilometers from the Mato Grosso de Sol and Cerrado savanna to major export ports in Santos, Paranaguá and Rio Grande (see map below).

These days a larger proportion of soya beans originating from Mato Grosso and expanding growing regions in the North are trucked along the BR 163 highway to Amazon river port cities. There, the beans are loaded onto river barges which travel along the Amazon and Tapajós rivers in convoys to ocean ports in Santarem, Bacarena and São Luis.

All routes may take multiple weeks depending on availability of transport and weather conditions which severely affect the condition of the roads. The laden trucks and barges may be regularly exposed to heavy rain showers.

The United States has traditionally been the number one exporter of soya beans to China. What is the current situation given trade tension between the USA and China?

Brazil was the world's second largest producer of soya beans for many years, competing only with the US. The rivalry between US and Brazilian soya bean farmers has been driven by China's growing appetite for soya beans which are crushed to produce soya bean oil for cooking and soya bean meal to feed China's swine herd, which was 440 million strong in 2017. China imported just over 95 million tonnes of soya bean in 2017. It is estimated that the US supplied some 32.9 million tonnes of this trade, while Brazil supplied some 50.93 million tonnes.

As a result of the US-China trade war in 2018, when China imposed a retaliatory tariff on US soya beans, shipments from the US halved. During this time, Brazilian soya bean growing regions expanded further and exports increased in order to meet Chinese demand. An outbreak of African swine fever virus in August 2019 wiped out nearly half of the Chinese swine herd and resulted in reduced demand for soya bean meal in China. This was reflected in the Brazilian soya bean export figures. The trade has since started to recover and Chinese crushers are keen to make up the supply issues related to COVID-19 restrictions earlier this year.

As of May 2020, Brazil surpassed US soya bean annual production, harvesting an estimated 117 million tonnes. Brazil's soya bean exports this year to China have been described as a bonanza.

We understand that bulk soyabean cargoes can self-heat and in our cases the types of condition of some of these bulk cargos that we have seen on discharge include mould, caking and discoloration. Can you explain this process?

The cargo temperature and the availability of moisture within a soya bean cargo are the two key factors that determine whether mould growth can be supported in soya beans in bulk storage. Mould spores that are naturally present on the soya bean seed can germinate and grow when the relative humidity at the surface of the soya bean is above 65%. The relative humidity at the surface of the beans is determined by the soya bean moisture content and temperature. Once established, mould growth can cause the degradation of the bean through the breakdown of the soya bean and production of heat. This may further lead to the self-heating pockets of cargo within a bulk stow. Pockets of self-heating cargo tend to become caked and as heat progresses, over time, the soya beans may discolour from yellow to brown to black in the worst-case scenario. High temperatures may compromise the quality of the extracted oil and protein availability within soya bean meal products.

What can be done by producers to prevent deterioration and damage?

To minimise the risk of deterioration during a voyage, the moisture content of a soya bean cargo should be as close as reasonably possible to the safe transportable moisture content at the time of shipment. Nonetheless, a risk of deterioration persists since large consignments typically comprise smaller parcels of different inherent quality, specifically parcels with varying moisture contents and potentially different temperatures.

To evaluate whether soya beans will go mouldy during a long voyage, the moisture content and cargo temperature should be measured and reviewed for each lot prior to loading the trucks/ barges for transport to ports. The data obtained can then be reviewed against the ASAE Standard D245.6 (Oct 2007 Revised 2017) standard. This standard describes the Moisture Relationships of Plant-based Agricultural Products and can assist Shippers determine whether a parcel of cargo may be liable to mould growth and associated self-heating based on the temperature and moisture content. According to this standard, soya bean temperatures above 25°C combined with moisture contents over 13% may create conditions suitable for mould growth and indicate that the parcel of soya beans should probably be dried further. This is contrary to the moisture content specified on most commercial contracts which specify a moisture content of 14% which is much too high a tolerance for soya beans being shipped over long distances.

Since there is potential for change in temperature and moisture content during the transport and storage chain, the soya bean temperature and moisture data should be monitored throughout the inland transport chain by experienced cargo superintendents. The industry also needs to invest to improve current infrastructure and storage facilities at the export ports. Adequate drying facilities should be available at the export port to allow drying of cargo parcels suspected of having a high moisture content on any barges or trucksloads arriving at the port. Suspect cargo should be re-dried prior to storage in the export bulk warehouses/silos before final loading onto vessels. Alternatively, any lots of cargo suspected to be at risk should be redirected for shipping over a shorter distance rather than longer voyages to China.

Turning to the vessels chartered to carry soya beans from Brazil to China, is there anything for shipowners to do pre-loading?

From a shipowner's perspective, the vessel should be fully sea-worthy with well-maintained hatch covers. A hose test/ or ullaging test should be performed prior to loading to ensure the hatch covers are weatherproof and a record of the test must be retained. The holds should be clean and dry prior to loading and the bilges kept empty for the length of the voyage. Photographs of the loading operations and the cargo throughout loading obtained by the surveyor and the crew are an absolute must as these may provide invaluable evidence in the unfortunate event of a cargo claim.

Since P&I clubs insure cargo claims for both owners and charterers, is there anything clubs could do proactively to limit these types of claims?

If claims are high value and common, it might be prudent for the shipowners and their clubs to consider appointing experienced surveyors or cargo superintendent during loading. The superintendent can monitor trucloads/ barge loads of soya beans as they are loaded. This should ensure that obviously caked/ mouldy cargo is refused for loading. The superintendent should also monitor the cargo temperature and moisture content regularly. Temperature probes and moisture meters should be in good working order and regularly calibrated. If samples are to be obtained throughout loading, sampling should be performed in accordance with FOSFA sampling rules. This will ensure any samples collected are representative of the quantity sampled.

When there is a claim, we have found that many of the cases revolve around ventilation practices. Can you elaborate on ventilation and the affect that it has on the outcome of carriage?

There is the possibility that condensation will form on the underside of the hatch cover and drip onto the cargo surface resulting in mould growth on the surface during a voyage from Brazil to China. This is known as ship's sweat and occurs when the warm air rising from a warm cargo comes into contact with cooled steelwork. As the air is cooled upon contact, moisture condenses onto the steelwork. This typically occurs when vessels sail from warm to cooler climates, for example sailing around the Cape of Good Hope.

Crews are encouraged to practice ventilation in accordance with accepted industry methods. Proper ventilation aims to remove warm air within the head space to reduce the risk of ship's sweat formation.

The two ventilation methods commonly used are the Dew Point Rule and the Three Degree Rule. It is almost impossible to accurately measure the dew point within a hold headspace during a voyage. CWA therefore recommend that ventilation practice is performed in accordance with the Three Degree Rule. This involves ventilating the cargo holds when the ambient temperature is at least three degrees Celsius lower than the cargo temperature **at loading** when weather conditions permit.

This relies on the cargo temperature in each hold being obtained during or upon completion of loading and compared to the ambient dry temperature at every watch without the need to measure additional temperatures in the holds during the voyage. We recommend that multiple cargo temperatures are obtained during loading, particularly towards completion, in order to calculate the average cargo temperature per hold which can then be compared to the ambient dry temperature each watch.

This ventilation regime is easier and safer to carry out as no crew member is required to enter the hold. There is also less opportunity for error as dew point calculations are not required.

Ventilation may also be required at night when ambient temperatures are at their lowest. The likely changes in the ambient temperature during the voyage should be anticipated. The point when ambient temperatures are at their lowest in the voyage is when ventilation is most likely to be required, although the weather conditions may not be deemed suitable by the Master.

It is important to maintain detailed ventilation records which state when ventilation was undertaken and why. In the event that ventilation cannot be undertaken for any reason, i.e. poor weather conditions, this should be clearly noted in the ventilation records. Ventilation is incapable of preventing self-heating and does not reduce the temperature of the bulk cargo. By reducing the risk of Ship's sweat dripping onto the cargo surface, however, there is a reduced risk that mould will grow at the cargo surface.

What can be done to mitigate losses if some damage is seen when the hatches are opened?

In the event damage is observed on the cargo surface when the holds are initially opened, good quality photographs of the cargo surface for each hold must be obtained. Photographs should be obtained throughout discharge which details the pattern of damage and all photographs should have clear captions and time stamped.

Obvious mould damage at the cargo surface can usually be segregated either by hand or by grab. It is also essential for an experienced cargo superintendent/ surveyor to be appointed to obtain representative samples throughout discharge in accordance with FOSFA sampling rules. This will ensure that representative samples of the cargo can be obtained and analysed according to the appropriate standards in order to confirm whether the cargo quality has been compromised.

Excessive heat damage to the beans can cause a deterioration of the oil and protein content. This is not always the case and the extent of any damage can only be determined through the analysis of representative samples. In our experience, blending of caked/discoloured cargo with visually sound cargo is usual practice at most Chinese crushing plants. Usually, the refinery will calculate the appropriate blend ratio in order to create a blended crude oil and soya bean meal product of acceptable quality.

Thank you Dr Heard for sharing your considerable knowledge and experience.

For additional loss prevention advice see our Insight article - Heat Damage in Soya Bean Cargoes – the importance of Inspections

About our author: Dr Stephanie Heard joined the CWA Food and Agricultural Commodities Department as a consultant scientist in 2013 after completing a PhD in field and molecular plant pathology at Rothamsted Research. She has specific expertise in understanding the deterioration of crops, grains and feed ingredients as well as associated problems regarding mould growth and mycotoxin contamination. She is involved in the forensic investigation of damage causation and mitigation of claims made against agricultural commodities. She regularly attends on-site to undertake such investigation. Dr Heard provides advice for the care of agricultural cargoes during storage and carriage and has acted as an Expert Witness in Chinese court.

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