Sampling and testing for ocean-going vessels

By Tim Ellis

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In February, Richard Smith of CERTISPEC wrote about the scale, complexity and the high degree of accuracy required during commercial sampling and testing as a critical component in trade transactions. The commercial needs for sampling and testing have a high profile because they are the benchmarks for value and quality, critical in any commercial transaction where the buyer and seller may be unknown to one another and where very large volumes are involved. Less well known are the constant sampling and tests required for the conduct of trade in granulated bulk cargoes. Here, then, are two examples of the critical importance that sampling and testing play in the safe transport of dry bulk cargoes by sea. These are followed by some general comments about the scope of these tests in the carriage of other granulated bulk cargoes.

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Cement

Because storage facilities are often limited in capacity, cement is usually loaded "hot" from the kiln and loaded immediately after grinding at temperatures up to 100° Celsius, usually around 50° Celsius at the ship's side but dependent upon the conditions. The movement of the cement from silo to ship is usually by conveyor or screw to a loading spout into ship's holds, thus the cement is highly aerated by as much as 14 per cent by volume. Due to stress upon a ship's structure, each hold is only partially filled during the first pass and topped off in subsequent passes. This results in striations within holds when the surface layer of the cement first loaded cools and subsequent layers are still hot. These temperature differentials, coupled with the aeration, can lead to cargo movement resulting in extreme listing and even capsizing. Thus, it is important that cement be allowed to settle to four per cent aeration prior to sailing. This was graphically demonstrated whilst loading a cargo of valuable white cement aboard a handy-sized vessel in Arhus, Norway. After inspecting the angle of repose, the Master dismissed concerns about aeration and declined to postpone sailing and departed in sub-zero conditions in poor weather, only to return with a severe list under tug escort hours later to a protected anchorage for her to be lightered and trimmed. She was not permitted to return to her loading berth and had to be lightered initially using floating cranes and later, her own gear. Not all such departures end so well and an expensive lesson was learned.

Furthermore, there is a tendency to overprotect cement cargoes by sealing vents and other openings to make the holds airtight as a preventative measure to protect the cargo from wetting. This can lead to a dangerous vacuum as the cement cools, causing serious damage to hatch covers and the risk of injury to stevedores and crew when attempts are made to discharge the cargo. Injuries to two longshoremen in Rotterdam occurred when a ship's gear was used to lift and crew simultaneously tried to pry open hatches under a vacuum with catastrophic effects. In the Mississippi, after a voyage from Greece, the release of the vacuum using a barge mounted crane completely displaced the MacGregor hatches of No.1 hold, creating a situation where the hatches could not be closed in a region prone to unpredictable heavy showers and with only

Barges loaded from an ocean going vessel on the Mississippi with cement destined for the Great Lakes.

Loading cement at over 50° Celsius in Shanghai.

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limited discharge capacity available. Nor should the risks posed to the overheating of HFO 6, usually located under the after holds and behind the aftermost hold, and condensation and the subsequent hardening of cement "in place" be underestimated as both can lead to costly repairs and astronomical cleaning costs.

Processed ores, also known as ore concentrates

Bauxite and nickel ores, particularly from mines in SE Asia have been a source of grave concern for years even when as many as 10 ocean-going bulk carriers are believed lost at sea each year over each of the last 10 years due to cargo liquefaction, subsequent cargo movement and for other reasons still unknown. Formerly, these products were simply the raw material with the greatest ore concentrations from which the metals would be extracted at their destinations. However, by partially processing the ores to separate the tailings from the valuable ore in a liquefaction process using agitation together with chemical additives not unlike fracking, significant freight cost savings have been made possible. However, wave action, normal vibrations associated with the operation of a vessel at sea and the resulting abrupt re-liquefaction into slurry can result in cargo movement, capsize and loss of life and vessel. Of course, there are controls in place to detect unsafe levels of wetness which are based upon the Transportable Moisture Limit (TML) but these gauges of transportable risk appear to be less reliable when applied to these particular cargoes, or they may be ignored, doctored, or gambled on by the unscrupulous.

These two examples — cement and ores, one dry and the other wet and both inert — illustrate very well why sampling and testing is needed to determine whether or not and when a cargo is suitable for carriage and, just as importantly, the need for continuous monitoring of the cargo while at sea.

An example of the sampling and testing required for all granulated cargoes is the previously mentioned TML which is calculated by measuring the Flow Moisture Point (FML) — the point at which a granular bulk material becomes fluid. The Transportable Moisture Limit is typically set at 90 per cent of the FMP. In fact, almost all cargoes require disciplined sampling and testing while at sea. Some carry much greater risks, for example, coal cargoes which exhibit the same issues as bauxite and ore concentrates when the TML is exceeded. Worse, coal can self-ignite. Coal vessel operators constantly monitor for temperature, oxygen, methane, CO_2 and carbon monoxide levels as indicators of the condition of the cargo whilst in transit.

Direct Reduced Iron (DRI), another concentrate, is iron oxide reduced to metallic iron and is used to produce steel. It is highly porous and free of oxygen and is highly susceptible to rusting and re-oxidation when in contact with air and moisture. It is also pyrophoric — that is, prone to catch fire. There are a number of measures to reduce the risks associated with the carriage of DRI, such as reducing porosity and forming Hot Briquetted Iron (HBI), but the two primary risks associated with the carriage of this kind of reduced ore are exposure to oxygen and moisture or wetting. The former being a slow and progressive event leading to heating and combustion while the latter leads the release of hydrogen gas with violent and rapid results. When air and water are the culprits, one begins to understand the scope of the problems facing carriers and why sampling and testing may be the difference between a loss or a safe arrival in port.

If we were to list the commonly carried bulk cargoes, each one requires a different sampling and testing regime to assure its value and quality remains intact, preserves the condition of the carrying vessel and protects the crew from unnecessary risk. The steady rate of losses, although in decline when compared to the volume of shipments, is actually rising as the globalization of trade puts more and more ships at sea. Commercial pressures are overriding operational considerations by demanding itineraries which place scheduling ahead of safe working practices — sampling and testing is one major plank in ensuring the safe carriage of cargoes at sea.

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