Technical Notes
#36

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Vessel Loss Control

When the vessel loaded, the gauging reports showed ***x*** amount but when it arrived at its discharge port, why was the amount vastly different? In this issue of TECHTALK, we will discuss and outline some of the causes and contributing factors to vessel volume discrepancies. Although this is one of our lengthier issues, we hope you find it informative and helpful.

Vessel Measurements

When addressing suspected problems with vessel measurements, the following issues should be considered.

a) Use of non-calibrated measurement equipment.
b) Weather and sea conditions.
c) Capacity tables may have been incorrect (i.e. for a different gauge point).
d) Differences between manual and automatic tank gauges (ATG) measurements.
e) Trim, list and wedge corrections may not have been correctly applied.
f) Gauge height adjustments to allow for retrofitted equipment such as vapor control valves and close system fittings may not have been correctly applied.
g) Different gauge points may have been used for measurements.
h) Unslotted standpipes may have been used for measurements.
i) Vessel line fill condition may have been different at load and discharge port.
j) Clingage, sludge, sediment and unmeasured Retains On board (ROB) and On Board Quantity (OBQ) may have been present.
k) Vessel line capacities may not have been correctly accounted for.
l) Insufficient number of temperature readings may have been taken for stratified or heated cargo tanks.

Vessel capacity tables – Vessel capacity tables should be specific to the vessel and carry the date together with notes and corrections for any structural changes, particularly modifications to standpipes and vapor control valve fittings.
Calculations should be checked to verify that trim and list corrections have been applied correctly, as this can have a significant impact on the measured quantities. Ideally a vessel should complete loading as close to even keel and upright as possible to reduce errors in gauging.

Transit differences – Transit differences are normal to most marine movements and result from either a physical gain or loss during the voyage or discrepancies in measurements. Measurement differences may be due to the use of different measurement equipment used at load and/or discharge ports. This can include inspector equipment, vessel equipment and vessels ATG's.

A comparison of the vessel's departure Total Calculated Volume (TCV) and its arrival TCV will give an indication of transit cargo variation. The measurements which make up the TCV (Gross Standard Volume and Free Water) should be reviewed individually.

A transit gain may be due to:

a) Material pumped from engine room bilges into slop tanks.
b) Heating coils leaking into cargo tanks
c) Displacement into cargo tanks of other materials, which were received/discharged between the time when cargo load and discharge measurements are made, e.g., bunkers, slops, and other parcels.
d) Introduction of water to cargo tanks.
e) Measurement inaccuracy due to vessel motion and/or equipment limitations.

If a vessel shows more cargo on arrival at the discharge port than was reported on departure from load port, the cargo volumes and measurements should be carefully reviewed and analyzed.

A transit loss may be due to:

a) Vapor losses.
b) Leaks.
    1) External-cargo that escapes from vessel tank to the sea.
    2) Internal-cargo that escapes to other cargo tanks or into voids, cofferdams, slop tanks, ballast tanks, or other non-designated areas but is not discovered.
c) Unreported cargo diversion, or cargo burned as fuel.
d) Transfer or decanting of free water from slop or dirty ballast tanks during voyage.

Caution should be exercised when recording transit variations since such variances may or may not have any bearing on the overall gain or loss.

Examples:

a) A large transit loss, with no corresponding difference between VEF adjusted vessel volumes versus outturn at discharge, might indicate a physical loss during the voyage.
b) A large transit gain, with a large vessel/shore difference at the load port and minimal differences noted at discharge, might indicate vessel measurement errors caused by gauging in rolling seas, the use of different calibration tables at each port, or a change in the reference gauge point.
c) Evaporative losses.

Change in Cargo Stowage:

Stowage refers to the arrangement of cargo in the vessel. Changes in stowage should be investigated. Some examples are:

a) Request from charterers for blending of cargo en-route or heating and/or circulation of cargoes between two or more tanks.
b) Need to alter the vessel's trim for stability/performance or to facilitate load/discharge.

Cargo diversion:

Any unauthorized diversion of cargo must be fully investigated and reported.
Bunker survey reports and receipts should be obtained where appropriate.

On Board Quantity (OBQ) and Retains On Board (ROB):
A difference in OBQ and ROB quantities may be expected as a result of unmeasured ROB or Clingage which may later settle to the bottom of the tanks and then become measureable as OBQ for the next voyage. ROB clingage which does not settle can result in shore to ship cargo gains at next load port. The practice of loading on top of retained oily residues (slops) and the implementation of enhanced cargo recovery techniques, such as crude oil washing (COW), have a marked effect on the differences in these volumes.

Typical ROB quantities have been considerably reduced since the introduction of double hulled vessels. Large quantities of cargo remaining in the tanks may suggest poor procedure or problems with vessel's equipment.

Liquid calculations should be checked to ensure that the wedge formula has been applied correctly where appropriate.

While measured ROB does not represent a measurement loss it may be a real loss to the receiving terminal. High ROB (measured and unmeasured) can be due to inadequate heating on the vessel, possibly coupled with low temperature at discharge.

If cargo heating has been specified and a problem is suspected, heating records should be obtained from the vessel. These should indicate whether charter party requirements have been followed.
If the cargo has not been correctly heated, wax may be deposited on the tank floor and sides, increasing measured and unmeasured ROB. Heated cargoes can suffer from high ROB if the cargo has not been discharged quickly once below the level of heating coils.

Excess ROB in one tank may indicate the stripping was to slow or that stoppages have occurred, allowing heavy cargo to begin to solidify. Time logs and any Letters of Protest should be reviewed.

The physical characteristics of the product and the ability of the vessel to pump it are factors affecting ROB. Problems can result from cargo vaporizing in the pumps (air lock) and loss of suction during final stripping. Trim and/or list may prevent the free flow of product to the suction point.

Undetected ROB:
Undetected ROB is the result of cargo that remains clinging to the bulkheads (Clingage) or in unmeasurable areas of vessel compartments.

Clingage varies depending on the physical characteristics of the cargo and the conditions under which the discharge is performed. It also can vary depending upon the type of vessel, the number of tanks, and tank condition. Any quantification of loss due to Clingage can only be a subjective determination, but it is an identifiable reason for cargo loss.

While Clingage cannot be measured for the voyage in question, it may be estimated for similar cargo type and voyage conditions by using one of two methods.

a) ROB versus subsequent voyage OBQ (excluding water introduced in cargo/slop tanks for tank washing on ballast voyage).
b) Load on top monitoring report calculation.

Note: *Clingage may be recoverable through COW or tank cleaning on a subsequent voyage.*

Crude Oil Washing:
Crude oil washing (COW) operations can reduce the cargo volumes retained on board after discharge. Although COW is a useful technique to improve cargo discharge, its effectiveness is dependent on many factors including the nature of the cargo, the efficiency of equipment, the number of tanks being washed, and the ambient air and sea temperatures during discharge.

A thorough COW may reduce ROB to less than the OBQ. However, COW may cause additional cargo losses with volatile cargoes due to the vapor generated. In cold weather, use of high pour or viscous cargoes for COW may increase rather than decrease clingage.

A flushing medium may be employed to COW a vessel's tanks or to displace a previously discharged cargo in the shore line. The medium, typically a light oil, is loaded aboard the vessel and stowed in a suitable tank for the intended purpose. The vessel should be gauged before and after the flushing medium is transferred to the vessel. The quantity received by the vessel (TCV) should be compared to the volume from the shore tank or meter and must be correctly accounted for to properly reconcile quantities. Any flushing medium remaining on the vessel after discharge should be accounted for as ROB.

Slops:
Slops are a readily identifiable source of gain/losses in cargo outturns when compared with Bill of Lading volumes and should be taken into consideration in the reconciliation. Slops discharged with the cargo may have been either commingled with the cargo (loaded on top) or segregated from the cargo in a separate tank.

Water Determination:
Free water – Sales are based on Gross Standard Volume (GSV) or Net Standard Volume (NSV) and therefore accurate water measurements are critical.

When investigating possible losses, a water balance should be carried out between each measurement point. In cases where large amounts of water are found, analysis may determine the source of the water. Care should be taken that all aspects are checked as there is often confusion between fresh ballast water and formation water. Now that segregated ballast is almost universal, ballast water should not normally be found in cargo tanks.

Differences in the free water (FW) quantity could be due to the following.

a) Introduction of water into the cargo from vessel pipelines, inert gas system, cargo heating system, loading/discharge lines (particularly under sea lines or floating hoses), or shore lines during the loading or discharge operations. Water in the shore line between an automatic sampler and the vessel on loading may not have been accounted for.
b) Mixing of FW with cargo as it is pumped. This will reduce the FW volume while increasing the S&W volume.
c) Settling out of S&W which will increase the FW content at the discharge port, compared to the load port.
d) Insufficient time allowed for water to settle.
e) Different measurement methods, e.g. separate S&W and FW measurements versus total S&W of homogenized samples from an in-line sampler.
f) Different methods of detecting FW, e.g. water paste versus electronic interface detector, especially for crude oils containing emulsified water. Use of different or improper water paste.
g) FW volumes on the vessel not properly corrected for wedge or trim conditions.

h) Different sea conditions when measuring the FW on the vessel at the load port and discharge port, e.g. rough seas versus calm seas.
i) Changes in trim and/or list from loading port to discharge port. Depending on gauge point locations a wedge of FW may not be detected under certain conditions.
j) Tank bottom deformation or sediment in tanks affecting FW measurements.
k) The datum plate height above the tank bottom preventing measurement of water below the datum plate. This is a particular problem with cone bottom tanks where gauging points are typically offset to one side of the tank.
l) Shut down or malfunction of the automatic sampler during a part of the loading or discharge or improper cleaning and operation.
m) Ballast water entering the vessel's cargo tanks or lines.

Sediment and Water (S&W):
A difference between reported S&W at load port and discharge port will give a shore to shore NSV gain or loss, unless this is associated with a similar change in FW.

Inconsistent S&W results can occur for any of the following reasons.

a) The non-homogeneity of product may result in samples that contain more or less water than the whole cargo.

TANKER VOID SPACES

Tankers have many non-cargo compartments that are part of the integral structure of the vessel, these are more commonly known as void spaces and can be summarized as follows. Should a large variance occur between vessel and shore figures, one of the factors to consider is the possibility of cargo finding its way to the void spaces. Only by gauging and, if necessary, sampling the void spaces can this possibility be eliminated?

- **Permanent Ballast**

These are the biggest void spaces on the ship. They form the main barrier (double skin) between the cargo tanks and the surrounding sea. Ballast tanks are normally empty when a ship has full cargo onboard and are normally full of water after all cargo has been discharged. Their main function is to keep the propeller submerged and maintain positive stability.

- **Cofferdams**

These are permanent void barrier tanks between the cargo tanks and the forward and aft machinery spaces. Their primary function is to act as a barrier should the forward and aft most cargo tank bulkheads crack or break down.

- **Forward and after peak tanks**

These two permanent ballast tanks are located at the extreme forward and after ends of the vessel. Their main function is for "trimming" the vessel either to even keel or to the desired sailing trim. As the vessel burns fuel on the voyage the trim will change depending on where the fuel was stored, this can be effectively countered by ballasting the peak tanks.

AmSpec inspectors are trained to detect all scenarios listed in this document. Our coordinators, laboratory and technical support personnel are ready to serve you to account for all barrels from load to discharge.