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Fuel Oil (Bunker) Sampling
Break the link between politics and quality

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Summary

The objective of sampling is to determine, to the highest degree of accuracy possible, the properties of the fluid sampled. This proves beneficial to all parties as it can, if properly executed, ensure fair transactions. As the value of product increases or, as in the case of fuel oil, the potential for claims increase, it is necessary to assure all parties of the properties of the transaction both at the time of sale and in case of dispute later. In reading bunker related press it also becomes obvious that aside of the issue of a "fair deal" assurance of quality can have significant impact on the prevention of engine failure and the consequent disasters and claims than ensue.

PSA and DNV have both made serious attempts to assure certain sampling procedures but it is the belief of the author that these are not yet enough. This paper is to outline the basis on which an accurate sample should be taken, sampling techniques which if used will serve to both improve the overall quality of the trade and to determine unintended quality problems which need resolution.

Introduction

In the crude oil trading business, the sampling techniques have been enhanced over many years. A quantum shift in approach was made after the 1974 oil crisis and the overall standards brought up to what was then technically possible. In the light of experience gained over the last 10-15 years these standards are under review and enhancement. It is a shame therefore that the bunkers trade has yet to adopt a standard on which it can base its transactions.

In the last year an ISO committee was formed which amongst other things was charged with bringing sampling "up to date". This committee appears to date to have seconded the sampling responsibility to the experience of the IP 6.2 sampling committee with which I am involved.

Standards

It has been widely accepted that "spot sampling" i.e. the action of withdrawing a small volume of sample at a single point during the transfer does not yield an accurate result, therefore small samples should be taken throughout, in preference automatically. A long term comparison, over 40,000 tonnes of spot sampling vs. a latest technology automatic sampler, showed the average density loss between the spot and automatic sample was 0.1 % or approximately $2,800 and the viscosity varied from and average offset of 40cS to a worst case where the spot viscosity was 25cS and the automatic was 200cS. This serves to highlight the inadequacy of spot sampling and that in some cases, particularly with blended fuel, the potential for layering in the manifold or tanks.

What standards should be used? At this point the only generally applicable standards are those used for the "Automatic sampling of petroleum and petroleum products" i.e. the API 8.2, ISO 3171 and the IP 6.2. These are generally applied to crude oil and some other hydrocarbons. It is valid to consider their use for the bunkering business.

Crude oil has been hovering at about $15/bbl for some while which broadly relates to around $115/tonne. This relates to bunkers which stands at around $70/tonne currently, the trade value of the commodity is broadly of the same order. The running costs of vessels indicate that almost 50% of cost is based on fuel, therefore an incremental gain in fuel costs can make a substantial improvement to profitability. An average fleet of 15 ships will use about $6m of fuel annually, each 0.1% fuel gain is therefore $6,000.

The incentive to determine and to trade bunkers accurately should be in no doubt. From a buyers perspective, knowledge of true value should be a point of barter i.e. paid for basis a "received" quality. From the sellers perspective an accurate

determination should eliminate the price compensation/ premiums that such documents as the "white" list suggest the buyer use to adjust the price. In short accurate sampling is good for all parties. How then can this be achieved? If the business adopts the philosophy of the crude trader: If you are writing the ticket on the basis of the quality assessed at point of transfer, then the sampling system should attempt to determine the quality within the measurement repeatability of the tests performed on the samples.

Can this be achieved?

Experience in the manufacture of crude oil sampling systems for over 20 years has shown that if the designer takes sufficient care, accurate sampling is quite attainable. So why not do it ?

The short answer is that no one wants to, excuse the pun, "rock the boat". The sampling techniques offered to date are not complicit with good practice but they are certainly better than no sample at all and this is perhaps a key point in the discussion. What is needed is an approach where the sampling methodology used is beyond question and to achieve this perhaps the bunkers trade should adopt the approach of the ISO sampling committee and segregate the problems into areas aligned to the achievement of good physical sampling. The principal problems as addressed in the crude sampling business can be best summarised as follows :

> Pipeline conditioning
>
> Representative sampling of the batch
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> Sample handling and mixing
>
> Laboratory analysis

Everyone involved with the trade should strongly consider these points as applied to the bunkers business, given that the oil is often viscous, waxy and the sampling process takes place in less than ideal conditions. What do they mean?

Pipeline conditioning

This means that since the sample is taken from a point on the cross section of the pipe, this point should yield the same analysis as any other point. This should not be confused with longitudinal or time based property variance that is often misquoted as homogeneity. Unless the fuel is fully blended and agitation is maintained, there will be time based variance in quality.
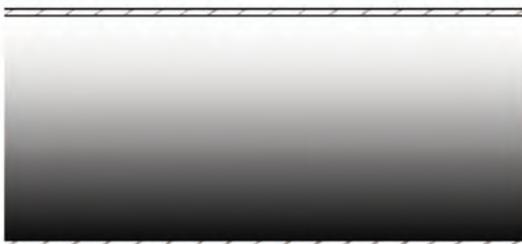

People at conferences frequently state that the oil in the manifold is layered. In reality the pipeline condition will be a function of many things : The specific gravity, viscosity, flowrate and the interfacial tension, not to mention the influence of anything that causes turbulence i.e. adds energy such as pipeline expansions or reductions, pumps, elbows etc.

The ISO 3171 provides a methodology to estimate the dispersion quality at the sample point and the figure below shows a plot in a 10" pipe of a 380 fuel oil. This does not take in any potential mixing and shows that water would mix into the oil in 10 diameters of straight pipe above about 50m3/hr. So how bad can layering be?
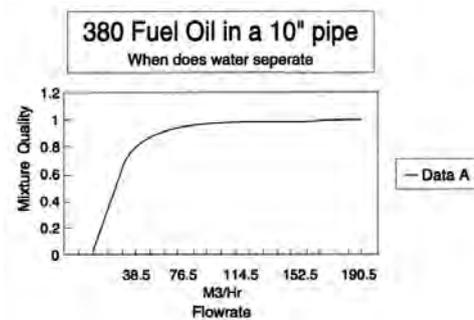
The problem is likely to be worse with the lower rather than higher viscosity grades. The same chart drawn with diesel shows a somewhat different story.
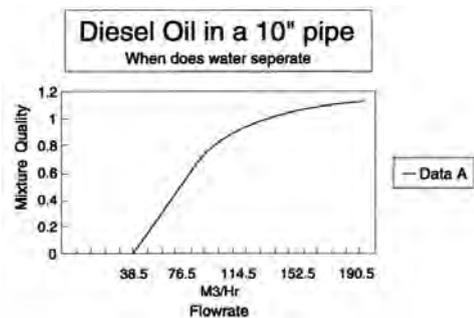
But of course no one ships water or chemicals so this mixing problem doesn't really exist, or does it?

Representative sampling of the batch

What this in effect means is that volume for volume the samples taken should represent what went past the sampling system i.e. flow proportional sampling. It is a simple fact that proportionately, more water will be at the bottom of an unmixed hydrocarbon filled tank than elsewhere, just where the pump suction is. But of course if you make the link to the fact that at the start of the load operation the flowrate is initially low, most of water will come off early. So if the sampling system is not flow proportional then this early part of the discharge may not correctly be represented in the overall analysis. Likewise if the sampling technique used takes more sample at high flowrate, higher manifold pressures or varies with viscosity similar errors can occur.

Sample handling and mixing

Sampling should be addressed from both ends of the problem, but a good starting point is "How much sample do we need?"

There are several elements to this question - what is required for analysis, by whom and what is to be retained in case of dispute. All inspection companies are in the habit of retaining samples for analysis in the case of dispute and I am

frequently advised that storage and disposal costs are significant, so the samples taken should be as small as practically acceptable without reducing representivity. It has been typically suggested that three samples be taken :- ship, shore and retention and that each, depending on who you talk to, should be either a litre or more. If three samples must be taken provided from a single volume taken, how do they get to be divided ? The problem with dividing samples is that fuel oil, water and some chemicals do not readily mix, this means therefore that given a can with 3 litres in it, shake it and pour it into three separate 1 litre cans and the analysis on the three will often be different.

Hand mixing of hydrocarbon samples has been proven time and again to be inadequate particularly for water determination. This is considered so important to general refinery/pipeline operation that recently the API drafted a whole new standard dedicated to sample handling titled the API 8.3. "Standard practice for mixing and handling of liquid samples of petroleum and petroleum products". Considerable emphasis is placed on container types and handling procedure in this draft standard and it states under Table 1. That for "crude oil and heavy fuels samples must be power mixed for density, sediment and water determination."

So coming back to the question - how do we get three identical samples?

The answer is either to ensure that the total sample is adequately mixed before division by say using a shear mixer or as an alternate maintain complete segregation of the sample throughout the process.

Addressing this from a practical standpoint, no-one is equipped to mix or handle samples onboard a barge or ship, therefore the selection must be for a completely segregated sampling technique.

Staying on the same subject of sample handling, the API also clearly outlines container materials, designs etc. that are suitable for analysis of certain properties. Open containers do not qualify, indeed exposure of the sample to air for any but the shortest time periods should be avoided. Another point of interest is that tin cans are stated to be unacceptable for sulphur determination.

How then does the image of the "watering can" collected sample fit it as a handling methodology - I would say it depends on whether it is hot, cold, sunny or rainy and of course whether you are the buyer or the seller! The final step in good sampling practice is of course to ensure the laboratory analysis and in this area the trade is fortunate to have a number of well established inspection companies such as Saybolt, Caleb Brett, SGS etc. all of whom have laboratories running to accredited standards. This paper therefore does not concern itself with the laboratory handling or the analysis.

Practical considerations

So much for the physical "needs", but in selection of suitable sampling equipment the practical "needs" should also be considered. Bunker fuel oil is an obnoxious fluid, often highly viscous it can even turn solid at low temperatures. Pipeline pressures at the sampling point can vary from almost negative at the ships manifold to 10 bar at the (barge) source manifold. Irrespective of politics, (or the ISO 8217) the barge manifold is a much better position to sample for most types of samplers. Again reverting to the ISO 3171 and normal crude oil sampling practice, although generally the point of custody transfer is accepted as the ships manifold, in reality practicality is the order of the day and the samplers are located in the best position to allow them to perform to the highest degree of accuracy.

Depending on the location and the need for portability, the equipment should be easy to move and install safely. Vessels rarely have excess manpower, therefore samples that require ongoing attention, or any skill to adjust, i.e. are manpower intensive, should be avoided. The equipment should provide some element of performance checking so that independent inspectors may verify correct operation.

In short, the above "needs" point to equipment that demands little maintenance, is highly reliable, simple to operate, needs little attention and is hard to tamper with. But these "needs" must be matched to accurate sampling procedures and the ability to fulfil the requirements for accurate sampling. A failure to match any one of the criteria will lead to invalidation of the overall sample accuracy.

Equipment available

There are two principal in-line sampling methods currently available: those that rely on pipeline pressure to assist in taking sample grabs (passive samplers) and those that do not (active samplers).

Pipeline pressure assisted samplers (passive)

Passive samplers use the difference in pressure between the pipe and the receiver to extract a sample, this means that if the pressure in the pipe is low and/or the fluid is viscous (i.e. because of low temperature) the sample volume will be reduced. This makes any device of this type extremely sensitive to both viscosity and pressure.

Force pressurised samplers (active)

An active sampler works independently of pipeline pressure and uses positive displacement technology to eject the sample. This type of sampler is insensitive to receiver pressure, viscosity or pipeline pressure and generates outlet pressures up to 100bar (1500psi) against a blocked outlet.

Flow proportionality

It is a requirement that the sample be drawn flow proportionally as discussed above. The only way to do this is to ensure that some method exists to measure the pipeline flowrate, either by velocity or other means.

Flow proportionalsamplers have been available in the fuel oil bunkers market for several years, The "Sample-Tec" has an impeller driving a valve which opens to draw a sample to each of three sample receivers sequentially. The technique suffers from being a passive rather than active technique which can result in reduced or no sample being taken if the manifold pressure is low or if the outlet is blocked.
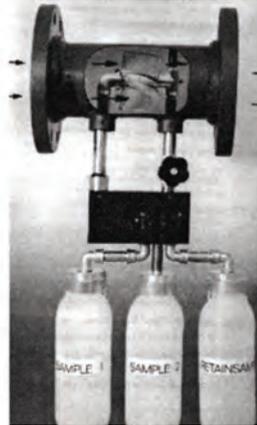
A less expensive and more recent method has been the so called "drip sampler". This relies on the manifold pressure for sample extraction, to imply the flowrate in the pipe, and thus provide the flow proportionality. This is not flow proportional and to claim so is an engineering fallacy.
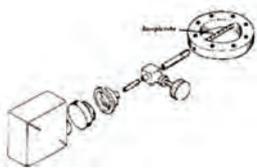
i) The sampling drip rate will vary with manifold pressure.

ii) The sampling rate must be adjusted vessel by vessel, i.e. operator intervention.

iii) A single batch sample is provided which must be mixed and divided later for the three samples required.

A recent design to appear is the "AQL" which was developed from the fiscal crude oil sampling market. The AQL represents an approach designed with the full set of "needs" in mind and against the basis of the established crude sampling standards and techniques. The device uses a force/pressurised technique (active) which ensures that it will work in extremely low manifold pressures and generate
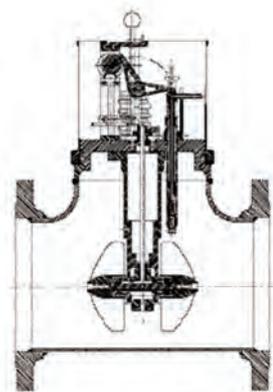
very high outlet pressures. This makes the sample volume taken constant (fully representative) irrespective of viscosity, wax or line pressure conditions.

The AQL has three fully independent samplers which are driven using a pair of impellers in the flow stream providing proportionality over a wide range of operating conditions. A simple gearbox allows selection of the sampling rate and may be secured against tampering prior to start-up. The AQL is provided for a wide range of applications and is fitted by means of a quick coupling in a "T" piece at the ship's or barge's manifold. The use of a quick coupling allows the AQL to be easily transported and fitted in a variety of locations. The sample is collected in three identical receivers that are secured against tampering during operation and have tamperproof packaging in which they may be sealed for storage or onward transportation.

A sample counter is also provided for verification of the number of samples grabs taken and can also be used for a check both of the volume per sample grab and of the overall batch validity. How does available sampling technology match these criteria?

Pipeline condition

Pipeline condition is largely beyond the control of a sampler, but sampling techniques using an impeller in the flow that will naturally promote turbulence with the sampling point downstream in a turbulent zone can only be beneficial, provided that the sample is trapped in the turbulent zone.

Representative sampling of the batch

Only devices with a real means of flow measurement can be representative, and only those that do not rely on pipeline pressure to take the sample can be fully independent of pressure and viscosity influence.

Sample handling and mixing

Only samplers that have a closed receiver system and where no local division of sample is made can meet this criteria and in general it is also true that the segregation of sample should be complete. i.e. from the sample point onward.

Conclusion

Technology to permit accurate, reliable and representative bunker fuel oil sampling does now exist and in the event that the buyer needs to resort to litigation to settle a claim, it is imperative that the overall quality of your sampling technique and analysis is above dispute. Whatever sampling methodology you select ensure minimal intervention (adjustment), closed receivers suitable to the task and make it tamperproof. Adoption of, or enhancements to the standards used for crude oil sampling and sampling handling would be a small step towards correct and supportable procedures.

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