VERITAS PETROLEUM SERVICES

INSTRUCTION MANUAL (POWER PLANTS)

FUEL QUALITY TESTING

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Sample for Supplier

Since it is not a common practice for power plant fuel suppliers to provide or draw a sample, we suggest that you ask the supplier's representative to witness and sign the label of the power plant's retained sample which may be a useful evidence in the event of a quantity or quality dispute at a later stage.

Fuel System Check (FSC) Sample

The purpose of the VPS Fuel System Check Programme (see page 7) is to utilise sample analysis for monitoring the condition of the fuel oil system and the effectiveness of the fuel oil treatment plant. Essentially, the plant staff draws samples periodically, if operational problems are experienced or as triggered by the VPS fuel oil analysis reports in connection with poor quality fuel deliveries. The samples are then analysed and the results assessed and reported by VPS.

Procedures for Sampling

The importance of proper sampling cannot be over-emphasised, as the analysis results will be only as good as the sample that you have submitted.

Please ensure that your staff is fully conversant with both the sampling procedure recommended in this instruction manual and your company's fuel management practices.

In order to obtain a representative sample of the fuel delivered to the plant, the sample has to be drawn continuously throughout the entire delivery process. To achieve this, VPS strongly recommends that you use a VPS continuous drip line sampler, together with clean VPS cubitainers.

The flow control valves of the VPS line sampler as shown below can be sealed to prevent tampering during the sampling operation.

Sampling Device

Please ensure that your plant has a proper sampling device at the plant's receiving manifold. Your sampling device and collection container must also be clean and ready for use.

As a routine, clean the sampling device immediately after every delivery to minimise the possibility of contamination by remaining fuel oil or cleaning solvents.

If your plant is not fitted with a proper sampling device, you will not be able to take a representative sample. We therefore strongly recommend that you place an order for a VPS Line Sampler.

Power Plant Kit

Each VPS Power Plant kit contains:

- Sampling bottles with caps
- UN certified shipping cartons
- Security seals
- Ziplock bags
- Labels for Sample Bottles
- "For receipt only - source unknown" stamp
- "For volume and temperature only" stamp
- One Instruction Manual, containing:

- FQT Instruction Manual
- Air Courier Directory
- Request to Witness Sampling Form
- Power Plant Report Form
- Standard Pro Forma Invoice
- Preprinted Air Way Bill
- Return Address Labels for sending fuel samples to the appropriate VPS laboratory

Request to Witness Sampling Form

Invite the supplier's representative to witness the sampling procedures. Complete a 'Request to Witness Sampling' form and ensure that it is signed by both parties. Give the original copy to the supplier's representative. Retain the blue copy for your file.

If the supplier declines to attend the witnessing of sampling, you must note this in the plant's log-book there and then. Such a record can serve as contemporaneous evidence should a fuel quality dispute later arise.

Please make sure that full information about the delivery method, delivery personnel, supplier, time, date and circumstances etc, is recorded.

Continuous Drip Sampling

Take a continuous drip sample by using the VPS Line Sampler. Adjust the needle valve to give a slow continuous drip throughout the whole delivery period. Seal the needle valve with the security seal provided. Record the seal number to prevent any tampering.

Collect approximately 5 litres of sample in the cubitainer. Both 5-litre and 10-litre cubitainers are supplied by VPS. If 5-litre cubitainers are used, precautions should be taken to prevent over-filling.

Check that there is sufficient fuel sample in the cubitainer by the end of the fueling. If you need to break the seal on the needle valve to make adjustments, you should invite the fuel delivery personnel or his representative to be present when you adjust the drip and replace the security seal. Keep proper records in the plant's log if the invitation has been declined and also when such adjustments took place.

Dividing the Sample Evenly

Cap the cubitainer and shake the contents vigorously for about 10 minutes to mix the sample thoroughly. If fueling in cold climates ensure that the sample collected in the cubitainer is warm enough to allow for shaking.

Fill two (2) sample bottles 1/3 at a time. Make several passes to fill up the bottles equally, capping and re-shaking the cubitainer before each filling. This is to ensure that the sample is evenly distributed and that the contents in each bottle is representative.

One sample should be sent to the VPS lab for testing and a second sample retained at the power plant. In some cases, other parties may require samples for testing and therefore additional samples should be taken as required.

Fill the bottles up to the 'FILL TO THIS LINE' mark. Stop at the line as shown in the diagram on the right.

Sealing the Bottles

- Close the bottles tightly using the screw caps provided.
- Seal all the bottles and record all seal numbers on the Power Plant Report form. It is important also to record this information in the power plant's fuel book. In addition, we advise that you ask supplier to record all sample seal numbers in the BDN for cross-reference purposes.
- Complete two fuel quality testing sample bottle labels.
  Sign these labels in the presence of, and jointly with, the supplier's representative.
- Do not sign any blank labels for the delivery personnel under any circumstances.
- Fix a label on each bottle.

Caution: If you are offered a sample by the delivery personnel and have not witnessed correct sampling procedures pertaining to this sample, please use the rubber stamp provided in the kit to indicate "For Receipt Only, Source Unknown" on the sample bottle.

- Put the bottle of sample to be sent for testing into the Ziplock bag to prevent any spillage.
  Gently squeeze the bag to minimize air content prior to sealing.
- The sample will be sent to the appropriate VPS Laboratory via air courier when the correct colour label is used.
  Refer to the Air Courier Directory to find out which labels to use.

Power Plant's Retained Sample

It is very important to retain one bottle of sample in a secure location as in most cases this may be the only sample left which represents the fuel delivered to your power plant. If this sample is eventually sent for testing, all parties involved or their representatives must be present to witness the breaking of the seals and the testing process, if required.

Dispatching the Sample to the VPS laboratory

Place the bottle with the Ziplock bag inside the UN certified box and fold the box as per Assembly Instructions given on the box.

Enclose the Power Plant Report form and a copy of the Bunker Delivery Note [if available] before closing the last flap on the UN certified carton. It is very IMPORTANT that the Power Plant Report Form be fully completed and sent in with the fuel sample.

Using Correct Colour Labels

Refer to the VPS Air Courier Directory and use the appropriate label for the forwarding box to ensure that the sample is sent to the appropriate VPS laboratory.

Plant Manager's Instructions

Complete the courier dispatch instruction on the side of the forwarding box as indicated in the Air Courier Directory. Any package forwarded by a courier company must be accompanied by an Airway Bill. Preprinted Airway Bills complete with the VPS Universal Account Number are included in this manual.

It is important that the supplied pre-printed Proforma Invoice and Airway Bill stating the Bunker Oil Sample as "Non-Restricted" are used.

Call the air courier company directly at the number indicated in the Air Courier Directory, and request URGENT pickup.

Safety Considerations During Sampling

The following safety precautions should be taken during any sampling:

- Protective equipment to be worn by personnel involved in the sampling
- H_2S detection should be carried out periodically
- Spill prevention procedures should be adhered to
- Spill containment equipment should be available at the delivery manifold
- Local regulations regarding the entry and equipment used in hazardous areas should be strictly observed.
- Smoking and naked lights should be prohibited in the vicinity of potential oil vapor sources.

General Guidelines

The Bunker Delivery Note (BDN)

It is usual for the supplier or his representative to provide the plant manager with a BDN, which should include the following details:

- Name of receiving power plant
- Delivery location
- Date of commencement of delivery
- Name, address and telephone number of fuel oil supplier
- Product name (grade)
- Quantity (metric tons/ volume)
- Density at 15°C (kg/m^3)
- Sulphur content (% m/m)

We strongly recommend that you do not sign the BDN or any sample labels from the supplier before the delivery is completed.

Volume Deliveries

Normally, the terms and conditions of sale state that the quantity of fuel delivered will be determined by meters or measurement of barge / tanker / truck outturn.

In either case, the plant engineer or representative should witness opening meter readings or barge/truck soundings and temperature. On completion of the delivery, the plant representative should also determine the 'actual' volume delivered. The volume recorded on the BDN should be at standard temperature, calculated by referring to ASTM Petroleum Table 54B.

To convert from volume to weight it is necessary to determine the density of the fuel and, by reference to ASTM Table 56, multiply the volume at standard temperature by the weight factor. VPS finds that the fuel density value on the BDN is often overstated, resulting in an overstatement of the weight delivered.

Receivers of fuel are advised to indicate on the BDN "*For Volume at Observed Temperature Only*". The rubber stamp is provided for your use. Please ensure that a copy of the BDN is enclosed with your sample in order for us to evaluate the VPS density determination against the supplier's statement.

Sampling of Tanks and Fuel System

General Guidelines

Disputes arising from poor quality fuel deliveries can be complex and what may seem to be a simple case can become very convoluted with respect to documentation, samples and alleged damages.

A fuel quality dispute can develop at any time, and investigators will need to compile an accurate report if the claim were to be successful.

We stress the need for good routine record-keeping at the plant as 'after the fact' accounting is difficult and confusing.

The VPS system will provide support in such cases but the plant manager, by following the guidelines listed here, will improve the chances of success in a claim.

- Keep a daily record of fuel quantities held in each tank. Record the date and amount transferred.
- Whenever possible, do not mix fuel from different deliveries and always load into empty tanks.
- Keep analysis records of all samples.
- Retain suppliers' samples and samples taken by plant staff for a minimum period of six months. Ensure that they are correctly labelled, sealed and stored in a safe location.
- In case of damages, compile a statement or record of events which should include date, time, damages and costs. Also retain broken or damaged parts for future inspection. Photographs of damages may also prove useful.
- If problems are encountered, it will be necessary to draw fuel samples from the fuel tanks or fuel system to confirm a poor fuel quality delivery, to resolve a fuel handling problem, or check the performance of fuel treatment plant.

Again, we must stress that analysis of such samples can only be useful if they have been taken properly. The following notes are intended as guidelines under such circumstances.

Tank Sampling

Ideally, to evaluate the quality of fuel stored in a tank, the following samples should be obtained:

- **Top sample** - taken at approximately 6 inches below the surface of the oil.
- **Upper sample** - taken from the middle of the upper one- third of the tank's contents.
- **Middle sample** - taken from the middle of the tank's contents.
- **Lower sample** - taken from the middle of the lower one- third of the tank's contents.
- **Bottom sample** - taken from the bottom surface of the tank.

The above samples should not be mixed together but submitted for analysis as individual samples. The label on each bottle must record the date, the sample type and tank location.

Sampling devices designed for such sampling should be used. If the sampling equipment is available, ensure that it is thoroughly cleaned before use. In some cases, due to limited access to tanks, it is not possible to obtain tank samples as described above. Under these circumstances, a sample may be taken at the fuel transfer pump as described below.

Transfer Pump Samples

If practical, line up the fuel oil transfer pump to discharge the tank to be sampled to an empty fuel oil tank. On the discharge side of the transfer pump, select a suitable position for taking a continuous-drip sample.

If the suction or discharge lines of the pump contain oil from previous transfers, start the pump and run it for a sufficient period to empty the lines. After this, start sampling by taking a continuous-drip or stream of oil into a clean cubtainer. Continue to collect the sample until the tank is empty, during which time you should have adjusted the sample flow to collect some five litres of oil. If an empty tank is not available, take a continuous-drip sample from the transfer pump discharge during circulation of the oil back to the same tank.

Thoroughly mix the 5-litre sample and pour one litre into a VPS bottle.

Mark the sample as 'Continuous drip - Fuel tank contents during discharge' together with the tank number.

DO NOT take the sample from tank bottom drain valves
– these samples will probably contain high levels of water and sediment which will not be representative.

DO NOT take sample from sounding pipes. These samples will similarly not be representative.

Fuel System Check (FSC)

Even if a delivered fuel meets the ordered specifications, it is imperative that the fuel treatment plant is operating at maximum efficiency or engine damage may occur. Sampling from a fuel system when a problematic fuel is delivered will also help indicate the efficiency of the treatment plant and thus assist the plant staff in taking preventive action, if needed.

Sampling before and after separators is also considered the only feasible condition and performance monitoring of the fuel.

Periodic sampling from the fuel treatment system will also identify such problems as water ingress from storage tanks, and leaking heating coils. A good fuel management system would include such sampling and analysis at least once a year.

Experience gained by VPS and our customers since the introduction of the VPS Fuel Quality Testing program, coupled with studies and research, confirms that fuel treatment systems are not always operated at optimum efficiency. Fuel contamination may also occur in the plant's fuel system and tanks due to, say, defective steam heating coils or water ingress resulting from badly located or damaged vent pipes.

Efficient centrifuge operation is essential for the removal of heavy fuel oil contaminants. With the FSC samples, malfunctions and defects in the centrifuges can be identified. The purpose of the FSC samples is to monitor the power plant fuel system, i.e. the 'gap' between the plant's manifold and the engine in a systematic manner. This is achieved by analysing samples drawn from key locations to assess the total fuel oil system operational condition.

For example, ISO 8217, the most commonly referred to marine fuel specification in the market, indicates 60 mg/ kg Aluminium + Silicon (Al+Si) as the maximum amount of catalytic fines (catfines) particles permitted in the higher viscosity HFO grades as delivered.

However, major engine manufacturers recommend less than 15 mg/kg Al+Si at the engine inlet. Hence, assuming a delivered fuel contains 55mg/kg Al+Si, the fuel treatment plant has to operate at an efficiency level capable of removing over 70% of these highly abrasive materials, in order to meet the engine manufacturers' requirement.

FSC Sampling

For analysis results to be useful, sampling must be carefully carried out at key locations that can provide a picture of fuel quality variation throughout the fuel oil system. Samples for FSC can be taken at fixed intervals, say, twice annually, or in connection with poor quality fuel deliveries or if operational problems are experienced.

In order to secure representative samples, it is recommended that the sampling locations are fitted with sampling cocks or valves. A connecting pipe may extend to a convenient position for sample collection. A facility should be provided to allow for the flushing of the connection back to the system or to a waste tank. Samples should NOT be drawn from tank drains.

FSC Sampling Procedure

When samples are being taken before and after the separators, the condition should be allowed to stabilize after adjustments have been made to the fuel oil flow rate, before drawing samples. The before/after separator samples should preferably be taken at the same time.

Time for sampling should be the discharge interval, divided by two. For instance, if discharge interval is set to two hours, the samples should be taken one hour after a discharge. First, the separator inlet sample is taken, and immediately after that, the sample of the cleaned oil at the separator outlet should be taken.

For Safety Reasons it is not recommended to take samples from the booster system. Safety precautions should be taken if such samples nevertheless are to be drawn because the fuel oil at this point has an elevated temperature and is kept under relatively high pressure.

All sampling equipment should be clean and in good order. Oil, sludge, water, and cleaning solvents from previous samplings can cause erroneous analysis results.

The recommended sampling procedure is as follows:

- The sample bottles from the FQT sampling kit should be used.
- Mark each sample container clearly with an ink marker before sampling to prevent mix-up.
- Ensure that the lines are flushed through before drawing the sample.
- The samples may be filled directly into the plastic sample bottles, except for samples taken from the booster system, where it is recommended to use a closed container that can withstand the elevated temperature.
- The plastic bottle cap should be firmly fastened after the sample has cooled to avoid leakage.

Testing & Reporting

Samples submitted for analysis under the FSC program will be analysed for a number of key parameters.

In order to assess the onboard treatment efficiency, the following parameters will be measured:

Water - Used to monitor if any settling of water has taken place and/or if there is any water contamination; for example, from steam heating coils or leaking solenoid valves on the separators.

Sodium - High sodium content can cause increased corrosion of the high pressure parts of the fuel system and to exhaust valves as well as increased deposits in the post- combustion spaces. Sodium is also an indicator of whether water in the fuel oil is fresh or salty.

Aluminium + Silicon (Al+Si) - These abrasive particles, otherwise known as “cat fines” can cause significant damage to an engine. Areas such as fuel pumps and injectors and the liners and piston rings can be subject to high wear rates if the “cat fines” content is not reduced to a satisfactory level as recommended by your engine manufacturer(s).

Iron - If present, this would most likely be in the form of Iron Oxide (Rust) and as such would be removed by the separator (s).

Total Sediment Potential (TSP) - This parameter is used to assess and indicate the stability and cleanliness of a fuel. Fuels with high sediment content can cause increased sludge problems in the separators and filters.

In addition the test parameters density, sulphur and vanadium are used as “fingerprint parameters” in order to confirm that the tested results correspond with the parameters of the delivered fuel oil.

The analysis report for the Fuel System Check samples will be sent to designated recipients in the same manner as the test results from the normal fuel analysis samples.

Fuel System Check Sampling Positions

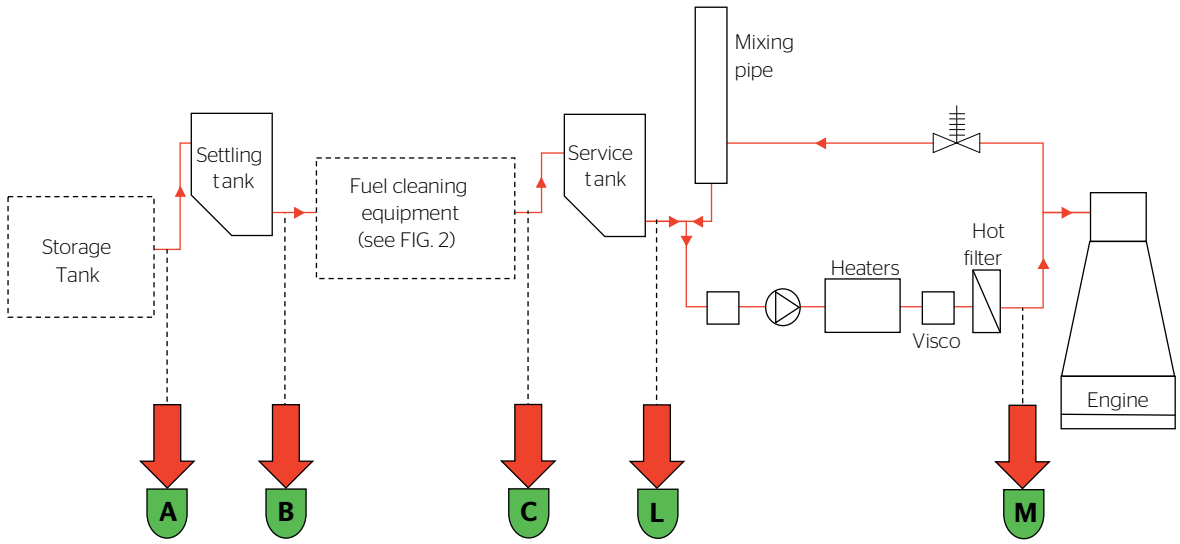

Figure 1 – Sample positions & sample identification letters

Figure 1 (Sampling Positions & Sample Identification Letters) shows the recommended locations from which FSC samples are to be drawn.

A Transfer Pump Discharge
B Before Separator(s)
C After Separator(s)
L After Service Tank (Before Heaters)
M Before Engine – Booster Unit

***Safety Note**: For safety reasons it is not recommended to take samples from the booster system. Safety precautions should be in place if such samples nevertheless are to be drawn because the fuel has an elevated temperature (130-145ºC) and is kept under pressure (5-8 bar).*

Guidelines on Interpreting Test Parameters

Density

Density is expressed in kilograms per cubic metre (kg/m^3) at 15°C. Density mainly affects the fuel separation. Conventional separators can remove water and to some extent solid particles from heavy fuel oils with densities up to 991kg/m^3 at 15°C. Separators of newer design can clean heavy fuel oils with densities up to 1010kg/m^3 at 15°C. An important issue is to ensure that the correct separation flow rate and temperature are used in order to achieve an efficient reduction of water, catalytic fines, sodium and sediments from the heavy fuel. Further, the exact density must be known to verify the weight of the fuel based on the received volume.

Viscosity

Viscosity is expressed in mm^2/s (centistokes, or cSt) at a stated temperature. This is a measure of a fluid's resistance to flow. The kinematic viscosity is measured by the time for a fixed volume of oil to flow through a capillary tube.

Viscosity is not actually a measurement of heavy fuel oil quality. The user of the fuel will need to be aware of the viscosity in order to set heaters correctly, prior to pumping and cleaning or treating the fuel, and before injection into the main engine. This is because heavy fuel oil must be heated to reach the correct injection viscosity to ensure optimized combustion and engine performance.

If the viscosity of the fuel is too high, the heating plant may not be capable of raising the fuel to the correct temperature. In extreme cases, transfer of the fuel onboard may be very difficult and the engine could suffer poor performance and possibly damages if insufficient heating is applied prior to injection.

Heavy fuel oils are also generally priced and ordered according to viscosity.

Water

Water content is expressed as per cent by volume. Water reduces the specific energy of fuel oil, thereby increasing consumption and reducing fuel economy. Water may cause corrosion in the fuel system. The sodium chloride (salt) in sea-water can also promote corrosion by giving rise to the formation of sodium-vanadium compounds during combustion (high temperature corrosion). The water content in heavy fuel oils is low during production; thus the presence of water in the delivered fuel oil is usually due to external contamination.

Separation of water from fuel oil can be a slow process, particularly if the difference in density is small or if the water is present as minute drops. Separation of water drops is also inhibited by various small-particle impurities, such as dust, sand and rust. The resulting emulsion clogs filters and affects efficient centrifuging.

Carbon Residue

The carbon residue level indicates the coke-forming tendencies of a fuel and is expressed as per cent by weight. Fuel oil with a high carbon residue may cause combustion deposits, particularly when the engines are running at low load.

Sulphur

The sulphur level in fuel contributes to sulphur oxide emissions and thus air pollution.

Sulphur compounds may corrode cylinder liners and piston rings. The sulphur dioxide generated by combustion may cause corrosion in exhaust passages at low temperatures.

Engines designed for operation on high sulphur fuels use special lubricants to minimise the effects of sulphur. The sulphur content of a fuel affects the energy available.

Sediment

All fuels contain sediment consisting of hydrocarbon sludge and extraneous materials. The Total Sediment Test is designed to determine, via a hot filtration method, the quantity of non-fluid material in the fuel.

Ash

Ash represents the incombustible components of fuel oil. These components may have their origin in the fuel or may have been introduced by poor house keeping. High ash levels can cause wear in the fuel injection system, deposits on cylinder components and resultant wear. In addition, some ashes are corrosive and may stick on to exhaust valves.

Catalytic Fines

Small particles of the catalyst (aluminium and silica oxides) used in the refinery process are sometimes carried over into the residual fuel. They are porous, extremely hard and of irregular shape. Some degree of removal may be achieved by settling and centrifuging at the plant. Due to their abrasive nature, they can cause rapid wear of system components and cylinder rings/liners.

ISO 8217:2010 prescribes a maximum level of 60 mg/kg aluminium + silicon in the heaviest grade fuels as delivered to vessels. However, fuel deliveries with levels of aluminium and silicon far in excess of this value have been recorded and severe engine damages have been attributed to such high catalytic fine levels. A single separator is not capable of handling aluminium + silicon levels above 50mg/kg in order to reduce the aluminium + silicon contents to an acceptable level at main engine inlet. We therefore recommend operating two or more separators in parallel or series, depending on type, when the tested level is in the 50-80 mg/kg range.

Elements

Fuel oils contain many metals, of which the most common are vanadium, nickel, iron and sodium. Vanadium and sodium are potentially most harmful as they may lead to high temperature corrosion. The worst situation is when the ratio of vanadium to sodium is approximately 3:1. Sodium salts are water-soluble and can be removed with water during treatment. Without presence of water, sodium cannot be removed. Vanadium is oil soluble and cannot be removed by the plant's fuel treatment equipment.

If present, Calcium, Zinc and Phosphorous are indicators of used lube oil (ULO) in the fuel. Although according to VPS' knowledge and information small amounts of ULO do not have any adverse impact on fuel oil treatment and consumption, ULO may increase the particulate emission and increase the risk of exhaust gasway fouling.

Flash Point

The flash point is expressed in degrees centigrade. Safe transport and storage requires that the flash point of the fuel oil is known. A flash point minimum of 60°C is prescribed for use in power plants. This minimum temperature is stated in the rules of Classification Societies and legislated by most governments.

Ignition and Combustion Properties

A rough indicator of ignition quality, Calculated Carbon Aromaticity Index (CCAI) as developed by SHELL is calculated on the basis of an empirical formula that includes density and viscosity. The CCAI can be used as an indication of the ignition quality of the fuel, but has in some cases proved not to be sufficient for predicting the ignition quality. To determine fuel ignition properties more accurately, VPS offers a laboratory test using a Fuel Combustion Analyser (FCA). This method is standardised as IP541/06. To receive more information, please email feedback@v-p-s.com or your local VPS Customer Service Manager.

FT-IR Scanning of MDO Samples

FT-IR scanning is performed on all distillate fuel samples received by VPS laboratories. FT-IR scanning enables detection of added substances such as esters and other oxygenated compounds in diesel and gas oils. It also indicates elevated amounts of organic acid found in the fuel. If the FT-IR scanning shows unusual amounts of organic acids, an Acid Number Test will be performed.

Pour Point

Pour point is the lowest temperature at which the fuel will flow as wax will form at lower temperatures. Wax may block filters and may deposit on heat exchangers. In severe cases, the wax will build up in storage tanks and on heating coils which will restrict the heating coils from heating the fuel, which makes the situation worse.

According to ISO 8217, the pour point for the heaviest residual fuel grades is maximum 30°C.

Pour point is only relevant for storage and handling of the fuel and neither impacts the ignition nor the combustion.

Specific Energy

The heat released during combustion of a fuel may be termed specific energy or heat of combustion. The energy content of a fuel may be measured by calorimetry but more often the energy is calculated to find the gross specific energy or the net specific energy.

Acid Number

Acid number can be measured as Acid Number (AN) or Strong Acid Number (SAN). The SAN measures inorganic acids only, whereas the AN detects all acids present.

The industry agrees that no inorganic acids should be present in the fuel (SAN = 0 mg KOH/g). Weaker organic acids may be naturally occurring in the fuel and they are present due to oxidation or contamination without harming the fuel system or engine.

There is currently no recognized correlation between Acid Number test results and the corrosive activity of a fuel although the risk of damage to engine fuel pumps as well as the fuel system in itself increases with the Acid Number.

An elevated Acid Number may be an indicator of other potentially harmful components in the fuel oil.

Chemical Contaminants

During the past years, several cases of chemical contamination of residual fuel have been found. Such contamination damaged engine fuel pumps, clogged filters, overloaded centrifuges and caused fouling of exhaust gasways.

As looking for special contaminants is both time consuming and expensive it is usually not done as part of a routine fuel analysis. Only when a plant operator reports problems related to operation on a specific fuel will the VPS labs look for chemical contaminants.

During the past years, components such as carboxylic acids, solvents, polymers and shale oil have been found to cause damage. Unfortunately, it is not always possible to find the component responsible for the damage. Finding the source of the problem is often the key to filing a complaint against bunker supplier, for which reason VPS takes chemical contaminants very seriously.

VPS is currently offering a GCMS headspace program which assists plant operators in finding possible contaminants.

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