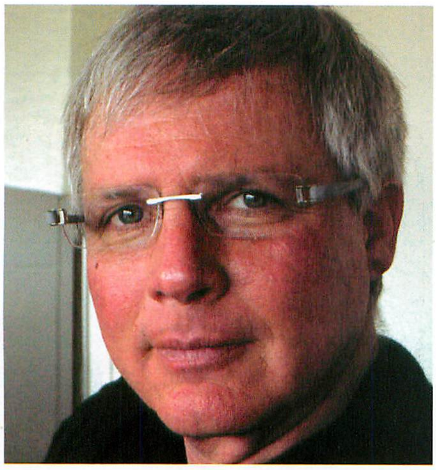
Loss recovery

Ralph Lewis of Power Research Inc. looks at how shipowners can recover lost fuel value



When a vessel lifts bunkers, the chances are that, at the very least, 1% or more of the fuel is lost to sludge precipitation. This sticky amalgam of asphaltenic goo, whether incinerated on board or offloaded to a slops barge, too often represents a lost opportunity.

Sludge may foul tank bottoms, heaters and fuel injection systems, yet it contains an energy-rich mother lode of fuel value, particularly in view of today's soaring bunker prices. Not surprisingly, many vessel owners are taking a renewed look at ways to recover it.

Ahead, we will look at the basic chemistry of heavy fuel oil, the root causes of sludge precipitation, the most effective test methods available to identify potential problems, and available remedies.

Sludge Chemistry 101

With apologies to Sergio Leone, heavy residual fuel oils are composed of three basic ranges of hydrocarbons: the good, the bad, and the ugly.

First, the good. These are the lighter hydrocarbons with relatively low carbon-to-hydrogen ratios. Burning the cleanest, they determine the extent of ignition quality, the first to 'light off' during combustion.

Next, the bad. These components are lighter weight asphaltenes with a medium range of carbon-to-hydrogen ratio molecules. These are dispersed into the oil medium and are known as maltenes.

Finally, the ugly. At the heaviest end are the carbon-laden asphaltenes that are condensed into aromatic structures known as micelles. While they have the greatest British Thermal Unit (BTU) value, they are the most prone to leave the party.

So if sludge fallout from bunkers seems worse than ever before, consider that today's residuum contains much higher levels of heavy asphaltenic components than in past years. Simply, refiners have become more efficient in extracting the more profitable lighter end fuels from a barrel of oil through advanced visbreaking units. The 'bottom of the barrel' is literally more 'bottom' than ever before.

To meet the **International Organization for Standardization's** ISO 8217 viscosity specifications, suppliers must cut the residuum with increasing amounts of middle distillate. This is an expensive proposition. High quality middle distillate fuels command a premium price. So more often than not, less costly 'waste' distillates are chosen.

These can be light cycle or napthenic oils. Light cycle oils (LCOs) are highly aromatic, good for reducing the rate of sludge precipitation. The downside is that LCOs have notoriously poor ignition quality. Petroleum naphtha typically has good ignition quality, but the reduced aromatic content can accelerate sludge precipitation.

After the blend, a finished heavy fuel oil will produce a nominal amount of sludge, typically from 0.75% to 1.5%.

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The solvency of the cutter stock will have disrupted the glue-like surface tension between the maltene and asphaltene components. But complicating matters is the fact that the chemistry of the base residuum can differ greatly depending on the origin of the feedstock and refining method. This can result in unexpected chemical reactions during blending with varying cutter stocks – a potential recipe for disaster.

When a union is consummated between two very disparate fuels, trouble can brew, simmering slowly at first, but eventually exploding into a progression of hellish rapidity. To call this marriage incompatible is an understatement. The copious amounts of sludge generated can strike long after receipt of a bunker analysis that confidently states: 'ISO 8217 spec is met.'

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CSI – Critical Sludge Investigation

Critical compatibility issues, now occurring globally with increased frequency, beg the question whether conventional test methods are truly predictive. While improved testing methodologies for sludge have been long considered, only recently has significant progress been made.

Efforts to quantify the tendency of a finished fuel to produce sludge began in 1948 with a method proposed by the **US Navy**, shortly followed by a test developed by **Shell Oil** to quantify dry sludge amounts by means of the Shell Hot Filtration method. The latter test involved the heating of the fuel sample for 24 hours at a temperature of 100°C. The fuel was filtered, the sludge remaining on the filter weighed.

For 37 years, the test was industry standard – a bulwark in the annals of sludge quantification. Then in 1985, a short version was developed, beloved by engineers seeking quick results. This upgrade involves heating the fuel for only one hour at 100°C. Sludge precipitation is 'accelerated' when the sample is laced with a small amount of hexadecane (cetane). This method is the one now incorporated as the **Institute of Petroleum** and the **American Society for Testing and Materials** (IP/ASTM) standard proscribed in ISO 8217. But is faster better?

'Let's face it, we're dealing with a test developed in the late 1940s,' says Geoffrey Jones, general manager for **Lintec Testing Services Ltd**, a UK-based fuel analysis firm. 'A given fuel may show a good Total Sediment Potential (TSP) result at first glance, but weeks later, the reality is that a severe incompatibility problem may have arisen with no prior indication evident from TSP analysis.'

Jones has been working with a newer method known as the Reserve Stability Test (ASTM D7061). He discovered that there is virtually no correlation between the results of a standard TSP test and those produced with the Reserve Stability method. In other words, a fuel may test well within specification under the TSP method, but show very poor reserve stability.

The 15-minute Reserve Stability test is conducted in a device known as the Turbiscan Heavy Fuel (THF), manufactured by the French company, **Formulacation**. The THF surveys the fuel by means of 'light scattering' technology, looking for destabilisation criteria such as creaming, sedimentation and clarification.

Results are interpreted on a numerical scale, a 'separabilty' number of 0-to-5 indicating a stable fuel. From 5-to-10, reserve stability is much lower, with sediment formation most likely from fuels that are heated or stored for any length of time (shipboard storage, for example). Above 10, the fuel has already experienced heavy sludge precipitation and will continue to do so long-term.

Few labs are equipped with the THF device, but Lintec, well known for expertise in detecting chemical contamination in heavy fuel, is an established bunker analysis facility quite up to the task of identifying potential sludge issues.

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Sludge slayers

Chemical additives to address sludge issues are offered by a number of companies at various dose rates and levels of effectiveness. Generically, these are often referred to as fuel oil treatments (FOTs). Dosage rates vary, depending on the extent to which the dispersant package is diluted with solvent 'filler'.

When effective, FOT chemicals help recover fuel value, keeping fuel storage and delivery systems cleaner. Injector atomisation patterns may also be optimised, maintaining original engine manufacturer's operational parameters. But be forewarned. Claims made for benefits exceeding the specific functionality of sludge dispersant chemistry should be held suspect. Dispersant chemistry alone, for example, does not provide any inherent improvement in fuel combustibility, nor will it result in any net reduction in particulate emissions under international testing protocols.

The effectiveness of FOT will vary, due in no small measure to how the particular chemistry reacts with the wide variety of chemistries of the finished bunker fuel product. Therein is the catch. What may work in some fuels can be wholly ineffective in others – yet another reason why some engineers are sceptical of additive capability. The fact remains that chief engineers faced with a sludge emergency can ill afford to have uncertainty when it comes to product capability.

Based on extensive laboratory work identifying the critical but diverse reactions that occur across a broad spectrum of cutter stocks and base residuum, **Power Research Inc. (PRI)** has formulated three products that have been proven to consistently handle even the most severe sludge precipitation issues.

The first is the company's flagship product, PRI-RS. Known for the capability to inhibit engine deposit formation while reducing emissions under the most rigorous international test standards, PRI-RS consistently provides fuel sludge reductions in the 50%-85% range.

PRI's mid-range deposit control formula, PRI-27, also capably provides sludge reduction. PRI-SOLV chemistry, designed solely for sludge prevention, is a 100% active series of proprietary organic dispersants, dosed at the very economical rate of 1:20,000.

With all PRI chemistries, the initial product investment is far offset by the fact that a substantial portion of the fuel value is recovered. And determining the extent of fuel value recovered can be easily quantified through the test methods mentioned herein.

Best yet, the capability of PRI sludge prevention chemistry is mirrored in years of shipboard experience. PRI routinely tracks sludge generation data on client vessels worldwide, and the savings in recovered fuel value long-term are substantial and consistent.

Vessel operators can determine how much fuel value can be recovered on a per-vessel basis. Savings achieved by recovering fuel value, and by deferring sludge disposal costs, make a significant impact on improving vessel profitability.