BUNKERSPOT
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Careful selection

Ralph Lewis, of Power Research Inc., argues that buyers of marine fuel additives must be diligent in their research before they take the plunge

'For a fuel treatment to be effective and provide a return on investment, it must be properly formulated for the specific set of problems at hand'

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Over the years, bunker fuel treatments have had their share of proponents and detractors. Some tout their value. Others doubt their effectiveness. But with MARPOL Annex VI now upon us, coupled with declining fuel qualities in certain regions, vessel operators are increasingly turning to fuel treatment solutions.

In this article, we will take a brief look at why fuel treatment programmes succeed for some and fail for others, why bunker suppliers and engine manufacturers typically turn an indifferent eye, and what fuel treatment chemistries are proving effective.

The success of a fuel treatment programme is dependent on three factors: the actual chemistry of the fuel treatment; the nature of the fuel treated; and the design parameters of the engine consuming the fuel. Fuel treatment can provide an excellent return on investment when these areas are considered.

A wealth of research has been conducted on the chemical nature and combustion behaviour of heavy fuel oil over the past 50 years. These voluminous studies, virtually unknown outside the arcane world of petrochemical research, are often couched in the cryptic terms of chemical terminology. Yet it is in understanding the subtle complexities of fuel oil behaviour in storage and combustion that enables us to develop effective chemical solutions.

This has been especially true for today's refiners, where extensive research has led to the development of cleaner automotive fuels laced with highly effective deposit control additives. In the US, for example, the **Environmental Protection Agency (EPA)** mandates the use of proven deposit control additives in all motor gasoline.

Yet on the bunker fuel supply side, refiners rarely bother with fuel treatment. Since bunker fuel is a price-sensitive commodity, bunker producers realise no benefit offering heavy fuel with performance additives.

Engine manufacturers are generally neutral on the subject – though they will state in fine print that additives are not necessary since the engines they design will operate 'satisfactorily' on fuels that comply with ISO 8217 specifications.

While engine manufacturers have made great strides in developing new engines that maximise combustion while reducing emissions, design improvement only goes so far. Refiners are simply not designing 'boutique' bunker fuels to go hand in glove with these new engines. Engines may be getting better, but they are consuming fuels that are of increasingly poorer quality in many areas of the world.

How serious is the problem? It was sufficient to prompt a 1997 study by **Mitsui OSK** engineers. This involved the chemical analysis of post combustion deposits taken from slow and medium speed diesel engines on 12 vessels. The study concluded that in spite of careful fuel selection and the latest advances in marine engine design, the formation of highly acidic, post-combustion residue is directly attributable to incomplete combustion of the fuel.

Environmental concerns are also re-awakening interest in fuel treatment. In Alaska, our cruise ship clients once experienced as many as three penalties per vessel each season for smoke opacity violations. Today, they receive none. Our chemistry for this application, PRI-RS ECF (emissions control formula), has been providing smoke opacity reductions in the 45%-plus range – a fact acknowledged and documented by State of Alaska officials.

Too often, these success stories are overshadowed by failures of other fuel treatment products elsewhere. Sometimes it is a result of improper application, or a poorly designed fuel treatment chemistry. For a fuel treatment to be effective and provide a return on investment, it must be properly formulated for the specific set of problems at hand. Let's take a look at the various types of products offered, what they do, what they do not do.

The most common bunker fuel treatments are dispersants. The good ones have a surfactant/dispersant package that inhibits the precipitation of organic sludge from fuel in storage. Dispersants can be excellent investments based on their capability to recover lost fuel value. A secondary benefit is that these products do help keep fuel delivery systems cleaner and tanks sludge-free.

Dispersants have limitations. Contrary to some claims, the chemistries of these products do not significantly alter the chemical reactions that occur during combustion that produce unburnable hydrocarbon structures. In turn, post combustion deposits and soot are only mildly affected.

A second treatment chemistry is the combustion catalyst. By definition, a catalyst

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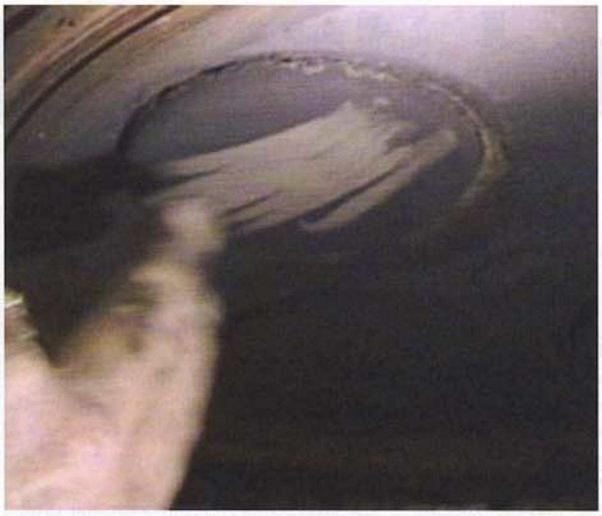

accelerates a chemical reaction – hence a 'combustion catalyst' accelerates combustion.

The primary mechanism for many bunker fuel catalysts is cyclopentadienyl iron, otherwise known as ferrocene. On the plus side, ferrocene is cheap. In some cases, it can be effective in reducing soot and engine deposits. But this comes at a price.

Ferrocene combustion produces an iron oxide residue that appears on piston crowns and exhaust valve faces. This reddish deposit, the primary component of 'jeweller's rouge', is a highly effective metal polishing agent. While great for jewellery, metal polishing can cause excessive wear on some modern diesel engine components. For this reason, the **Worldwide Fuel Charter**, an international organisation of refiners and automotive manufacturers, has banned ferrocene use in automotive fuels.

A third additive type is the vanadium control additive. These products typically contain an oil-soluble magnesium oxide (MagOx) or manganese component. They are generally effective in inhibiting the formation of low melting point vanadates.

The downside is that MagOx particles can be large – several microns in size. This limits the amount of effective MagOx concentration. Application in a motor ship can also be difficult, as it is advisable to introduce the chemical post purifier to avoid stripping out heavy MagOx particles. This requires installation of dosing equipment and additive tanks in engine rooms – a nuisance to many chief engineers.

In the mid 1980s, we began evaluating these steam-turbine era technologies, and quickly realised that in order to address the problems of sludge, post-combustion deposits, and emissions reductions in motor ships, a bold new approach was necessary.

First, we looked at ignition delay – the root causes, and potential solutions. In simple terms, ignition delay in a diesel engine results from the creation of high carbon weight material during the second combustion stage. This carbon is larger in structure and more difficult to burn. The more carbon produced, the more delay occurs and the poorer the combustion quality. Hence engine deposits increase, more particulate emissions are exhausted, and exhaust gas temperatures rise, creating higher levels of oxides of nitrogen (NOx).

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In solving the problem, we borrowed the basic deposit control concept from the technology originally developed for automotive fuels, thoroughly redesigning the chemistry for the much tougher challenge of heavier fuel oils. In basic terms, our PRI-RS 'thermal stability' chemistry blocks much of the process that creates the high carbon weight structure in the first place. The result? Deposits are inhibited, particulate emissions are reduced, and NOx is slightly lowered.

The latest generation of this chemistry, PRI-RS ECF, is our leading selling product. Used on cruise ships for major reductions in visible smoke opacity, PRI-RS ECF is applied by most vessel owners to inhibit post combustion deposits on both slow and medium speed diesels. In many well-documented cases, exhaust valve overhaul intervals have been doubled. Piston crowns remain essentially free of hard carbon deposits, and the remaining light carbon residue can typically be removed by hand. Soot fouling of exhaust gas economisers is also greatly reduced.

PRI-RS ECF also incorporates a specially formulated series of dispersants that reduce organic sludge formation by an average of 70% in a wide range of fuels, based on vessel experience and independent, third party laboratory testing. Just this one functionality typically covers initial investment in the product, and depending on hazardous material disposal charges, can offer a net financial gain.

To prevent high temperature corrosion, PRI-RS ECF incorporates chemistry that reduces SO3 in the exhaust gas stream – an effect also verified in independent testing. Another product component offers a highly effective alternative to MagOx that prevents vanadate formation, and permits dosing to occur at the bunker manifold during bunkering by means of an air-driven gear pump.

These are but a few of the benefits that provide an excellent return on investment from a carefully designed fuel treatment strategy.

Bear in mind that no miracle product exists. No fuel treatment can elevate the melting point of aluminum (cat fines), for example, nor can fuel treatment provide dramatic reductions in fuel consumption. There simply are not enough candles to light, words to chant, or secret alchemist tricks to make the impossible happen.

In summary, technical managers should request three basic items from fuel treatment suppliers and manufacturers: independent documentation of claimed benefit; a full technical description of the science behind the product; and a list of referrals from product clients. With good due diligence, the proper fuel treatment choice can be made – one that offers a significant return on investment.