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SHIP MANAGEMENT INTERNATIONAL

Gloves off
for Greek ship owners

Dispatches: Malacca Strait
Securing your shipping lanes

Round Table Debate:
Greek ship owners fight back

P&I:
Facing some startling realities

Battling the brutal X-Factor

These things, says John L David, are starting to eat ships' engines. "These things" are catalyst fines, or "cat fines" which are tiny, very abrasive metal particles, found in ship's fuel. They are the X factor in the midst of ships and becoming the source of more and more claims on the marine insurance market – often at an average of more than $1m a time. Ironically, this menace is a by-product of global efforts to clean up the air emissions of ships by reducing the sulphur in bunkers, *writes James Brewer.*

Capt David, a partner in the consultancy/surveying company Marine Professionals, has been briefing underwriters at Lloyd's and in the International Underwriting Association, on the menace, with large audiences at both venues.

He has a compelling way of describing the problem. Ship's engines are brutal machines, he says, some half the size of a large building, and they are operated under harsh conditions in all kinds of climates and environments.

Engines are often operated by unsophisticated personnel and to ever more technical specifications and tolerances. The room to get it wrong is "very thin." If all engines burned diesel, there would be little to worry about, but heavy fuel is far more economical. It is what Capt David calls the garbage in the heavy fuel that is increasingly causing more damage.

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Traditionally, fuel supplied to ships has often caused on-board wear, handling and combustion problems. All these problems were primarily to do with poor on-board fuel management, and the damage occurs in the top part of the engine, the combustion part.

Recently the quality of fuel supplied to ships has started to worsen and the origin of this was good intentions. Sulphur, which occurs naturally in most crude oil, is in most ship fuels and when these fuels are burnt in engines, the sulphur is released from the exhausts to the atmosphere, where it falls back to earth as acid rain.

The sulphur from ship's engines mostly falls into sea, but is still a threat to the environment. Burning high sulphur fuel in European waters meant that the acid rain often fell on Europe. Hence, MARPOL VI has dictated a reduction of sulphur in various stages and geographies. Legislation worldwide sets a maximum sulphur content of 4.5% in any fuel on board a ship, but in northern European waters, the figure is currently 1.5% (as it is in California where there are demands for lower limits still).

In July there will be calls for a maximum 0.1% sulphur content in ship's fuels while trading in some geographical areas. Worldwide, there is pressure for a continuing squeeze on reducing the sulphur content in all fuels, and in ship's fuels in particular.

It seems that marine engines have never had a good diet. Some authorities used to encourage garages to dump their old car lube oil into the residual fuels destined for ship's engines. Used dry cleaning solvents, and old cooking oils (chip-fat) have been found in such fuels, and this was all before it was fully realised that cat fines were to be found in fuels.

Marine engines are robust, so much so that they could probably run on heated road tar; they are able to burn the residual dregs from the original, simple, distillation refinery processes with ease and quite cheaply.

However, the boffins in the oil refineries worked out that if they cooked the residual dregs in a vacuum, then passed it through a catalyst cracking tower, they could get even more petrol and gas oils out of it, and so make money out of every barrel of crude oil. Almost emerging as a by-product, the gunge-remnant was still a burnable fuel, and low in sulphur, which is ideal for the environment and the demands of legislators.

The trouble for ship's engines is that this secondary refining process uses catalysts to "crack" the residual hydrocarbon chains into more valuable fuels. Catalysts are marble-sized balls of aluminium and silicon oxides (silica), basically metal balls tumbling in the catalyst distillation tower. Often as they bounce around, tiny,

talcum powder sized flakes at 5 to 30 microns in diameter, chip off the outer surfaces. These shed outer layers falling into the heavy ship's fuel that is left at the bottom of the refining system, and cat fines in fuel are born.

The carry-over catalyst fines are too expensive to re-re-refine out, so the fuel is sold to ships "as is", and the crews are left to "get on with it,"; they have to get the cat fines out, and keep the ship steaming at all costs.

Ironically, the better refining techniques and the growing demand for low sulphur fuel mean that fines are found in fuels in increasingly large amounts, and will be more so, as time goes on, warns Capt David.

These little flakes are hard – harder than engine parts – and very abrasive. No more than 15 to 20 mg/kg (or parts per million, ppm) of particulates can cause engine damage. "If cat fines are not efficiently removed before being injected into the engine, cat fines can trash an engine very fast," says Capt David.

Capt David forecasts that in 30 years there will be no residual fuels left, all will be blended fuels (save for diesel), so the quality of the fuel burned in ships' engines is definitely going to get worse. Purifiers that should remove cat fines are struggling to cope to remove this stuff, and the attitude is often "just run it one more day" before engineers are horrified to see the top end of the engine destroying itself with massively increased wear.

It is no good blaming the fuel quality (more on that later); what is needed is good fuel management. This entails rigorous operational requirements; ensuring the crew has the machinery, skill, knowledge, and instructions to handle and clean the fuel. Additionally, proper equipment is essential to test and monitor the purified fuel before it is used, as it is difficult for crew to know how good a purification job has been done otherwise.

Fuel is usually sold to the ISO 8217 (2005) international standard, that among other things requires that there should be no more that 80 mg/kg of aluminium plus silicon ("Cat Fines") in the fuel. Any fuel contractually bought to the ISO standard could legally be rejected if it did not meet all the ISO requirements and the 80 mg/kg provision in particular.

But as can be seen from the above scenario, 15-20 mg/kg can seriously damage a ship's engine – the crew HAVE to get the cat fines down from a potential supplied maximum of 80 mg/kg.

Let us suppose that a ship is correctly supplied with fuel containing just under 80 mg/kg of cat fines. Leaving the fuel to settle in the fuel storage tanks should reduce the mg/kg (ppm) figure by 50%, were the particles to settle out by gravity, good housekeeping, and time. The fuel coming out of the storage tanks can be like treacle -- it has to be heated up before anything can be done with it. Then, good purification should reduce the remaining cat fines by 80% again. The purifier is like the "spin drier" of a washing machine; you have to heat the settled fuel to 98 deg C (water boils at 100 deg C) and spin it at high speed to throw the heavier metal cat fines out of the liquid fuel. There is no margin for error; done well, the fuel coming out of the purifier system should have about 8 ppm of abrasive particles left– which is, if you will forgive the expression, fine.

Settling and "slow" purification definitely works, explains Capt David, and additional filtration can reduce the amount of cat fines further, but good, efficient purification must be done EVERY single time, every single day of the life of the engine. Let us say that the ship ventures into the Bay of Biscay, rolling in swells, then all the carefully stored fuel that has settled the cat fines down to the bottom of the storage tank, gets stirred up again.

Symptoms of cat fine damage are poor combustion, high

exhaust temperatures, and poor fuel injection pressures, quickly followed by accelerated wear in fuel pumps, injectors, piston rings and cylinder liners and a build up of carbon residues. When someone sees black smoke – it is too late!

Significant costs are at stake if ships get their purification wrong; major damage and spare part replacement of fuel pumps, engine cylinder liners and piston rings would be needed; then there are the costs of loss of daily hire, and the down time spent repairing the engine to add to the bill.

Fuel is usually paid for by the time charterer, and by the ISO standard, a level of 79.99 mg/kg cat fines is legally acceptable (the 80 mg/kg ceiling will be dropped to 60 ppm during 2010, but this will still be 45 mg/kg too much to be safely burned in most engines).

Knowing the exact catalyst fine content as delivered to the ship is the start of the chief engineer's problems. As the fuel is being pumped over the ship's handrail into her storage tanks, a sample is taken and sent to a laboratory for analysis for cat fines (among other things). But is the sampling representative? And is the analysis reliable? A large vessel can take on 2,000 tonnes of fuel in one go, which may take 10 hours to load. Someone metaphorically dips a 1 litre sample bottle into that supply of 2 million litres, and they do this at some random point during those 10 hours... how representative is that?

The cost of fuels plays its part in this problem. For a start, if a ship is carrying too much fuel, then she can carry less paying cargo, which encourages the supply of different parcels of fuel at various stops along the voyage. Then the cost of the various fuels in those ports takes on an economic dimension; as at March 10 2010, for instance, Rotterdam heavy fuel oil IFO 380 Cst was $ 454 per tonne; heavy fuel oil IFO 180 Cst cost $474; low sulphur IFO fuel was about $500; and good old diesel oil was $655 (that is 40% more expensive).

It currently costs around $600,000 to send a Panamax bulk carrier, fully laden with 70,000 tonnes of grain from New Orleans to China, using the "lower" quality grade IFO 380, instead of IFO 180, which can save about $25,000 on the total voyage fuel bill. Using only diesel for the same voyage would cost $900,000, and there would not be the problem of cat fines. But to put this into perspective, if the cat fines are not properly removed from the IFO fuel, the replacement and delay costs for all the parts in the top end of the engine could cost between $1m and $2m.

Multiple bunker suppliers are used by many ships tramping round the world, picking up a stem of fuel here and there. If the sellers can get away with delivering cheap, off-spec fuel, to an unwary ship, they will; if that fuel contains some waste oil, or chemical waste that they can sell, then so be it. "Think of the consequences when you start mixing this dodgy stuff into already poor quality fuel," scorns Capt David.

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Many ships do not even insist on ISO standard fuel supplies, so it is often open season on them, and the adage "you get what you pay for" could not be more appropriate.

Prudent ship owners are insisting that their vessels are only ever supplied with "better" than ISO standard fuels and with a cat fines level specified at, say, no more than 25 mg/kg.

As an absolute minimum, ship owners should always insist that supply is to ISO standards; insert a no fuel mixing clause/or instructions into their charter parties (mixing parcels of different fuel supplies often brings out and combines the very worst in each separate fuel stem); analyse EVERY stem of fuel; and get technical advice on how to handle and purify the goods. Analysis and technical advice costs only about $70 per stem, but many owners fail to take advantage of such a service.

It is an ISM requirement to run a ship safely, and if owners are taking in fuel which is going to trash the engine in a day, the authorities are going to be all over the owners and crews for breaching SOLAS and pollution requirements, and the company potentially faces criminal charges, if (when?) that ship runs on to the beach because her engine has been immobilised.

The most vulnerable vessels are the older ones, with medium to high speed engines, burning low sulphur fuel, working hard with quick port turn-round times, and with a small complement.

"The increasing cat fine problem has been foisted on to the ship owner and his crews, and a lot of people just do not want to know"

In older vessels, already suffering wear and tear, an increase in cat fines in the injected fuel will accelerate in a week what might have taken years to do; the faster the revving of the engine, the faster the wear rate, and as often as not, already over stretched crews may not even have the time to treat the fuel properly.

The practical, on-board, headaches will feed into complex questions of liability and of insurance claims. For instance, would a claim for engine damage be presented as "fire, explosion", or "latent defect in machinery"? Technically and legally, is fuel "in machinery"?

What about allegations of "crew negligence"; were members of the team properly equipped, instructed and supervised? was their negligence causative of the damage? was cat fine wear the proximate cause of the damage – or was it long worn engine parts that finally gave up the ghost? Which supply of fuel was THE one that caused the damage? and if more than one supply of fuel, how many events were there? and finally, who is the "assured" who did not tell the crew of the results of fuel analysis and how to treat the fuel properly before injecting it into the engine?

Capt David says it may well be time for a "fuel management" clause in hull and machinery policies, to encourage "best practices" by assureds. (As an aside, a similar "lube management" clause would encourage best practices for lubrication oil and reduce major crankshaft and bearing claims in the bottom part of the main engines).

Underwriters are considering writing the cat fine fuel damage aspect out of the hull and machinery policy... "then you are going to have to write out all engine damage, as it will be difficult to prove what actually caused the damage, and then bring all engine damage cover back in - I suppose for extra premium," speculated Capt David.

"The increasing cat fine problem has been foisted on to the ship owner and his crews, and a lot of people just do not want to know," he laments, "But the crews should know that there are cat fines in their fuel and be able to get it out, or ultimately refuse to burn it in their engines".

Brussels funding boosts European shipyard competitiveness

Europe's shipbuilders have signed a funding agreement with the European Commission covering their four-year 'Breakthrough in European Ship and Shipbuilding Technologies' maritime research project aimed at securing and improving their competitiveness in a sustainable way. BESST, which is expected to result in a reduction of life cycle costs of some Euros 120m per panamax vessel and a reduction of CO2 emissions by approximately 12% per ship each year, was initiated by the European Economic Interest Group EUROYARDS, last September.

Its primary goal was to increase the competitiveness of European-built ships through decreased life cycle cost, drastically reduced environmental impact and continually improved safety, with a focus on passenger ships, ferries and mega-yachts. Partners include leading shipbuilders STX Finland, STX France, Fincantieri, Meyer Werft, Thyssen Krupp Marine Systems and Damen Group, classification societies Germanischer Lloyd, Det Norske Veritas, Rina and Bureau Veritas and various research institutes, universities and industrial companies.

Key technical development areas include space optimisation and maintenance, improving payload to gross tonnage ratio, cost efficient building and refurbishment processes, improved energy efficiency and reduced emissions, noise and vibration, improved reliability through model-based design and condition monitoring, optimisation of logistic chains as well as improving safety and security.

The partners see cooperation in research and development and networking as the European answer to the challenge posed by Asian yards. BESST will help in overcoming the historic fragmentation of European shipbuilding and combine the high flexibility of smaller industry groups with the critical mass to achieve a breakthrough in innovation and market impact.

BESST will also achieve close interaction with ship operators through a dedicated advisory group. A multi-level management structure, based on shipyards' experience of previous research and development and commercial projects, will "ensure efficient and targeted work of the large consortium to ensure the desired impact."