KISH P&I CLUB

KISH P & I LOSS PREVENTION CIRCULAR KPI-LP-167-2014
(Possibility of engine damage due to catalytic fines)

►What are catalytic fines?
Catalytic fines or "cat. Fines" are small and very hard particles used in the so-called Fluid Catalytic Cracking process (FCC) of most large, modern oil refineries. The particles show individual variations in shape, size, density, hardness and composition. A full chemical description of FCC catalyst is complex, but the particles are normally aluminum silicates formed from aluminum and silicon oxides. The particles participate in the cracking process with a catalytic effect, and are recovered from the process and recycled. The recycling, however, is not 100% effective and a certain level of cat. Fines will always be present in the output product of a catalytic cracker. This product is often referred to as heavy cycle oil (HCO) or slurry oil.

The main path, in which these particles may end up in marine fuels, is when slurry oil is used for blending purposes in the fuels to adjust the viscosity of the final product. Problems arise when the recycling process in the catalytic cracker is not working at optimal conditions, causing a significant amount of catalytic fines to escape from the process. Relatively large amounts of catalytic fines will then end up in the slurry oil, and small quantities of this product blended into the fuel oil will result in a fuel hazardous to ship's machinery. However, if too much of a slurry oil with "normal" level of cat. Fines is used in the blend, the final contamination level may still be unacceptable for a marine fuel oil. Catalytic fines may also end up in marine diesel fuels (distillates), but is then a less critical problem due to the rapid settling of particles in low viscous diesel oils.

High levels of catalytic fines cause increased abrasive wear of fuel pumps/injection nozzles, cylinder liners, piston rings, and other moving parts of machinery where they are present. The rate of wear is a non-linear function of the contamination level. The effect on catalytic fines in concentrations below 15- 20 mg/kg (PPM) into the engine is low, but will increase rapidly at higher concentrations. The particle's size, shape and hardness will strongly affect the wear rate in the engine. Particles larger than the lubricating oil-film thickness (about 8 microns in slow speed engines) will have the strongest effect on piston/liner abrasion. Particles may also get trapped in the piston ring grove and cause serious damage on rings and pistons.

►The history:
We are being cornered by many ECA & SECA areas.
International legislation requiring the use of fuels with limited sulphur content has led to a steady increase in the levels of catalytic fines (cat fines) found in fuels. The current global average for low sulphur fuel (LSFO) is more than 30 ppm and this level increases the danger of cat fines settling and accumulating in the bunker and settling tanks. It also increases the risk that, in rolling conditions or rough weather, the fuel entering the purifiers contains cat fines in a concentration exceeding that which the purifiers are able to handle.

It appears that the majority of the fuel samples received and analyzed by specialized Petroleum Services in 2013 were tested against the older ISO 8217:2005 marine fuel specification instead of the latest ISO 8217:2012 specification. The new specification

introduced stricter requirements on several fuel parameters, and reduced the maximum permissible level of cat fines from 80 ppm to 60 ppm. Taking the unscheduled and costly engine breakdowns into consideration, it is somewhat surprising that the majority of operators are still testing against the older ISO 8217:2005 specifications.
There is, however, a discrepancy between the maximum acceptable levels of cat fines as stated in common marine fuel specifications such as the ISO 8217 and those recommended by engine manufacturers, which are typically 10-15 ppm. It is therefore important that the fuel treatment plant is managed and operated in the most efficient way in order to reduce the levels of bunker cat fines to less than 15 ppm at the engine inlet and hence prevent serious damage to main engine components. In this respect, The Joint Hull Committee of the London insurance market has issued guidelines on how to prevent engine damage due to cat fines. The main recommendations made by the Committee in its report are summarized by reputable advice centers & quoted below:

1-Prior to bunker fuel delivery:

- ✓ Ensure that there are sufficient empty tanks available to store the newly purchased fuel.
- ✓ Be aware of the fuel quality analysis statistics of the port of supply, especially if there are relevant warnings issued by testing laboratories, P&I Clubs and the maritime press.
- ✓ Ensure the vessel has sufficient fuel on board to enable the testing of new bunkers prior to usage. The vessel should avoid using newly purchased fuel without obtaining and acting on the results of fuel analysis.

The agreed ppm value of aluminum (Al) and silicon (Si) in charter-parties and bunkering contracts should preferably be kept below 60 ppm (ISO 8217:2012) to ensure that the purifiers can effectively bring this value down to less than 15 ppm at the entry to the engines. It is recommended that the contractual agreement also considers the maximum density for the separators installed in the system (Conventional versus HD).

Note; if bunkered oil contains more than 60 ppm of catalytic fines as expressed by the Al and Si levels, in some instances fuel at the engine inlet has had higher levels of cat fines than those recommended, due to the limitations of on board fuel treatment equipment.

2-During and immediately after bunker fuel delivery:
Ensure that representative bunker samples are drawn in line with industry guidelines and tested by a suitable independent laboratory, preferably against the ISO 8217:2012 specification requirements:

- ✓ Drip fuel samples should be taken from each bunker source/barge/tanker during bunkering.
- ✓ Expedient dispatch to follow, from bunker port to laboratory for analysis with the provision that the fuel analysis report returns to the vessel as soon as possible and in any case prior to using the bunkered oil.

Note; in the unlikely event of an emergency where the bunker fuel has to be used without receipt of analysis results, contact the technical superintendent for permission.

3-During use of bunker fuel:

Regular testing after bunker fuel purchase

- ✓ It is recommended that a proper Fuel System Check (FSC) is carried out by taking samples throughout the fuel system at intervals of four to a maximum of six months. However, FSC Samples should also be taken whenever Al/Si as bunkered exceeds 40 ppm.
- ✓ Subsequently the recommendation will be to carry out proper testing of samples taken before and after the purifier(s) as well as before the engine, at the same time. The samples should be sent to accredited laboratories for analysis.

Purifiers

- ✓ Where possible, run two purifiers in parallel with minimum flow and keep the HFO inlet temperature at the optimal temperature of 98 degrees C to ensure efficient purification.
- ✓ If the vessel is equipped with a conventional purification plant, always ensure that the purifiers are fitted with the optimal gravity disc corresponding to the actual fuel and the fuel test result.
- ✓ Purifier capacity should be sufficient to cope with daily fuel consumption plus 10% in order to enable some recirculation of fuel in the settling tank to occur. Purifier efficiency tests should be carried out regularly by fuel specialist bodies.
- ✓ Regular checks of the purifiers should be made by the manufacturer's service engineers to enhance system efficiency. Fuel system filters should be regularly inspected and cleaned – not only when high differential alarms are activated. However, where a ship has bunkered "dirty" fuels a few times, tank cleaning at shorter intervals should be considered. Furthermore, it is recommended that these tanks should have sloping bottoms to prevent the build-up of sediments and cat fines in the bottom.

Fuel storage, settling and service tanks

- ✓ New bunkers should preferably be placed in empty tanks, and blending of different fuels avoided. If blending is deemed necessary ensure that an adequate compatibility test has been performed.
- ✓ Frequent (daily) draining of water and settled bottom sediments from fuel storage, settling and service tanks should take place. During calm weather, the heavy components in the Heavy Fuel Oil (HFO), such as cat fines, will settle in the tank bottom, and in heavy weather these abrasive particulates can be stirred up and fed into the purifiers in concentrations exceeding the maximum acceptable levels. If unchecked, this can impede the efficiency of the treatment system, leading to large quantities of cat fines at the engine inlet.
- ✓ Drained oil from automatic fuel oil backwash filters should not be reintroduced into the fuel treatment system.
- ✓ Clean settling and service tanks during dry docking in order to deal with any long term build-up of cat fines and sediment in the bottom of the fuel oil storage tanks.
- ✓ Equipment maintenance

- ✓ Fuel treatment heaters should be opened and cleaned regularly to ensure that the optimal temperature of 98 degrees C for purification is reached.
- ✓ Purifiers should be opened for cleaning at the scheduled intervals recommended by the manufacturers, or more often if poor fuel quality is suspected. Vessels should maintain the necessary spare parts on board.

Training

- ✓ There should be company Bunker Handling and Management plans provided to vessels.
- ✓ The operator should ensure that the personnel responsible are sufficiently trained to be able to fully and independently operate and maintain all the above mentioned equipment as appropriate, both through existing qualifications prior to employment as well as through on-going training courses and market practice updates, if and where necessary.
- ✓ The personnel responsible should be familiar with the issues raised in these recommendations.
- ✓ Record keeping. Crew and operator must maintain records of bunker fuel management procedures, including maintenance records and reports of mechanical or procedural failures.

What if a problem is found?

If engine damage is thought to be due to cat fines, experts should be instructed to confirm the presence of cat fines. Such confirmation can only be obtained by replica testing of the affected cylinder liners and piston rings carried out by the engine maker's technicians.
If the presences of cat fines are confirmed, all tasks necessary to eradicate them from the fuel should be carried out immediately. This should include:

- ✓ Cleaning of all relevant fuel tanks including fuel system components,
- ✓ Replacement or machining of all affected engine components, and
- ✓ If off spec fuel is the issue; removal of contaminated fuel oil from the vessel.

This will help to prevent the escalation of engine damage caused by cat fines, and minimize delays in commercial operations and unnecessary additional costs and insurance claims.

Options for improvement

Operators are recommended to carry out an internal review of their bunker handling and treatment procedures. They may also wish to enhance their planned maintenance by increasing inspections of engine cylinder assembly parts in order to provide early identification of fuel related problems. Apart from inadequate equipment it is the actual operation, or rather the improper operation, that may be the main reason for insufficient reduction in cat fines. Improper operation in turn may be due to lack of an understanding and the attitude towards proper on board fuel treatment.