

Managing Catfines in Marine Fuels

Minimising catfines in the fuel protects the engines ensuring operational and commercial reliability.



The shipping industry operates within a highly complex global context, balancing commercial demands with an evolving maritime regulatory framework. The operational reliability of vessels significantly influences not only the fulfilment of commercial commitments but also the safety of human life and environmental protection.

While there are several factors which can adversely affect the operational reliability of ships, the presence of catfines in marine residual fuels has been a longstanding concern. Catfines have been responsible for machinery damage, leading to reduced propulsion capability and, in certain instances, a complete loss of propulsion.

This guidance highlights the operational measures that vessels can implement to minimise catfines in the fuel, while also emphasising the critical role of the fuel conditioning system and crew diligence in effectively managing fuels containing elevated catfines.

1. What are catfines?

Catfines, short for catalytic fines, are “left behind” microscopic particles comprising Aluminium Oxide (Al_2O_3) and Silicon Oxides (SiO_2) from the zeolite catalysts which are added to the catalytic cracking process utilised in crude oil refineries.

The presence of catfines in fuels have been associated with damage to not only engine cylinder liners and pistons, but also to components in the fuel system such as injectors, fuel pumps and valves.

As these catalysts are expensive, refineries attempt to recover and reuse them, until recovery is no longer economically feasible.

2. Why is their presence undesirable?

Catfines are hard particles which can range in size from sub-micron sizes up to 100 microns, and which, owing to their extreme hardness, are highly abrasive.

To provide context on material hardness, on the Mohs hardness scale (ranging from 1 to 10), diamond is rated at 10, while Aluminium Oxide (Al_2O_3) and Silicon Oxide (SiO_2) are rated at 9 and 7 respectively.

If catfines enter the combustion chamber, they may become lodged between the cylinder liner and piston rings, potentially leading to abrasive wear which can result in catastrophic damage to the engine in a short period of time.

3. Residual versus Distillate Fuels

Catfines are primarily found in residual grades of fuel owing to the fact that the refineries extract distillate grades by vacuum distillation from the upper levels of the distillation column, ahead of the catalytic cracking process where the catalysts are introduced.

While the presence of catfines in marine residual fuels is not new, there has recently been a trend of increased levels of catfines in supplied fuels. This has been largely attributed to refineries striving to meet regulatory standards of low sulphur fuels, by blending residual fuels with increased proportions of low sulphur cutter stocks which come from the catalytic cracking process.

4. Fuel Lab Analysis

The lab analysis of the received bunker sample serves as an important and timely validation of the bunker quality for and beyond the ISO 8217 specs. The quantification of catfines in fuel, allows the vessel to take informed decisions on fuel conditioning measures, ensuring the catfines are minimised before the fuel enters the engine.

Depending on the ISO 8217 specification, the limit value for catfines could be 60 mg/kg or 80 mg/kg for the fuel to be considered “on-spec”. However, from an operational perspective, while zero catfines would be ideal, engine manufacturers generally consider up to 15 mg/kg of catfines as being acceptable for short durations.

5. Managing Catfines

There are established industry best practice operational measures available for the removal of catfines. The effectiveness of these measures in achieving the desired outcome of reducing the level of catfines hinges on the optimal performance of the fuel conditioning systems and the diligence exercised by crew.

a. Settling Tank (s)

An increased resident time of the fuel in the settling tank facilitates heavier catfines to gravitate to the bottom of the tank, from where they can be removed by periodic draining of fuel.

Three factors influence the efficiency of removal of catfines in the settling tank.

- Resident time - An increased resident time of the fuel in the settling tank affords time for facilitating heavier catfines to gravitate towards the bottom of the tank.

- Temperature - Higher temperatures in the settling tanks lowers the viscosity of the fuel thereby aiding movement of the heavier catfines through the fuel to the bottom of the tank.
- Water - Owing to their hydrophilic properties, catfines tend to form an emulsion with water, which hinders their separation from the fuel.

Recommendations:

- *Plan and optimise fuel transfers to maximise the residence time of fuel in the settling tank.*
- *If two settling tanks are available, where possible, alternate their use to maximise fuel residence time.*
- *Ensure that fuel in the settling tank is maintained at a temperature between 80-85 °C, or at a temperature recommended for the fuel grade.*
- *Carry out frequent draining to ensure the removal of catfines and water collected at the bottom of the settling tank.*

b. Purifiers

Fuel purifiers (also known as separators) are the most crucial equipment in the fuel conditioning system for minimising the catfines in the fuel. The temperature and flow rate of the fuel fed into the purifier has an influence on its effectiveness in removing the catfines, along with entrained water and other contaminants.

Three factors influence the efficiency of removal of catfines in the purifier.

- Feed rate – A low fuel feed rate allows an increased resident time for the fuel in the purifier, improving its effectiveness in the removal of catfines.
- Temperature - Higher temperatures improves the separation of catfines in a purifier by lowering the fuel's viscosity, allowing the centrifugal force to more effectively separate the denser catfines from the fuel.
- Performance – The effectiveness of the purifier in removing catfines is dependent on its operational performance.

Recommendations:

- *Where available, have more than one purifier in operation to facilitate better removal of catfines from the fuel.*
- *Maintain the lowest possible feed rate in the purifiers, just sufficient to meet the fuel demand.*
- *Maintain the recommended temperature of the fuel at the purifier.*
- *Maintain the purifiers in accordance with the manufacturer's recommendations to ensure optimal operational performance.*
- *Perform periodic efficiency tests by initiating lab analysis of fuel samples before and after the purifier.*

c. Heat Exchangers

The efficiency of heat exchangers and associated control instrumentation within the fuel conditioning system plays a significant role in aiding the removal of catfines.

In the settling tank(s), the efficiency of the heating coils has an impact on the time taken by the transferred fuel to attain the desired temperature, and consequently the resident time of the fuel in the tank under optimal conditions for effective separation of catfines.

The efficiency of the fuel pre-heater in continually achieving the desired temperature has an impact on the effectiveness of the purifier in removing catfines from the fuel.

Recommendations:

- *Carry out functional tests of temperature control equipment and calibration of temperature sensors/transmitters.*
- *Inspect and clean settling tanks and heating coils of sludge build-up.*
- *Inspect and clean fuel purifier pre-heaters*
- *Test heat exchangers for leaks.*

d. Fuel Filters

Fine mesh filters (10-25 microns) in the fuel conditioning system serve as the final barrier in preventing catfines from reaching the engines. Whilst these filters are not the primary method for the removal of catfines from fuels, they can capture some particles that remain after treatment in settling tanks and purifiers.

Auto-backflush fuel filters are set to backflush at set intervals and on set pressure differential across the filter. Frequent backflushing would be indicative of the filter getting overloaded, suggesting that upstream operational measures are not being fully effective and require further optimisation.

Recommendations:

- *Inspect fuel filters regularly to ensure their integrity in service.*
- *Clean fuel filters frequently to remove any accumulated catfines on the filter mesh.*
- *Ensure the fuel filters and replacement components are of correct specification.*

e. Engine Monitoring

While consuming a fuel with high catfines, even if recommended operational measures are followed, it is prudent to closely monitor engine parameters that may be indicative of abnormal wear. For instance, depending on the engine type, abrasive wear in a cylinder can manifest itself initially through an increase in cylinder liner wall temperature, whilst a drop in compression pressure would indicate damage to the piston rings and/or liner.

Additionally, utilising test kits which analyse the iron content in scavenge drains has been found effective in detecting excessive liner wear during engine operations.

Recommendations:

- *Ensure that engineers on watch are fully aware of key engine parameters that indicate potential abrasive wear in the cylinders.*
- *Utilise test kits which can provide a real time indication of abrasive wear in the engines.*

When elevated catfines are detected or machinery damage is alleged, maintaining comprehensive documentation pertaining to the bunker stem is essential for efficient and timely dispute resolution. Members are therefore encouraged to follow strict procedural and operational protocols during bunkering and onboard fuel conditioning, paying particular attention to the following key considerations.

- a) Proper bunker sampling procedures to be followed, obtaining and retaining representative samples of the supplied fuel.
- b) Correct bunker documentation and records are completed and retained on board.
- c) Lab analysis reports, including any recommendations for fuel management, to be reviewed and implemented, as appropriate.
- d) Industry best practices to be implemented for optimisation of fuel conditioning capabilities.
- e) Engineering watchkeeping to be diligently carried out with oversight of the Chief Engineer.
- f) Engine logbook records to detail all relevant fuel handling parameters and additional supporting documentation to demonstrate appropriate levels of due diligence and serve as evidence in defending potential claims.
- g) Fuel conditioning equipment to be maintained in accordance with the maker's recommendations.
- h) Records of inspection, maintenance, tests and calibration activities for equipment within the fuel conditioning system to be meticulously maintained.

This document provides practical guidance on managing catfines in marine residual fuels, outlining the associated risks, the need for effective fuel conditioning systems, and adherence to industry best practices, while also emphasising the importance of maintaining proper documentation to support timely and effective dispute resolution, if required.

Supportive Information

For further information on this or other Loss Prevention topics please contact the Loss Prevention Department, Steamship Insurance Management Services Ltd.

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