Fuel - Not Fit For Purpose

The Houston fuel case

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Fuel – Not fit for purpose

Houston case. What has happened?

• There have been a number of cases with sticking fuel pumps, blocked filters and engine black-outs in the past months.
• All kinds of marine engines seem to be affected. Two and Four-stroke, main and auxiliary engines.
• Bunker alerts regarding Fuel contamination in the Houston / Mexican Gulf area have been issued by a number of fuel analysis companies - and now also in Asia.
• The contaminated fuel seem to be present in other parts of the world. Probably because the fuel is transported to other ports and sold there.
• This is one of the most widespread fuel quality issues in recent years.

MARPOL Annex VI, Regulation 18.3: Fuel quality “fuel shall not include any added substance or chemical waste that jeopardizes the safety of ships or adversely affects the performance of the machinery.”
Fuel – Not fit for purpose

Houston case: The cause is not completely established

- The reason to the issues is not established and there are many rumors.
- Contaminated cutter stocks or cutter stocks which are not fit for purpose have probably been used.
- The marine business have not reached an agreement on what causes the issues.
- Probably there are more than one fuel component responsible. Some of the compounds or characteristics found in the fuel are:
  - multiple fatty acids, C12-C18
  - high acid number
  - multiple nitrogenous compounds
  - 4-cumyl-phenol

- Fatty acids are not from petroleum refining.
  - But there might be very low levels in some fuels and that might not be an issue.
- Nitrogenous compounds and phenols, these should not either be present at high levels.
  - But there might be very low levels in fuels and that might not be an issue. We don’t have experience on either concentration levels nor how often these compounds are found in well-running fuels.
- The above substances do not necessarily create issues.
  - However, they could be indicators of something else: Some substance(s) that create issues, but it is not found because we don’t know what to look for.
  - When the glue-like substances is analyzed, the causing factors might have been destroyed / consumed in the process when the glue-like substance was formed.
Fuel 2020 - Demands

**IMO demands:**
- %S in fuel
- The fuel shall not:
  - jeopardize the safety of the ship or adversely affect the performance of the machinery
  - be harmful to personnel
  - contribute to additional air pollution

**Commercial demands:**
- ISO 8217 – ISO/PAS 23263
- Fit for purpose
- Viscosity
- Density
- Energy
- Cat fines
- Cold flow properties
- …
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Houston case: ISO 8217 – specification of marine fuels

- The fuels have been said to be within the limits of Table 2 in ISO 8217.
- However ISO 8217:2017 (E) states:
  - “1. Scope: This document specifies the requirements for fuels for use in marine diesel engines and boilers, prior to conventional onboard treatment (settling, centrifuging, filtration) before use. […]”
  - “5. General requirements: […] 5.2 The fuel shall be free from any material at a concentration that causes the fuel to be unacceptable for use in accordance with Clause 1 (i.e. material not at a concentration that is harmful to personnel, jeopardizes the safety of the ship, or adversely affects the performance of the machinery). […]”
- When the clauses 1 and 5 are merged the result is:
  - The fuel shall be free from any material at a concentration that causes the fuel to be unacceptable for use in marine diesel engines and boilers, prior to conventional onboard treatment (settling, centrifuging, filtration) before use (i.e. material not at a concentration that is harmful to personnel, jeopardizes the safety of the ship, or adversely affects the performance of the machinery).
- The conclusion based on the existing wording is as follows:
  - There shall not be anything in the fuel that after conventional on-board treatment can adversely affect performance of the machinery.
Responsibility & actions
Fuel

Fuel buyer:
- Fuel properties and ship technical capabilities must fit together

Fuel supplier:
- Stability:
  - During bunkering
  - Over time
  - In the fuel system to and into the engine

Ship:
- Mixing fuel on board: DON’T MIX
- Cleaning:
  - Separators
  - Filters
  - Heating / Cooling

Engine:
- Combustion

Fuel producer
Fuel system
# Fuel - Not Fit for Purpose
## Selection of cases with confirmed damages, MAN ES two-stroke

<table>
<thead>
<tr>
<th>Engine type</th>
<th>Fuel pumps stuck</th>
<th>Sludge, Separator and filter issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>S70MC-C</td>
<td>All fuel pumps stuck and valves stuck. Main engine and 1 Aux. engine</td>
<td>Not reported</td>
</tr>
<tr>
<td>S60MC-C</td>
<td>Fuel oil pumps requiring cleaning and replacement</td>
<td>Continuous blocking of filter</td>
</tr>
<tr>
<td>S50MC-C</td>
<td>All units fuel pump seizing. Cleaned</td>
<td>Maybe. FO back flushing filter normal now. Indicating that has not been normal.</td>
</tr>
<tr>
<td>S50MC-C</td>
<td>Main engine, 3 units plunger barrel stuck, other 3 sluggish. Stuck several times</td>
<td>Not reported</td>
</tr>
<tr>
<td>S50MC-C</td>
<td>Engine is turning on air but the fuel rack of all units are NOT moving at all.</td>
<td>Not reported</td>
</tr>
<tr>
<td>S50MC-C</td>
<td>Repeated seizing of fuel of pumps</td>
<td>Not reported</td>
</tr>
<tr>
<td>S50MC-C</td>
<td>High pressure pumps stuck, 5 units. Fuel deposits, Cleaned and used again</td>
<td>Not reported</td>
</tr>
<tr>
<td>S70MC-C</td>
<td>Pumps stuck. Happen after black out.</td>
<td>Not reported</td>
</tr>
<tr>
<td>S50MC-C</td>
<td>Not reported.</td>
<td>Separators filled with sludge. Scavenging air fire. 2 units.</td>
</tr>
<tr>
<td>L70MC</td>
<td>Damages in diesel generator fuel pumps, fuel valves</td>
<td>Clogged filters.</td>
</tr>
<tr>
<td>G60ME-C</td>
<td>Fuel plunger Not returned alarm on 5 units. Not possible to start. Plunger are stuck on top due to sticky fuel.</td>
<td>Stopped duplex filter</td>
</tr>
<tr>
<td>S50MC-C</td>
<td>Suffered from fuel pump, injector suction and plunger valves seizure on ALL units.</td>
<td>Not reported</td>
</tr>
<tr>
<td>S60MC-C</td>
<td>All fuel pumps stuck. Cleaned and put back. Use same fuel. Stuck again</td>
<td>Not reported</td>
</tr>
<tr>
<td>K90MC</td>
<td>All fuel pumps were stuck. all plunger barrels, suction valves, puncture valves and many fuel valves were replaced</td>
<td>Not reported</td>
</tr>
<tr>
<td>S50MC-C</td>
<td>M/E need to be stopped due to HPP plungers sticking either at operation or stand still mode. Very sticky yellow/black deposits inside. Can be washed out with MGO.</td>
<td>Not reported</td>
</tr>
<tr>
<td>S50MC-C</td>
<td>All units of fuel rack are stuck and cannot move</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

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Note – This a small selection of cases reported to MAN ES, sent either directly to R&D or via PrimeServ. PrimeServ have received a large number of reports on incidents.
Case from service: Fuel - Not fit for purpose

All fuel pumps stuck. Cleaned and put back. Used same fuel. Stuck again

Plunger: Before and after cleaning
Case from service: Fuel - Not fit for purpose

All fuel pumps stuck on main engine. One aux engine affected too.

Before and after cleaning. Various methods used to clean. Hot oil bath and force seemed to be the way forward.
Case: Fuel - Not fit for purpose

No sticking reported, but extreme amounts of chewing-gum like sludge, high wear and very poor cylinder condition, scavenge air fire.
Case: Fuel - Not fit for purpose in service

All fuel pumps were stuck. Plunger/barrels, suction valves, puncture valves and many fuel valves were replaced.

Fuel pump barrel and plunger as received.

Plunger after disassembly

Plunger after cleaning

After cleaning, the plunger and barrel, the were re-assembled and the plunger could move freely.
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A fuel valve story. Black glue-like substance stuck on a fuel valve and the attempt to clean it

The surface is sticky. Glove is stuck on the surface
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Fuel – Not fit for purpose

A fuel valve story.

The diesel are not able to hold the substance in suspension.

Fuel valve almost clean on the outside. The inside is another story, yet to be discovered.
1. If the fuel analysis indicates multiple acids, high acid number, multiple nitrogenous compounds, 4-cumyl-phenol, talk to the fuel supplier. Clause 5 in ISO 8217 or MARPOL Annex IV, Regulation 18.3 may be applicable.

2. Keep the fuel in a separate tank. Don’t mix the fuel with any other fuel.
   a. Mixing one good fuel with a “bad” fuel, increase the risk of ending up in one large batch of bad fuel.
   b. But, if mixing is the only option, dilute the “bad fuel” to as large extent as possible.

3. If or when the fuel shall be used, it is advisable to start using it in deep waters and well before entering high-risk areas (e.g. ports and other congested areas).

4. Monitor the engine condition and the condition of the fuel system.
   a. Fuel index. See next slide.
   b. Monitor changes in the separators and filters performance. Increased sludge amounts, indication of filter clogging etc.
   c. In many cases the deposits in the fuel pumps can be removed and the pumps cleaned, reassembled and used again.
      − Diesel (marine gas oil) or similar can be used in order to attempt to remove the sticky fuel.

5. Make scavenge port inspections and monitor whether the condition changes.

6. Be aware of that problems can occur if using fuel Not fit for purpose. If problem occurs STOP using the fuel immediately.

7. It is therefore strongly advisable to carry a different fuel on-board, if there is a need to make a switch.

Houston case: Recommendations

− Don’t mix fuel batches
− Monitor condition and act!
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Houston case: Recommendations

**Detecting worn fuel pumps – Monitor Fuel Index**
In general, if the Fuel Index has increased by more than 10% at a given load compared to a load from shop test, the plunger and barrel are worn out.
This is under the assumption that the suction valve is still functional.

**Worn fuel pumps can cause:**
- higher leakage volumes
  - especially when operating on low viscosity fuel
- starting difficulties,
  - especially in astern
- MC engines are more sensitive than ME engines

**Seizures and damage to plunger and barrel**
- Scores and damage to the upper part of the plunger and barrel are normally due to particles in the fuel.
- Seizure marks on the plunger body are normally caused by temperature shocks or too low viscosity.
- Minimum viscosity at engine inlet: 2 cSt
- **In practice:** Keep the viscosity around 3 cSt
  - to achieve a safety margin against minor temperature deviations and
  - failing viscosity controllers
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Fuel samples to be taken

WG ISO 8217 has formed a subgroup on performance testing for “sticky fuel”
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Thank you