Service Experience of ME/ME-C/ME-B engines

Mitsui Engineering & Shipbuilding Co. Ltd.
Quality Assurance Department

August 2015
1 Malfunction items on ME/ME-C/ME-B engine

1.1 Malfunction of exhaust valve on S50ME-C
1.2 Burn-away of exhaust valve on S50ME-C/ME-B
1.3 Malfunction of Hydraulic Control Valve

2 Cylinder condition -Cold corrosion issue-

2.1 Guidelines on cylinder lubrication

3 Use of Low sulphur fuel

3.1 Cylinder oil
3.2 Specification of low Sulphur fuel oil
3.3 Viscosity and Lubricity
1 Malfunction items on ME/ME-C/ME-B engine
   1.1 Malfunction of exhaust valve on S50ME-C
   1.2 Burn-away of exhaust valve on S50ME-C/ME-B
   1.3 Malfunction of Hydraulic Control Valve

2 Cylinder condition –Cold corrosion issue–
   2.1 Guidelines on cylinder lubrication

3 Use of Low sulphur fuel
   3.1 Cylinder oil
   3.2 Specification of low Sulphur fuel oil
   3.3 Viscosity and Lubricity
1.1 Malfunction of exhaust valve on S50ME-C (1)

Preface:

Knocking due to malfunction of exhaust valve which occurs at comparatively high load was reported on some S50ME-C with Low force exhaust valve.

The following failure scenario is found out.

Step 1: Exhaust valve once pauses just before closing for several cycles
Step 2: Exhaust valve cannot return to original closing position but keeps original stroke amount (Drifting of closing position)

Fig. 1: Log data at knocking in ME engine control system
1.1 Malfunction of exhaust valve on S50ME-C (2)

【About the Low force exhaust valve】

Reduced size of piston for hydraulic exhaust actuator (Pos. A, B)

Reduced working force for exhaust valve

Fig.2 Low force exhaust valve
1.1 Malfunction of exhaust valve on S50ME-C (3)

**[About the Low force exhaust valve]**

**Simple structure**

Heat resistance steel (SNCrW) exhaust valve can be used

Exhaust valve stroke amount is determined by amount of hydraulic oil amount delivered from the actuator

Exhaust valve is mechanically stopped.

Conventional type for ME engine

- Hydraulic damper
- Thread part to fix the hydraulic damper
- Heat resistance steel (SNCrW) can not be applied
- Nimonic valve is applied

Low force exhaust valve

- No hydraulic damper
- No thread part of spindle
- Heat resistance steel (SNCrW) valve can be applied

Fig 3 Comparison between conventional type and low force exhaust valve
1.1 Malfunction of exhaust valve on S50ME-C (4)

Cause:

① High friction between spindle guide and exhaust valve spindle

Relatively harder sliding mark was observed inside of spindle guide

Fig.4: Hard contact mark inside spindle guide
1.1 Malfunction of exhaust valve on S50ME-C (5)

② Excessive damping of hydraulic piston

It is suspected that the exhaust valve pausing is caused by excessive damping force due to narrowed clearance by deformation.

③ Shortage of oil flow from throttle valve

Oil flow amount is limited by orifice, and excessive oil trapped at previous cycle may not be drained off sufficiently. Accordingly, the drifting of closing position might occur.
1.1 Malfunction of exhaust valve on S50ME-C (6)

Countermeasure:

1) Countermeasure I: **Redesign of Spindle guide**

   ① Increase of clearance between spindle guide and exhaust valve spindle
   ② Making spring guide shorter
   ③ Increase of cooling efficiency to reduce thermal expansion of spindle

![Fig.5: Redesign of spindle guide](image)

Original

Countermeasure

① Increase of clearance
   Original: 0.26～0336
   Countermeasure:0388～048

② Short (30mm)

③ Making additional cooling area

Clearance
Spindle guide
Housing
Cooling
Not cooling
1.1 Malfunction of exhaust valve on S50ME-C (7)

2) Countermeasure II: Redesign of hydraulic piston in exhaust valve

- The orifice size is changed from φ 0.5mm to φ 3.0mm so that the damping force is optimized by increasing the oil flow rate.
- Hydraulic piston without side pieces, which had been used in MC-C engines, is applied in order to omit the deformation on the oil cylinder.

3) Countermeasure III: Redesign of throttle valve in exhaust valve

The oil flow is increased by changing orifice size from φ 1.0mm to φ 2.0mm in order to keep higher drain off capacity.
1.1 Malfunction of exhaust valve on S50ME-C (8)

Application:

**New building engine:**
These countermeasure will be applied to all S50ME-C engines with Low force exhaust valve.

**Engine already in service:**
We will supply necessary parts for modification (countermeasure) to all the vessels in question free of charge. We would like to ask customers to replace the parts at the next scheduled maintenance of exhaust valve.
1 Malfunction items on ME/ME-C/ME-B engine

1.1 Malfunction of exhaust valve on S50ME-C
1.2 Burn-away of exhaust valve on S50ME-C/ME-B
1.3 Malfunction of Hydraulic Control Valve

2 Cylinder condition –Cold corrosion issue–

2.1 Guidelines on cylinder lubrication

3 Use of Low sulphur fuel

3.1 Cylinder oil
3.2 Specification of low Sulphur fuel oil
3.3 Viscosity and Lubricity
1.2 Burn-away of exhaust valve on S50ME-C/ME-B (1)

**Phenomenon:**

Exhaust valve spindle whose base material is heat resistant steel with Ni based high hardness alloy welded seat has been applied on S50ME-C with Low force exhaust valve and S50ME-B. Recently, rather high burn-away rates on exhaust valve bottom surface have been reported from some of these engine types after long time low load operation.

![Image of exhaust valve spindle]

**Fig.1:** Born-away on bottom surface, S50ME-C8.2

**Fig.2:** Design of exhaust valve spindle

**Sear area:**

Ni based high hardness alloy

**Base material:**

Heat resistance steel
1.2 Burn-away of exhaust valve on S50ME-C/ME-B (2)

**Countermeasure:**

Dura-Spindle with welded layer of Ni based heat resistance on its bottom surface is applied to S50ME-C with Low force exhaust valve and S50ME-B engine.

【Original】
- **Sear area:** Ni based high hardness alloy
- **Base material:** Heat resistance steel

【Countermeasure】
- **Sear area:** (Dura-seat)
  - Ni based high hardness alloy
  - + Cold rolling process
  - + Aging heat treatment
- **Base material:** Heat resistance steel
- **Bottom surface:** Ni based heat resistance alloy

Fig.3: Comparison of exhaust valve spindle
1.2 Burn-away of exhaust valve on S50ME-C/ME-B (3)

**Application:**

**New building engine:**
Dura-Spindle with welded layer of Ni based heat resistance on its bottom surface will be applied to all S50ME-C with Low force exhaust valve and S50ME-B engines.

**Engines already in service:**
We will supply Dura-Spindle with welded layer of Ni based heat resistance on its bottom surface to all the vessels in question free of charge. We would like to ask customers to replace the exhaust valve spindle at the next scheduled maintenance of exhaust valve.
<table>
<thead>
<tr>
<th>1</th>
<th>Malfunction items on ME/ME-C/ME-B engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Malfunction of exhaust valve on S50ME-C</td>
</tr>
<tr>
<td>1.2</td>
<td>Burn-away of exhaust valve on S50ME-C/ME-B</td>
</tr>
<tr>
<td>1.3</td>
<td>Malfunction of Hydraulic Control Valve</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th>Cylinder condition -Cold corrosion issue-</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Guidelines on cylinder lubrication</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>Use of Low sulphur fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Cylinder oil</td>
</tr>
<tr>
<td>3.2</td>
<td>Specification of low Sulphur fuel oil</td>
</tr>
<tr>
<td>3.3</td>
<td>Viscosity and Lubricity</td>
</tr>
</tbody>
</table>
1.3 Malfunction of Hydraulic Control Valve(1)

**Phenomenon:**

Alarms activated and Engine speed decreased automatically by slow-down function due to malfunction of FIVA valves, which controls the oil flow to fuel oil boosters, exhaust valves and cylinder oil lubricators.

![Hydraulic oil system](image)

Fig.1 Hydraulic oil system
1.3 Malfunction of Hydraulic Control Valve(2)

【Hydraulic oil system for ME engine】

Fig 2 Hydraulic oil system
1.3 Malfunction of Hydraulic Control Valve(3)

**Investigation:**

Many scratches and wear was found at the edge part of spool in hydraulic control valve on FIVA valve.

![Hydraulic control valve](image)

Spool in hydraulic control valve

Scratches and wear at the edge of spool

![Fig.3 Damaged condition of Hydraulic control valve](image)
1.3 Malfunction of Hydraulic Control Valve (4)

**Cause:**

1) Particle contamination of lube.oil / Hydraulic oil

2) Water contamination of lube.oil / Hydraulic oil

**Countermeasure:**

**Countermeasure 1:**
Prevention of particle contamination of lube. oil  【Service Note No.193】

**Countermeasure 2:**
Prevention of water contamination of lube. Oil  【Service Note No.192】
1.3 Malfunction of Hydraulic Control Valve(5)

**Countermeasure 1:** Prevention of particle contamination of lube. Oil.

1) Evaluation of lube. Oil / hydraulic oil

The cleanliness of lube. oil is required ISO 4406 xx/16/13 or better at after flow of HPS fine filter.

Contamination of oil can be measured accurate by means of ISO 4407 / JIS B9930 (Measurement by LASER is not suitable for used oil, because the measurement by LASER counter frequently counts the particles more than its proper value because of discoloration, sludge or other effects.)

Although the used lube oil seemingly appears dirty than ISO 4406 xx/16/13 as the color is changed to dark blown, sometime cleanliness of discolored used oil is still better than ISO 4406 xx/16/13. On the other hand, even new oil may dirty than ISO 4406 xx/16/13. Therefore, it is recommended to measure the contamination by the above-mentioned method (ISO4407 / JIS B9930)

Take lube oil samples every 3 months to analysis the lube oil quality. The sample oil can be taken from the plug on HCU, by using the pressure measuring hose, supplied as main engine tool.

In case the cleanliness become worse in short time, it is recommended to inspect the lube oil system and remove the source of the particles.
1.3 Malfunction of Hydraulic Control Valve(6)

**Countermeasure 2: Prevention of water contamination of lube. oil**

We received the information that the hydraulic control valves on FIVA valves were damaged by water contamination of the lube. oil.

Freshwater content in the lube oil is allowed max. 0.2% or 0.5% for short periods.

However, it is strongly recommended to find the root of water contamination and to remove water by circulation and centrifuging (at preheating temperature) as quickly as possible, if water contamination is observed even less than 0.2% water content.

![Fig.3 Water in crank case.](image)
1 Malfunction items on ME/ME-C/ME-B engine

1.1 Malfunction of exhaust valve on S50ME-C
1.2 Burn-away of exhaust valve on S50ME-C/ME-B
1.3 Malfunction of Hydraulic Control Valve

2 Cylinder condition -Cold corrosion issue-

2.1 Guidelines on cylinder lubrication

3 Use of Low sulphur fuel

3.1 Cylinder oil
3.2 Specification of low Sulphur fuel oil
3.3 Viscosity and Lubricity
2.1 Guidelines on cylinder lubrication

**Effect of TBN100 Cylinder oil**

Cylinder condition was obviously improved after using of TBN100 cylinder oil

**Engine type:** S65ME-C8.2

**Normal service load:** 50 % LOAD

Before: TBN70 (at 2,400 hours)

- ACC factor: 0.40 g/kWh·S%

After: TBN100 (at 5,000 hours)

- ACC factor: 0.40 g/kWh·S%
2.1 Guidelines on cylinder lubrication (2)

**Cold corrosion on S60ME-C 7.1**

- **Maximum liner wear rate**: 0.19mm / 1000hr
- **Running hours**: 3,600 hours
- **Normal service load**: 50%
- **Cylinder oil feed rate**: 1.2g/kWh
- **Cylinder oil TBN**: TBN70
- **Sulphur in fuel oil**: 3%
- **ACC factor**: 0.40g/kWh • S% (calculated)
- **Previous Guiding ACC factor range**: 0.34~0.20 g/kWh • S%

*Cylinder condition was improved after using of TBN100 cylinder oil.*
### 2.1 Guidelines on cylinder lubrication (3)

<table>
<thead>
<tr>
<th>Engine type</th>
<th>All Mk.8, Mk9 and S60Mk7.1</th>
<th>Mk7 and older types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubricator type</td>
<td>Alpha lubricator</td>
<td>Alpha lubricator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mechanical lubricator</td>
</tr>
<tr>
<td>Guidance</td>
<td>Service Note No.189</td>
<td>Service Note No.188</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service Note No.183</td>
</tr>
<tr>
<td>Cylinder oil (S% (\geq 1.5%))</td>
<td>100BN</td>
<td>70BN</td>
</tr>
<tr>
<td>Cylinder oil (S% &lt; 1.5%)</td>
<td>15~40BN</td>
<td>15~40BN</td>
</tr>
<tr>
<td>ACC factor (g/kWhS)</td>
<td>0.40~0.20 x (100/BN)</td>
<td>0.34~0.20 x (70/BN) x S%</td>
</tr>
<tr>
<td>Feed rate (g/kWh)</td>
<td>0.40~0.20 x (100/BN) x S%</td>
<td>0.34~0.20 x (70/BN) x S%</td>
</tr>
<tr>
<td>Min. feed rate (g/kWh)</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Part load control</td>
<td>Load dependant</td>
<td>Load dependant or MEPdependant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Speed dependant</td>
</tr>
</tbody>
</table>

*Optimal ACC factor should be evaluated base on the actual condition which shall be confirmed by port inspection or drain oil analysis.*

*Optimal feed rate should be evaluated based on actual condition which shall be checked by port inspection.*

Newly applied based on service experience.

---

三井造船株式会社
MITSUI ENGINEERING & SHIPBUILDING CO., LTD.
2.1 Guidelines on cylinder lubrication (4)

Guideline for All Mk8, Mk9 and S60Mk7.1 (TBN100 cylinder oil)

Before reducing the feed rate to the next step, cylinder condition must be evaluated by scavenge port inspection or drain oil analysis (next page), and confirmed that condition is satisfactory.
2.1 Guidelines on cylinder lubrication

Judgment of cylinder condition by scavenge drain oil analysis

Iron content is increased by wear

Residual TBN is decreased by increase of sulfuric acid

Sweep Test

【Service Note No.190】

Seep test is the fastest way to evaluate the corrosive behavior and optimal ACC factor.
1 Malfunction items on ME/ME-C/ME-B engine

1.1 Malfunction of exhaust valve on S50ME-C
1.2 Burn-away of exhaust valve on S50ME-C/ME-B
1.3 Malfunction of Hydraulic Control Valve

2 Cylinder condition -Cold corrosion issue-

2.1 Guidelines on cylinder lubrication

3 Use of Low sulphur fuel

3.1 Cylinder oil
3.2 Specification of low Sulphur fuel oil
3.3 Viscosity and Lubricity
3.1 Cylinder oil

**Attention**

- When operating on low sulphur fuel (S<1.5%), it is recommended to use low TBN cylinder oil (15～40BN).

- It is important to prevent the excessive cylinder oil dosage.

- Monitor the cylinder condition and act accordingly after switching to low sulphur fuel.

<table>
<thead>
<tr>
<th>Oil company</th>
<th>Oil name</th>
<th>Base number (TBN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castrol</td>
<td>Cyltec 40SX</td>
<td>40BN</td>
</tr>
<tr>
<td>Chevron</td>
<td>Taro Special HT LF</td>
<td>25BN</td>
</tr>
<tr>
<td></td>
<td>Taro Special HT LS40</td>
<td>40BN</td>
</tr>
<tr>
<td>ExxonMobil</td>
<td>Mobilgard 525</td>
<td>25BN</td>
</tr>
<tr>
<td>Shell</td>
<td>Alexia S3</td>
<td>25BN</td>
</tr>
<tr>
<td>Total</td>
<td>Talusia LS25</td>
<td>25BN</td>
</tr>
<tr>
<td></td>
<td>Talusia LS40</td>
<td>40BN</td>
</tr>
<tr>
<td>JX Nippon oil &amp; Energy</td>
<td>Marine C255</td>
<td>25BN</td>
</tr>
<tr>
<td></td>
<td>Marine C405</td>
<td>40BN</td>
</tr>
</tbody>
</table>
3.2 Specification of low sulphur fuel oil

**Distillate fuel**

- Mitsui-MAN B&W engine allows using the distillate fuel oil such as MGO and MDO according to ISO 8217 without any modification on current fuel system.

**New type Low Sulphur fuel (ULSFO = Ultra low Sulphur Fuel Oil)**

Characteristics of ULSFO are different depending on the product. It is important to confirm the characteristics of used fuel (ULSFO) and inform the crew about the appropriate actions to ensure that the fuel could be used safely and efficiently.

The General characteristics of these fuels (ULSFO) are:

- They might have higher viscosity and higher pour point. (Heating is necessary)
- They might contain cat-fines (Al+Si). (Cleaning is necessary)
- There could be compatibility issues when blending with other fuels.
3.3 Viscosity and Lubricity

**Viscosity**

- The viscosity at engine inlet should be kept above 2mm²/s (cSt).
- Fuel pumps should be in adequate condition. (Worn fuel pumps must be renewed)
- It is advisable to make start checks in an area for safe operation prior to entering high risk areas, e.g., ports and other congested areas)

**Lubricity**

- Too little lubricity may result in fuel pump seizure. However, we do not regard the lubricity of fuel as a major issue.
- ISO 8217-2012 lubricity limits, HFRR (High Frequency Reciprocating Rig) wear scar limit max. 520μm, is adopted.
- When lubricity modifiers are used, follow the instruction manual of used lubricity modifier.
地球には、夢がある。
We have a dream for our earth.

ご清聴ありがとうございます。
Thank you for your attention.