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A REVIEW ON BLENDING ON BOARD AND OIL ANALYZER SYSTEM WITH INNOVATIVE ENGINE LUBRICATION MANAGEMENT

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Abstract: **The system mainly deals with cylinder lubrication of a 2-stroke marine diesel engine. Since the current cylinder lubrication system has major drawbacks, which are due to the presence of sulphur in fuel. The sulphur do not get perfectly neutralized because of the low Total Base Number (TBN) value of cylinder lubricating oil used. The non-neutralized left over sulphur in fuel develops severe problems in engine operation and thus reduce the efficiency of engine. The decrease the Time Between Overhaul (TBO) increases the cost of maintaining the engine components. To overcome all such drawbacks, an alternative idea has been developed as "Blending ON Board" system. The concept used here is blending of lubricating oil used in the system with new lubricating oil to completely neutralize the sulphur content in the Fuel Oil used for combustion.**

Keywords: **BOB(Blending On Board), BN(Base Number), MDE (Marine Diesel Engine), XRF (X-ray fluorescence) technology, TBO (Time between Overhauls), HFO (Heavy Fuel Oil).**

1. INTRODUCTION

The new concept called 'Blending on Board' (BOB) optimizes the overall lubrication performance of large bore Marine Diesel Engines. The operational flexibility and in-dependency of MDE operation are enhanced..Traditional Piston and its rings along with liner inside the combustion cylinder and engine bearing lubrication on Two-stroke Cross-Head Diesel Engines use at least two different type of lubricating oils. The system oil, serves as the lubricating and cooling oil for engine components. The special cylinder lubricating oil is produced by blending new Cylinder Oil with the system oil which is used for lubricating bearing in two-stroke engines (1). The cylinder lubricating oil is specially formulated with additives to satisfy these purposes:

- To reduce the wear and tear of the moving components inside the cylinder liner including the piston and its rings, a sufficient oil film is to be created.
- For cleaning the piston, piston rings, and cylinder liner from deposits, special additives with detergency and dispersant properties are added.
- Cold corrosion is prevented by neutralizing the acid produced from sulphur content of the fuel burnt in the engine which is created during engine operation.

2. TRADITIONAL LUBERICATION SYSTEM

The cylinder lubricating oil system and main bearing lubricating oil system are different in two-stroke cross-head MDEs. Cylinder lubricating oil is injected into the cylinder liner via the QUILLS (2). The system oil usually remains for a long

time in the engine as it is consumed in only relatively small quantities. For neutralizing the acid formed while using high sulphur content fuel, Engine Manufacturers recommend that cylinder lubricating oil with BN70 (Base Number70) for sulphur content >1.5% and BN40 for sulphur content <1.5%, be used. Along with these standard oils, other oils with BN levels between BN40 and BN70 are available in the market. So these grades of lubricating oil are incapable of neutralizing varying sulphur present in fuel used and so the left over sulphur creates a corrosive environment inside the cylinder combustion chamber which hiders the smooth operation of MDE.

3. BLENDING ON BOARD

The main purpose of cylinder lubricating oil produced by Blending on Board concept is to build an optimal lubricating oil film on piston ring moving surfaces, neutralizing sulphuric acid formed as a result of fuel combustion process and cleaning the sludge deposits. It would be both commercially and technically beneficial if the cylinder oil feed rate is maintained at the most optimal level under all operational conditions including load while simultaneously adjusting the cylinder oil properties to the required conditions (3).

The answer to all such question is Blending on Board system. It gives us a unique, flexible solution to all the above mentioned various challenging requirements. The adequate necessity is to keep the cylinder oil feed rate constantly low while adjusting the concentration of the additives in the oil. This results in a wide base number ranging from 15BN to 160BN (12). Furthermore, it is applicable for heavy fuel oil and its different sulphur content and also to keep the optimum feed rate for whatsoever load on the engine i.e Load in-dependency for lubrication.

With a Blending on Board installation, the used system oil which is in use is transferred from the main engine lubricationg oil sump and optionally also from the auxiliary engines (up to 10% of the total used oil volume), and is then blended with a specially formulated cylinder oil additive (High BN lube oil) . This results in a new cylinder lubricating oil for the vessel's specific operating conditions corresponding to load and sulphur content of fuel used for combustion, thus reducing a vessel's lube oil consumption by 20%-50%, calculated according to the present feed rate. Since the system lubricating oil is being consumed by transferring the oil to the blender, decreasing level of the lubricating oil sump will be replenished with fresh oil. Hence, there is no waste oil disposal (As in traditional method), where adverse lubricating oil test results will warrant cleaning and renewal of lubricating oil. This result in a cleaner engine and better engine performance, that means engine lubricating oil with better properties gives less friction in engine components and hence results into better engine efficiency.

4. SYSTEM REQUIREMENTS

4.1.BLENDER

4.2.ANALYZER

WORKING:

4.1Blender

The equipment includes a blender and an analyzer. The Blender is connected to the "Used System Oil Tank" and the "Additives Tank" on inputs, and discharges to the "Blended Cylinder Oil Tank" or the "Day Tank" on the other side.

The blender has a easy to operate computer system. Following values are to be entered on the BOB system of the blender control panel:

- The used system oil's BN level – this can be found out using the used oil analysis testing kits supplied onboard vessels or from the data supplied by the oil supplier or from the lubricating oil analysis done by shore based laboratories.
- The additive's BN level – this will be entered at the beginning unless the additive product with different BN is preocured at a later stage
- The required BN level for the new batch of blended cylinder oil – This value can be calculated from the Blending on Board instructions or from the integrated function in the blender control panel.
- The amount in tonnes for the new batch of blended cylinder oil

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The Blender will start operations when the "Start" button" on the computer is pressed. Optionally, the operation can also be started from the blender by changing the mode to manual from the manual /automatic/ semi-automatic, modes available locally. Automatic mode will repeat the blending process with the set values, once the blended cylinder oil tank reaches a set minimum level. The Blender will comply with all surveying class requirement for safe maritime operation including engine protection against tank low level.

4.2Analyzer

Blending on Board installation includes the oil Analyzer. X-ray florescence technology(XRF) is used in the analyzer that analyses the condition of cylinder blended onboard and the condition of the scrap down oil obtained from the under piston spaces after lubricating the cylinder. (4). A complete information about the lubrication level and engine condition will be displayed. This maintains a continuous condition monitoring of engine cylinder and its lubrication which is a class requirement. The software detects the mouse arrow for help instruction and displays the elaborate guidance on screen.

At regular specified intervals, the samples are collected and marked with identification bar codes. The samples are analyzed and stored for future reference. This bar code can be read by the Oil Analyzer reader from which the details of the sample analysed results can be read. The oil analyser analyses along with BN level, other elements present in the sample, eg: Iron, Sulphur, Zinc, Chromium, Copper, Calcium, Vanadium, Nickle etc. By analysing these elements, the status of lubrication and condition of Piston, its rings and liner can be detected. This gives a clear indication about the abrasive and corrosive wear.

The analyzer test results were compared with onshore oil analyzing laboratory reports by collecting and sending samples to them. The comparison showed a very good correlation between the laboratory results and analyzer results.

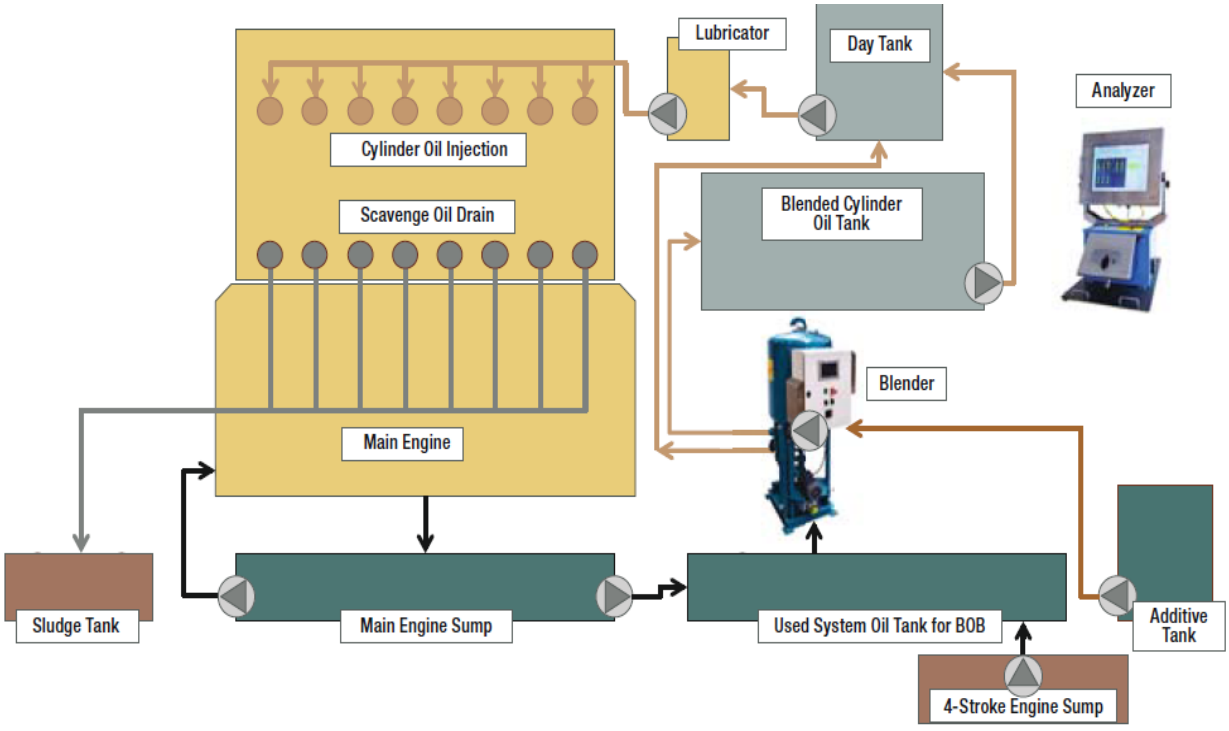

Fig.1. Two stroke Marine Diesel Engine cylinder lubrication arrangement outline diagram of Blender and Analyzer.

5. BENEFITS

5.1 Blender

5.1.1 Technical benefits

- Cold corrosion of the cylinder liner will increase when a acidic environment than recommended prevails inside the liner and, consequently, the wear on the cylinder liner will increase. Due to variable BN blending, the correct cylinder oil feed rate is selected automatically corresponding the sulphur content of fuel in use.

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- Of late, to achieve better fuel savings and to reduce emissions- CO2, NOX and SOX, new sailing and operating practices have been followed such as 'slow steaming' or 'super slow' steaming especially at engine low load. Controlled cylinder liner and rings wear during harsh operating conditions, such as slow steaming can be obtained using Blender.

- Engine sump "cleanliness" and reduction of deposits (crankcase, liners, piston rings, servo) due to the regular replenishment of new system oil in both the main and auxiliary engines results into reduction in maintenance and the need for oil separator discharging. (5)

- Reduced frictional losses with positive effects on fuel oil consumption Up to 1.5% improvement.

- Improved environmental footprint due to reduced lube oil consumption and the reduction of waste oil volumes Lower harmful particulate emissions and up to 80% less waste oil.

- High combustion chamber pressure and the intensity of liner cooling along with the high operating time at low load (slow steaming) produce "cold corrosion" on the cylinder liner walls. It is a corrosive wear due toacid condensation resulting from a drop in engine operation temperature during the slow steaming mode or when the overall length of the piston stroke is increased due to engine design. For better effectiveness-piston ring surfaces should be hard and chemically inert. Slow steaming weaknesses can be solved using- Low feed rate BOB variable BN cylinder oil,as shown in fig.2.

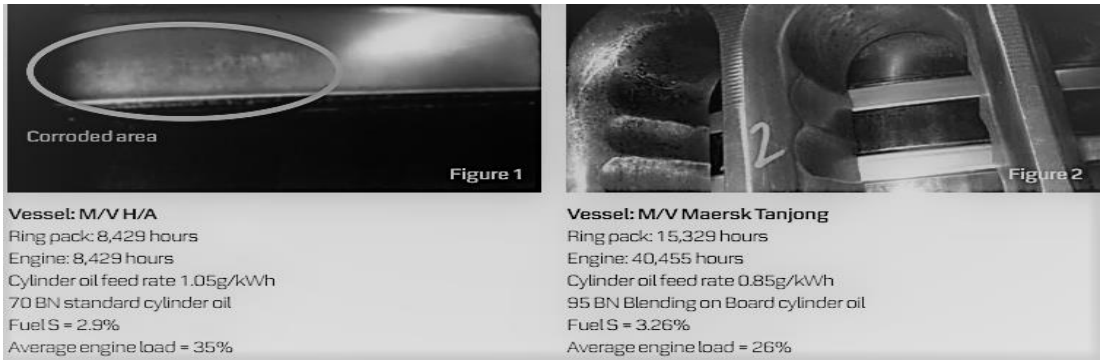

Fig.2. Cold corrosion effect on piston ring on two different pistons, one with cold corrosion effect and another without cold corrosion effect after operating on slow steaming.

- Fig 3 - Spongy surfaces on the liner wall are created by cold corrosion which can be seen as black patches and the lack of additives in cylinder oil unable to neutralize the acid and remove the carbonaceous deposit.

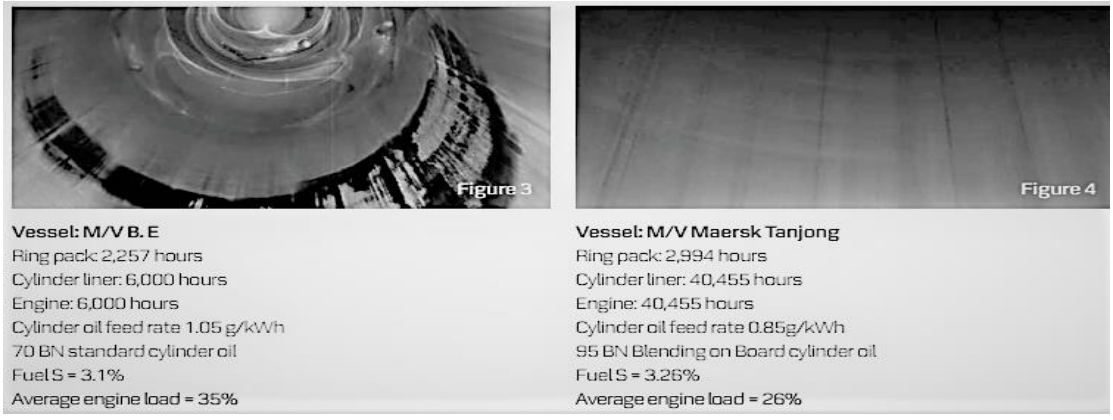

Fig.3.This picture above shows cylinder liner with carbon patches and without it after operating on slow steaming.

5.2. Analyzer

- From the analysis of piston underside oil, also known as Cylinder Scrape-Down Oil we will be able to identify cold corrosion of cylinder liners and also optimization of cylinder oil feed rate can be carried out. Blending on board with oil analysis detects wear (liner scuffing) and supplies information about cat fines and BN. Feed rate optimization gains cost and TBO extensions.

- Heavy fuel oil contains Cat fines (catalytic fines) which are hard aluminum and silicon oxide particles (6). To induce low temperature fuel cracking, cat fine are added to crude oil. The maximum concentration of aluminum plus silicon allowed according to ISO 8217:2012 is 60ppm. This shows that 60mg Al + Si is allowed for each kg of fuel. Marine engine manufacturers recommend less than 15ppm cat fines at the engine inlet, implying that there should be an efficient onboard fuel oil treatment system as well as analyzing mechanism . Analysis of HFO for cat fines and fuel sulphur level supports the Blending on Board process and operation of the fuel treatment plant

- Ability to trace each sample point's history, and to forecast problems by observing trends Supporting professional lubrication management.

- Measurement of important elements (Ca, V, Cr, Fe, Ni, Cu, Zn, Pb, S). possible with the Analyzer.

- Engine operated with minimum cylinder oil feed rate since the ability of knowing the true iron wear in the cylinder possible using the analyser.

5.3. Commercial benefits

Table.1. The table shows the annual savings being achieved by using blending on board

Savings / Year	Amount (USD/Year)
Cylinder Lubrication without BOB	**66000**
Using BOB Lubrication System	**36273**
Saving	**=29273**
HFO Saving	**14625**
System Oil Saving	**14625**
System Oilsaving	**5400**
Auxiliary Engine Oil saving	**2025**
Maintenance and spare parts saving	**15000**
Total Saving	**= 66777**

- Compared to using cylinder oil available in market, blended cylinder oil produced from used system oil along with additives results in reduction in total costs.

- Consumption of used system oil instead of discarding it reduces overall lube oil consumption.

- By loading additives which is small in volume in tanks helps to sail the ships for a longer period of time and there will be no need to buy fresh cylinder oil in expensive ports.

- The BOB product has wear control of liners and piston rings, thermal and oxidation stability, piston deposit control on Ring grooves, lands and Under crown, Detergency / Dispersancy (Engine cleanliness), Rust Inhibition and Free of gelling tendencies (7).

6. CONCLUSION

The Blending-on-Board system allows ship owners to meet the upcoming 2020 Sulphur regulation and at the same time the automatic system simplifies crew operation. Many ship owners want to limit the crew's daily activities by automating more processes on board the vessel. This system requires less crew interaction than other systems and thus eases the work of the crew.

The availability of Blending On Board system on commercial ships is very advantageous and provides higher quality of cylinder oil to the system by neutralizing the BN in the fuel and improves environmental footprint due to reduced lube oil consumption and the reduction of waste oil volumes.

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