

Proof of Performance Report

Customer:

Peter Döhle Schiffahrts-KG

Vessel:

M/V Tabea

Product:

Mobilgard™ 560 VS

Engine:

Wärtsilä 10RT-flex 96C-B

Benefit:

Minimising wear and deposits helps extend engine life, reduce maintenance costs, and lessen ship's environmental impact whilst simplifying operations with a variable-sulphur cylinder oil.

MobilGard™

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Proof of Performance: Mobilgard™ 560 VS

Benefit Summary

Mobilgard™ 560 VS is an all-new cylinder oil formulated to respond to changes in marine engine designs and the evolving conditions in which today's ocean-going vessels operate. In particular, it provides a solution to challenges resulting from tightening emissions standards that require ships to use low-sulphur fuels when in designated Emission Control Areas (ECAs). The oil delivers the highest level of performance for two-stroke marine diesel engines operating under extreme conditions that might include slow-steaming, reduced cylinder oil feed rates and the use of both high- and low-sulphur residual fuels.

In back-to-back field tests aboard the container vessel *M/V Tabea* owned by Peter Döhle Schiffahrts-KG of Hamburg, Germany, engineers from Wärtsilä and ExxonMobil Marine Lubricants evaluated the performance of Mobilgard 560 VS in a variety of operating conditions.

The first field test concluded in June 2010, after 5,614 hours on *M/V Tabea*'s Wärtsilä 10RT-flex 96C-B main propulsion engine. The overall engine condition was satisfactory with very low levels of deposits, plus low liner and ring wear rates. As a result, Wärtsilä issued a "No Objection Letter" to the use of Mobilgard 560 VS with high-sulphur residual fuels.

The follow-up field test — which concluded in April 2012, after an additional 4,134 hours — compared the performance of new Mobilgard 560 VS to Mobilgard™ 570 and Mobilgard™ L540, whilst operating under extreme operating conditions that included slow-steaming and the use of high-sulphur fuel. Cylinder numbers 1 through 5 were lubricated with the new Mobilgard 560 VS and cylinder numbers 6 through 11 with Mobilgard 570 or Mobilgard L540 (when engine operated on low-sulphur fuel).

The field demonstration confirmed that cylinders lubricated with Mobilgard 560 VS were in excellent condition, similar to those lubricated with Mobilgard 570, the widely respected cylinder oil it replaces.

Minimising wear and deposits can help extend engine life, reduce maintenance costs, and lessen a ship's environmental impact.



Test results confirmed that after 4,134 hours burning fuel with an average 2.38 percent sulphur content, pistons lubricated with Mobilgard™ 560 VS (Piston 2 pictured) were in similar or better condition than pistons lubricated with Mobilgard™ 570 or Mobilgard™ L540.



The maximum liner wear for the Mobilgard™ 560 VS-lubricated cylinder (Piston 2 Liner pictured) was 0.031mm/1,000 hours, demonstrating that the new oil provided outstanding liner protection throughout the test.

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Proof of Performance: Mobilgard™ 560 VS

Situation

Evolving international emission standards, changes in operating speeds and cost-saving reductions in cylinder oil feed rates have conspired to create unprecedented operating challenges for today's two-stroke marine diesel engines, many of which now must perform at levels beyond the capabilities conceived for their original designs. Increasingly, ship operators are focussing on the capacity of cylinder oils to protect engines operating under severe conditions and burning fuel with variable sulphur content. To respond to those challenges and conditions, ExxonMobil developed Mobilgard™ 560 VS.

Before launching Mobilgard 560 VS, ExxonMobil conducted extensive tests on the product both in the laboratory and in vessels at sea. This included two field tests onboard *M/V Tabea*, a modern containership owned by Peter Döhle Schiffsahrts-KG of Hamburg, and powered by a Wärtsilä 10RT-flex 96C-B main engine.

The purpose of the first field test was to obtain Wärtsilä's approval for Mobilgard 560 VS; the second was to compare the new product's performance with that of Mobilgard™ 570, the ExxonMobil cylinder oil considered best-in-class by many in the marine industry.

Field Test 1: Extended Performance Review

The first field test was initiated in July 2009, after pistons number two and number six were overhauled. Mobilgard 560 VS was then supplied to all cylinders for 5,614 hours. An interim scavenge port inspection conducted in October 2009 confirmed that everything looked normal and the oil was performing satisfactorily.

At the end of the test in June 2010, piston number 6 was pulled for inspection. The maximum liner wear rate was found to be very low. Ring and piston deposit measurements also confirmed the oil's ability to effectively neutralise combustion acids whilst protecting piston and liner parts. Based on the successful results of this field test, Wärtsilä issued a "No Objection Letter" for the use of Mobilgard 560 VS in two-stroke marine diesel engines with high-sulphur residual fuels.

Field Test 2: Comparison with Mobilgard™ 570

The second field test provided a side-by-side comparison of Mobilgard 560 VS with Mobilgard 570 and Mobilgard L540* whilst performing under the same operating conditions. Throughout the test, the ship's engine operated under slow-steaming conditions and a load that ranged within 9 – 50 percent. The average sulphur content of the fuel burned was 2.38 percent, with the average cylinder oil feed rate at 1.00 g/kWh.

Five of the engine's cylinders were lubricated with Mobilgard 560 VS, whilst the other five were lubricated with Mobilgard 570 or Mobilgard L540. Regular scavenge port inspections,



After 4,134 hours burning fuel with an average 2.38 percent sulphur content, the piston lubricated with Mobilgard™ 560 VS was found to be very clean, with very light deposits on the piston top ring land and no deposits on the lower ring lands.

LinerScan measurements, scrapedown analysis results and ring pack spray samples were used to monitor engine condition.

After 4,134 hours, two pistons were pulled for inspection: one lubricated with Mobilgard 560 VS and the other lubricated with Mobilgard 570 or Mobilgard L540.

- The liners of both pistons were found to be in good condition based on the liner running hours.
- Maximum liner wear for the Mobilgard™ 560 VS-lubricated cylinder was 0.031mm/1,000 hours, demonstrating that the new oil provided outstanding liner protection throughout the test.
- Piston rings lubricated with Mobilgard 560 VS were also found to be in good condition, with very good running services and no traces of wear. Ring grooves and back surfaces of the piston rings were found to have deposits, but less than those lubricated by Mobilgard 570/L540.

This field demonstration confirmed that cylinders lubricated with Mobilgard 560 VS were in similar or better condition than those lubricated with Mobilgard 570 or Mobilgard L540.

* Mobilgard L540 was used instead of Mobilgard 570 when the engine was switched to low-sulphur residual fuel.

Mobil Gard

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Proof of Performance: Mobilgard™ 560 VS

Solution

Mobilgard™ 570 and Mobilgard™ L540 have a long history of delivering outstanding protection for slow-speed marine diesel engines. Each product is, however, limited in the range of fuel sulphur it can effectively lubricate over an extended period of time.

Mobilgard™ 560 VS is a single-product solution that delivers outstanding performance for engines operating under extreme conditions and burning fuel with sulphur levels as low as 0.5 percent and as high as 4 percent.

The proprietary formulation used in Mobilgard 560 VS provides outstanding piston deposit and wear control, plus effective neutralisation and anti-corrosion performance.

Testing conducted onboard *M/V Tabea* confirmed that cylinders lubricated with Mobilgard 560 VS were in similar or better condition than those lubricated with Mobilgard 570, the widely respected cylinder oil it replaces.



ExxonMobil researchers designed Mobilgard™ 560 VS using hand-picked, high-quality heavy neutral base oils and proprietary additives that deliver the highest level of performance. These carefully selected components are properly balanced to create an advanced formulation that can help extend the life of an engine's pistons, piston rings and cylinder liners.

Impact

The results of more than 9,700 hours of in-service testing in *M/V Tabea's* Wärtsilä 10RT-flex 96C-B main propulsion engine confirmed Mobilgard 560 VS's ability to minimise engine wear and deposits, despite challenges that included slow-steaming and the use of high-sulphur residual fuel. The product's outstanding performance can help extend engine life, reduce maintenance costs, and lessen the ship's environmental impact.

Mobilgard 560 VS is endorsed by engine builders MAN Diesel & Turbo, Wärtsilä and Mitsubishi Heavy Industries for use in two-stroke marine diesel engines burning both high- and low-sulphur residual fuels.

MITSUBISHI HEAVY INDUSTRIES, LTD.
1-1, 1-CHOME, WADASAKI-CHO, HYOGO-KU
KOBE, JAPAN

MAN Diesel & Turbo

To: ExxonMobil
Subject: Mobil Oil Heavy Duty
194 Syngro
176-71 Altheim
Att.: Mr. Yarn

Dear Sir / Madam,

Following guidelines 560 VS is Diesel RT according to service hour

The actual low (around 1000 hours) to more than 1000 hours

MAN Diesel acceptable

MAN Diesel two-stroke engine guidelines

As the Turbo cannot components

Wärtsilä Switzerland Ltd

Mr. K. Crouthamel
ExxonMobil EMRE,
600 Billingsport Road
Paulsboro, NJ 08058
United States of America

WÄRTSILÄ

Your Reference / Date: 11.02.2010
Our Reference: 11.02.2010
Date / Date: 11.02.2010
Page / Page: 1 / 2
Document: 11.02.2010
No. 2010/12.001

No Objection Letter: ExxonMobil Mobilgard 560VS (BN60, SAE50)

Dear Sir / Madam,

The ExxonMobil lubricating oil Mobilgard 560VS has completed two 4000 hour validation tests in the Wärtsilä 10RT-flex96C-B engine on board the vessel Tabea. Additionally a 2000 hour test in the Wärtsilä 7RTA20U engine aboard the vessel Stingsborg was completed. Based on the results of the engine inspections and lubricating oil analyses, Wärtsilä has no objection to the use of the lubricating oil in Wärtsilä RTA, RT-flex and W-X as well as Sulzer 2-stroke engines operating on fuel with sulphur content in the range 0.5-4.5 % m/m on a continuous basis. Instructions for older engine types designed by Wärtsilä and Sulzer can be requested from Wärtsilä Switzerland Ltd. The lubricants must comply with Wärtsilä's lubricating oil requirements and recommendations. The lubricants should be used as recommended in the Wärtsilä Service Bulletin RT-18.4, RT-113 as a BN60 cylinder oil and other manuals.

ExxonMobil assumes all responsibility for the performance of the lubricating oils in service of the above mentioned engine types to the exclusion of any liability of any Wärtsilä company belonging to the Wärtsilä group. ExxonMobil along with other possible manufacturers and distributors of the products in question shall indemnify, compensate and hold harmless Wärtsilä and companies belonging to the Wärtsilä group from and against any claims, damages and losses caused by the lubricating oils in question.

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Mobilgard™

Learn more at mobilgard.com

Proof of Performance: Mobilgard™ 560 VS

Appendix: Peter Döhle Schiffahrts-KG Customer Profile

Peter Döhle Group is one of the leading providers of shipping services worldwide. Founded in 1956 in Hamburg, the family-owned company operates a modern fleet of about 450 container vessels, multi-purpose vessels and bulk carriers. Beside chartering and sale and purchase of ships, the company offers financial, commercial and technical support, insurance, crew management, full agency and bunker services, and the development of shipping software.

The company owns approximately 100 vessels, with an estimated additional 100 units part-owned by the Group. ExxonMobil Marine Lubricants has been working with Peter Döhle Schiffahrts-KG since 1999, and currently lubricates about 130 of the company's owned and part-owned vessels. This includes *M/V Tabea*, a 5,500 TEU containership built in 2006. For more information on Peter Döhle Schiffahrts-KG, please visit doehle.de.



New Mobilgard™ 560 VS was tested in M/V Tabea's Wärtsilä 10RT-flex 96C-B main propulsion engine for 9,748 hours. Results confirmed the oil's ability to minimise wear and deposits despite challenges posed by slow-steaming and the use of high-sulphur fuel.

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Appendix

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