SEA-Mate® Blending-on-Board

Case study: Variable Base Number (BN) Cylinder Oil Blended cylinder oil laboratory evaluation

MAERSK FLUID TECHNOLOGY

Introduction

The SEA-Mate® Blending-on-Board system enables the operator to produce Fit-for-Purpose cylinder oil.

The system allows for a tailored cylinder oil BN to be adjusted and delivered. The performance of Blending-on-Board lubrication is documented and well-proven on-board vessels.

Besides operating vessels with Blending-on-Board, it is also important to understand the blended oil characteristics compared to traditional cylinder oils. Laboratory analysis is very clear: Blending-on-Board cylinder oil is of equal or superior quality compared to traditional cylinder oil, on a number of critical parameters.

Questions have been raised as to the use of used system oil as a base oil. Actually, the combination of well-handled cylinder oil additives and used system oil delivers very interesting and beneficial cylinder oil qualities, since the system oil is used as a premium quality (or enhanced) base oil.

Laboratory results illustrate that the performance of Blending-on-Board cylinder oil is always at the higher end of what can be expected. This better performance, combined with the technical flexibility that on-board blended cylinder oil allows when it comes to defining the BN and the feed rate to be used, makes it superior.

As a basis for comparison, various BNs of Blending-on-Board cylinder oils were produced on various vessels using various additive packages. This document summarizes the results obtained from standard laboratory tests that are used to assess cylinder oils.

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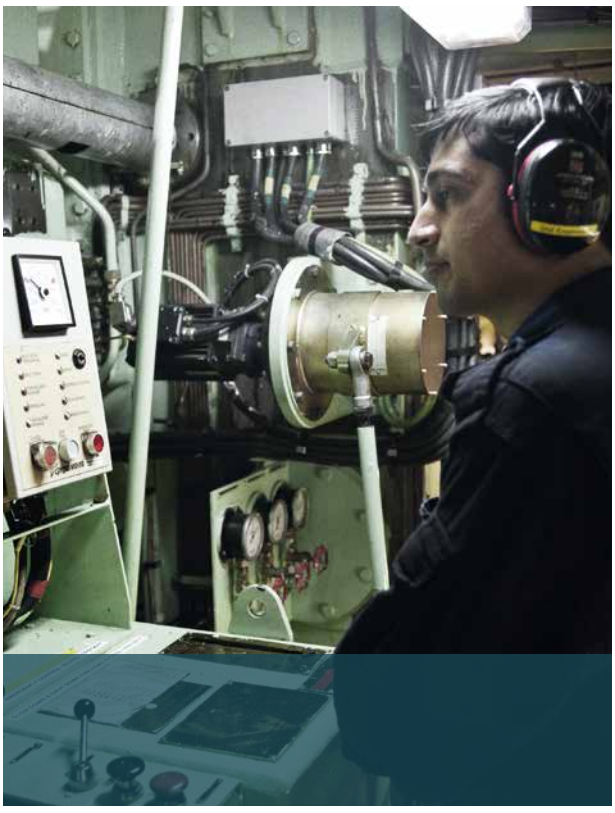


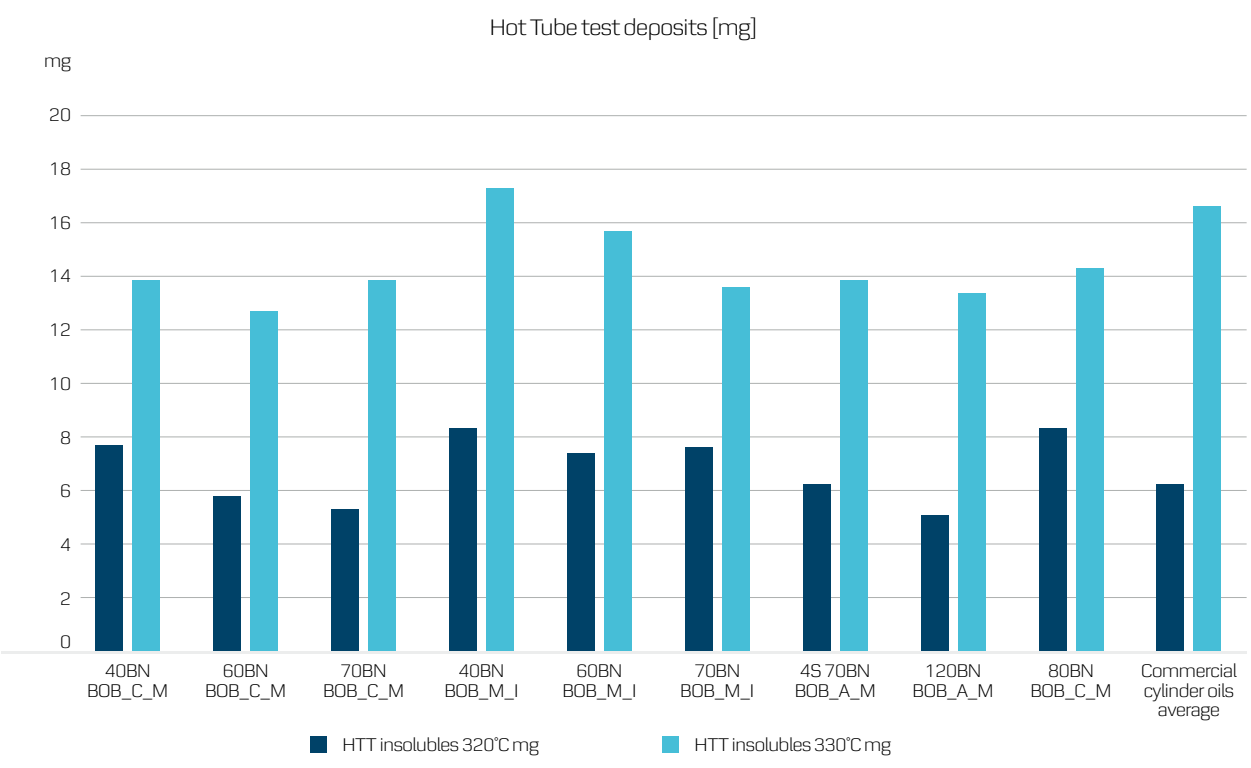
Detergency and deposit handling

When it comes to cylinder lubrication, the tendency of the oil to form deposits and its ability to clean them is of the outmost importance. These deposits can be found on the piston crown and also in the piston ring grooves. They will eventually strongly contribute to a third body abrasion phenomena that will accelerate the wear of the liner, as well as the wear of the piston grooves.

The Hot Tube test (also known as Komatsu Hot Tube test) provides an indication of the control of cylinder oil deposits and detergency at high temperatures in an oxidative environment.

The result is expressed in terms of the quantity of deposits created. The lower the quantity of deposits created, the better the lubricant is considered on that aspect. The Blending-on-Board cylinder oil results consistently showed a smaller or equal quantity of deposits in the Hot Tube test.

It can therefore be concluded that when it comes to deposit control and detergency, the variable BN Blending-on-Board lubricant behaves at least as good as the classic, fixed BN cylinder lubricants.



Oxidation resistance

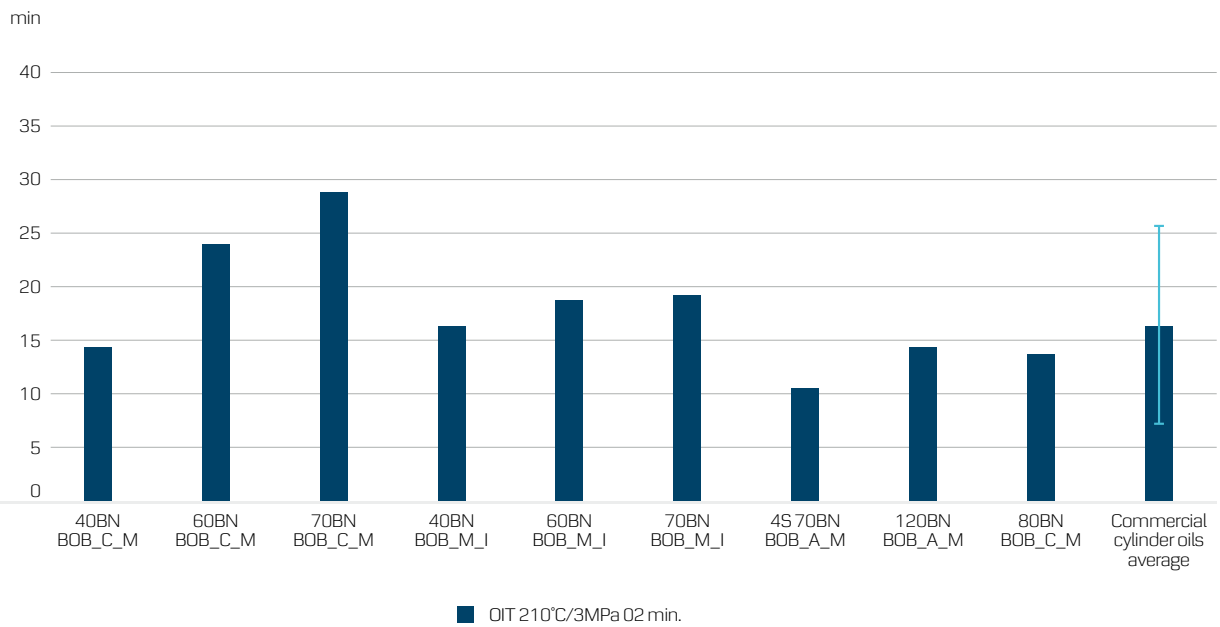
Cylinder oil is subject to high temperatures and as a consequence the lubricant molecules are submitted to thermal stress that they have to be able to withstand. Otherwise, the molecular structure may be destroyed, the additives rendered inoperative, the viscosity increased and acidic species created.

The cylinder oil must be able to withstand high temperature oxidation in order to perform its main functions (oil film build up, neutralization, detergency and dispersency). The pressure differential scanning calorimetric (PDSC) test assesses the oxidative stability of the various cylinder oils at high temperature and pressure. The result, expressed in minutes, represents the time the lubricant can resist oxidation at 210°C with a forced influx of oxygen. The higher the oxidation induction time, the better the lubricant is considered for its oxidation resistance performance.

The results in the table below compare various Blending-on-Board cylinder oils (with various additives and BNs) with the average of commercial cylinder oils.

The results show that the blended cylinder oils exhibit at least an oxidation resistance comparable to the commercial cylinder oils, and in some cases even better.

Oxidation Induction Time

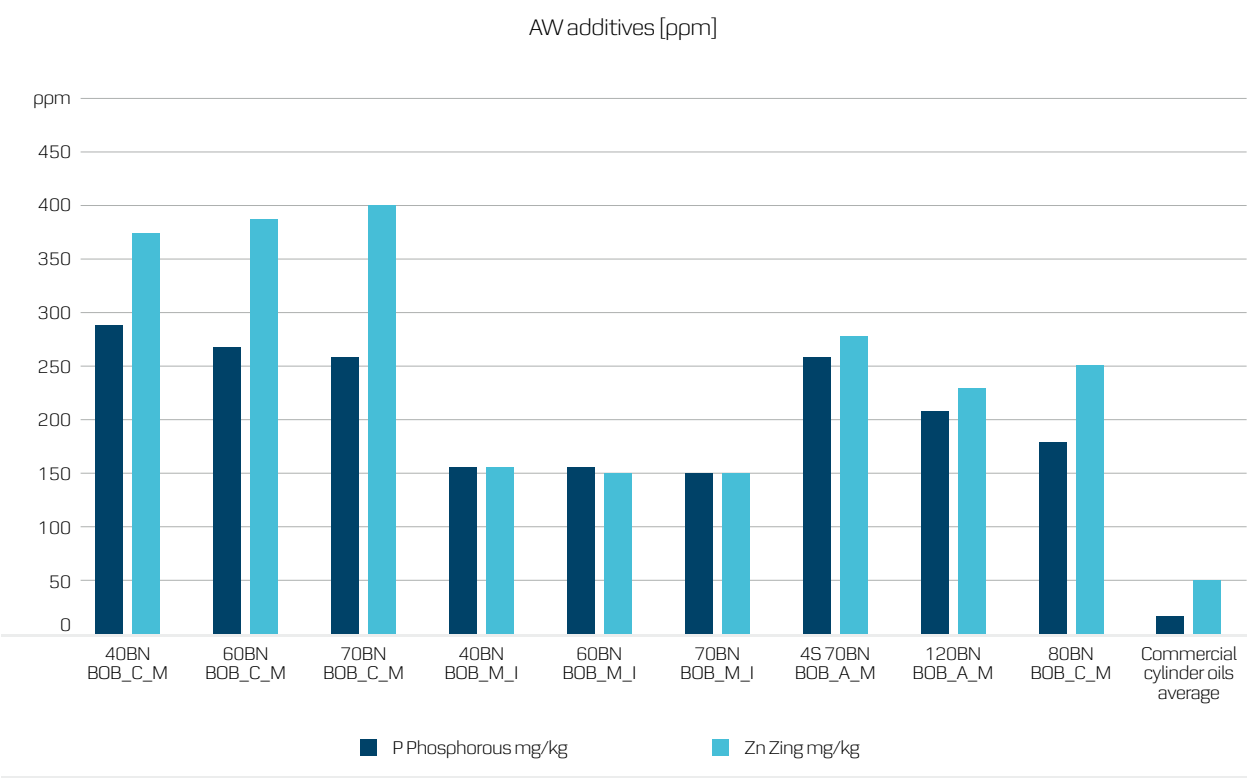


Wear resistance

Interestingly, Blending-on-Board cylinder lube oil will always contain anti-wear (AW)/Extremepressure (EP) additives, mainly in the form of ZDDP (Zinc DialkylDithioPhosphate) or equivalent.

System oil, which constitutes the base oil in the blended cylinder oil, contains a high quantity of those additives. As a consequence, the wear resistance, as well as the load carrying capacity of the blended cylinder oil, will be enhanced in comparison to a standard cylinder oil with a classic group I or group II base oil.

The unique presence of anti-wear additives in Blending-on-Board cylinder oil has proven to be a performance-enhancing parameter during difficult operating conditions and it reduces the risk of excessive or sudden severe wear.

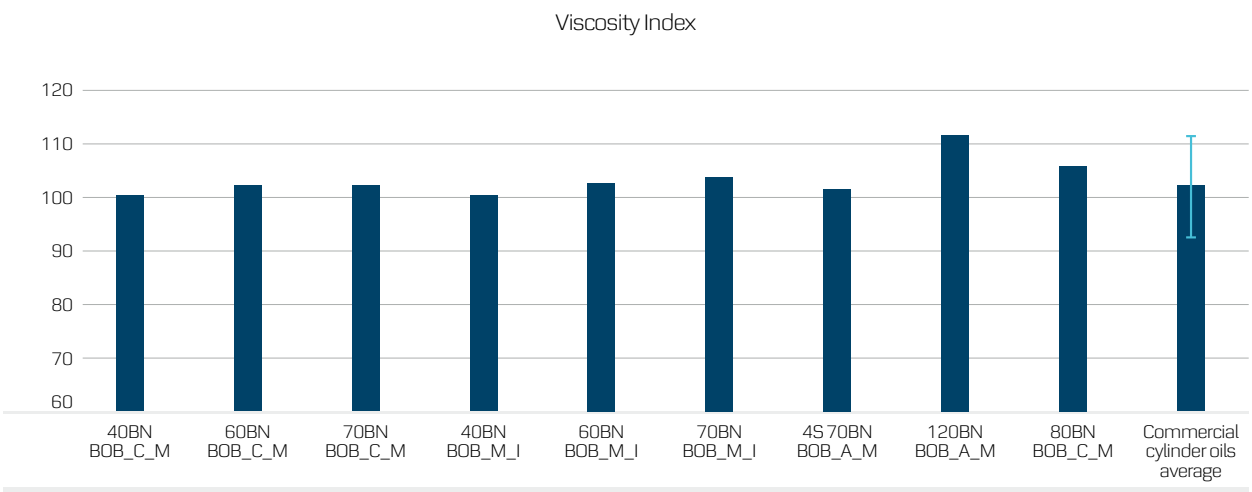


Viscosity index

Cylinder oil is meant to operate over a wide range of temperatures, considering the temperature distribution over the length of the cylinder liner or the variation of temperatures depending on the operating load.

The viscosity index VI is used for the description of the viscosity–temperature behaviour. The higher the viscosity index is, the less the oil will degrade when the temperature increases.

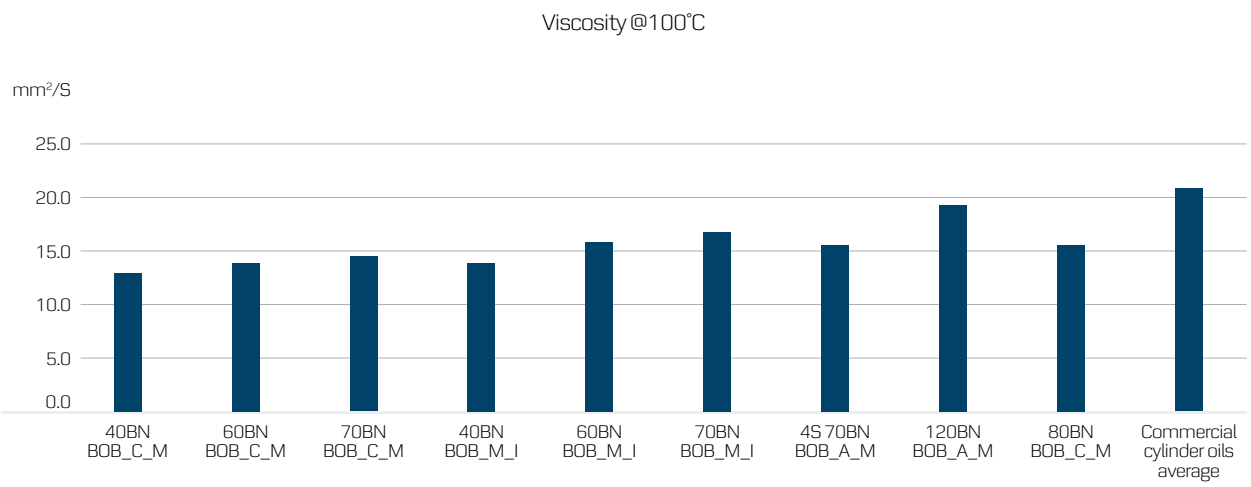
The Blending-on-Board cylinder lubricant always exhibits a viscosity index greater than 100 and is always as good as or even better than standard fixed BN cylinder oils.



Viscosity

As Blending-on-Board operates with a variable BN cylinder oil, the Blending-on-Board cylinder oil will have viscosities ranging from lower SAE 40 to SAE 50. Although historically an SAE 50 cylinder lube oil has been required, the use of these SAE 40 to SAE 50 grades did not show any detrimental effect during field operation.

Actually, this lower viscosity (that is still suitable for optimum piston ring/liner contact) has an additional advantage: The lower viscosity might improve the cylinder lube oil distribution on the cylinder liner circumference, which is still today a big challenge for the large bore 2-stroke engines and can lead to irregular wear, also known as clover leafing.

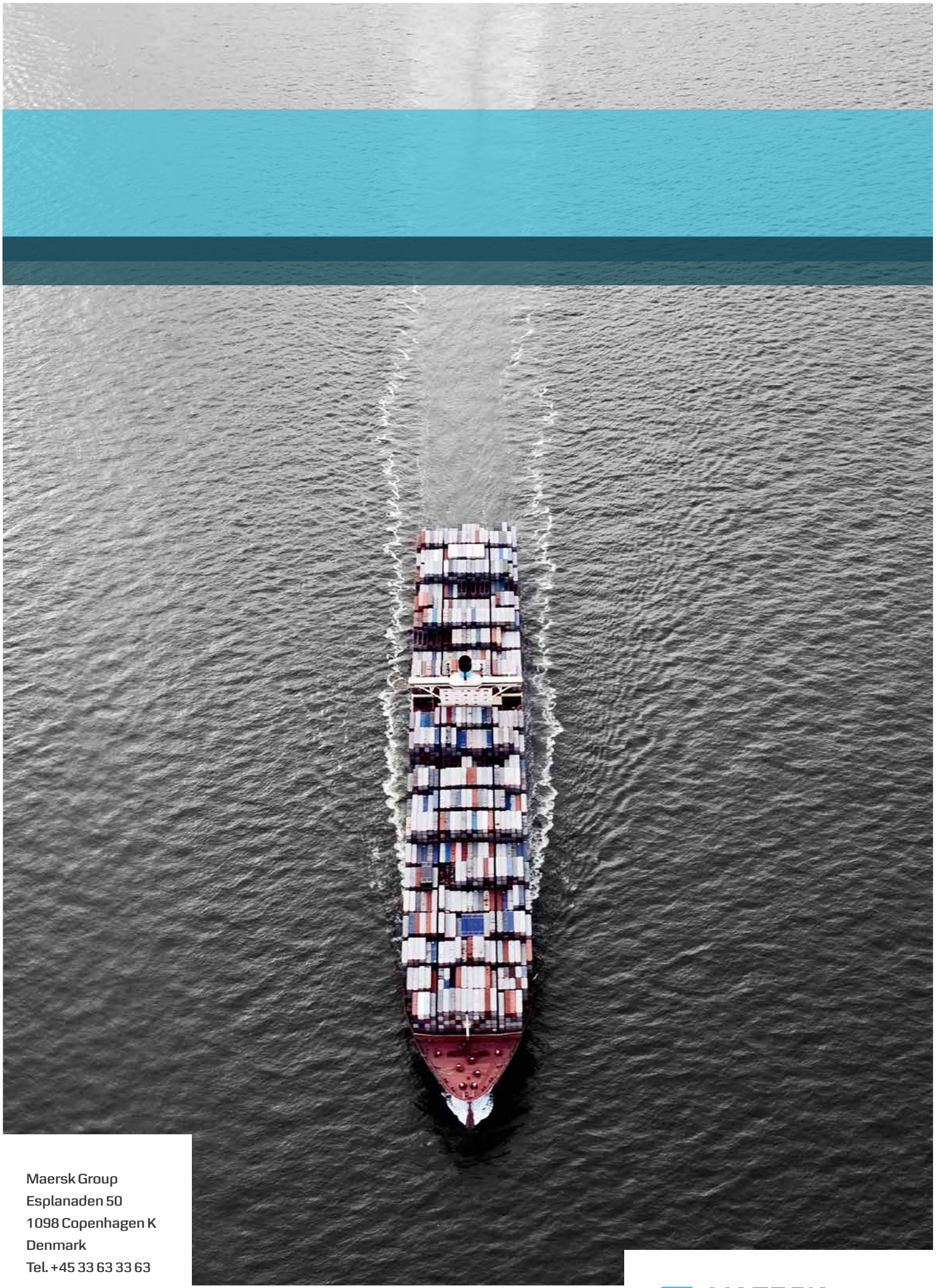


Conclusion

These results illustrate that the performance of Blending-on-Board cylinder oil is equal to or better than the commercial cylinder oils average, on the following parameters:

- **Detergency and deposit handling**
- **Oxidation resistance**
- **Wear resistance**
- **Viscosity index**
- **Viscosity**

The Blending-on-Board cylinder oil meets or exceeds performance expectations and also offers a technical flexibility when it comes to defining the BN and the feed rate to be used, making it a superior choice.



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