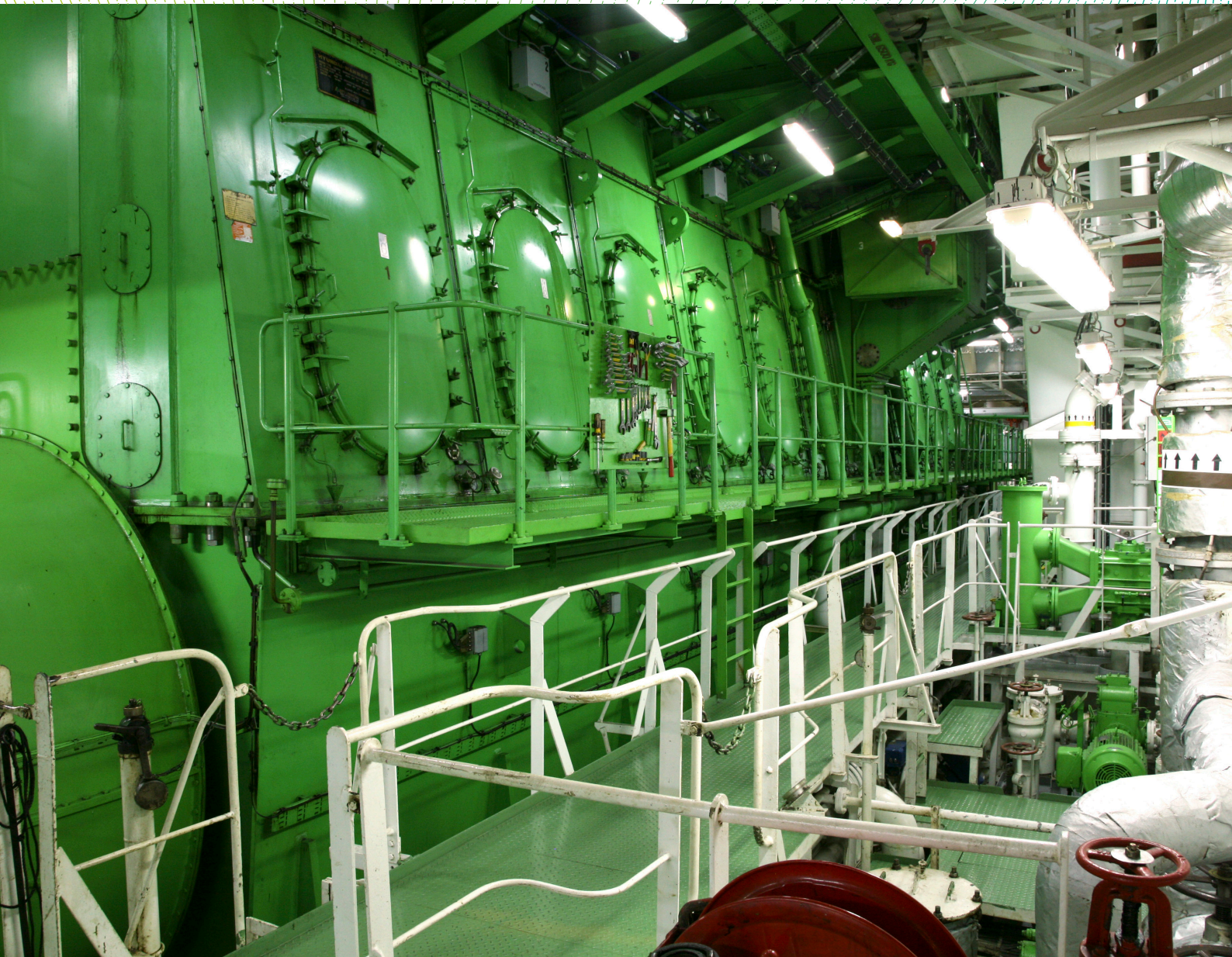


MobilGard™ cylinder condition monitoring

Energy lives here™





An advanced condition monitoring programme to optimise engine performance

Scrape down oil analysis is an essential tool for vessel operators – it can provide information that can help improve engine reliability, reducing associated maintenance and repair costs.

That is why ExxonMobil developed its MobilGard™ Cylinder Condition Monitoring (CCM) programme – a comprehensive lubrication support service founded upon a suite of three simple-to-use on-board tests, coupled with on-shore technical support, that analyse scrape down oil and provide a complete picture of engine and lubricant performance.

MobilGard CCM is designed to help vessel operators reduce costs and increase vessel reliability. Properly implemented it can contribute towards extending piston overhaul intervals and help optimise feed rates while also providing the data needed to tackle cold corrosion.

Also, many operators are now required to switch between fuels and lubricants when entering and leaving Emission Control Areas (ECA) in order to meet the 0.10% fuel sulphur cap. Knowing what is happening inside your engine has never been more important.

The MobilGard CCM programme comprises three independent tests coupled with the expertise of ExxonMobil engineering teams to analyse two key parameters, iron content and Base Number (BN) in the oil. The tests identify:

1. The concentration of ferrous iron in the scrape down oil, which provides an indication of an engine's liner wear rate due to abrasive wear.
2. The level of iron salts in the sample, which provides an indication of an engine's liner wear rate due to corrosive wear.
3. The BN level, which indicates whether the engine's liners are being protected from the effects of the acidic products of combustion, or are in danger of suffering from corrosive wear. This test also provides early indication of the dangers of over-lubrication whereby deposit build up can cause significant engine wear.

Moreover, vessel operators are increasingly encountering fuels with high levels of cat fines, which can cause abrasive wear if not treated. With CCM such a fuel will immediately be identified by a spike in metal content (and analysis of laboratory results), helping ensure that preventative steps can be taken before the fuel is used.

Through regular testing, results can be plotted and trends uncovered to gain a full understanding of cylinder oil and engine condition. The results can help vessel operators identify the most appropriate BN cylinder oil and feed rate to protect engines from cold corrosion.

Each sample is analysed against a database of more than 200,000 sample test results, which enables ExxonMobil to offer vessel operators an extensive insight into wear characteristics and guidance on engine feed rate adjustments. Also, by using MobilGard CCM in combination with high-performance MobilGard™ cylinder oils, marine operators can look to identify the most appropriate BN cylinder oil and feed rate to help extend engine life and reduce operating costs.

Sampling and analysis

Testing for Ferrous Iron

The MobilGard™ Monitor tests scrape down oil for indications of abrasive wear on engine liners.

The MobilGard Monitor contains a highly sensitive measuring head that detects ferrous iron particles in oil. Accurate calibration is ensured using the set of reference bottles that are supplied with the unit.



Testing for Corrosive Iron

The MobilGard™ Corrosion Check tests scrape down oil for indications of corrosive wear on engine liners.

The MobilGard Corrosion Check Kit includes a non-toxic reactant, which enables users to quickly and easily check for the presence of iron salts – the result of corrosive wear on an engine's cylinder liners. This test enables users to uncover an engine's liner corrosive wear rate and act immediately to rectify any cold corrosion issues.



Testing the BN level

The Digicell Easyship measures the residual BN value of scrape down oil samples, which demonstrates if an engine's liners are being protected from cold corrosion.

The Digicell Easyship kit provides a quick and easy on-board test for the level of residual BN in oil scrape down samples. The kit's output enables operators to see if a vessel's engine liners are being protected from the acidic products caused during combustion and the associated corrosive wear.





Data collection

Regular testing ensures better report accuracy, which helps to deliver customised feed rate guidance.

Each vessel on the CCM programme is provided with software to record and transmit the sample data back to ExxonMobil for analysis. Vessel operators log the results of their on-board tests and use proprietary software to submit compressed data files to ExxonMobil's CCM engineers, minimising satellite data costs.

It is recommended that scrape down samples are taken every 250 engine running hours for on-board testing and every 500 engine running hours for laboratory testing. If there is a significant change in fuel sulphur level, feed rate or operating conditions then sampling after 50 engine running hours is recommended.

Graph Key

Green:

Results are healthy and it is unlikely significant wear will occur if conditions remain unchanged.

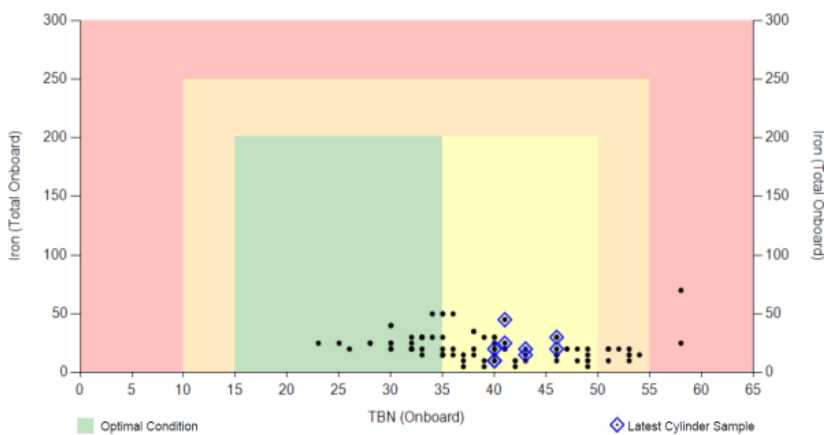
Orange:

Results are reasonably healthy but if left unchecked may lead to elevated wear and engine damage.

Red:

Results are outside OEMs recommended limits and action is required to prevent engine damage.

Iron vs TBN (Onboard)



Expert Analysis and Reporting

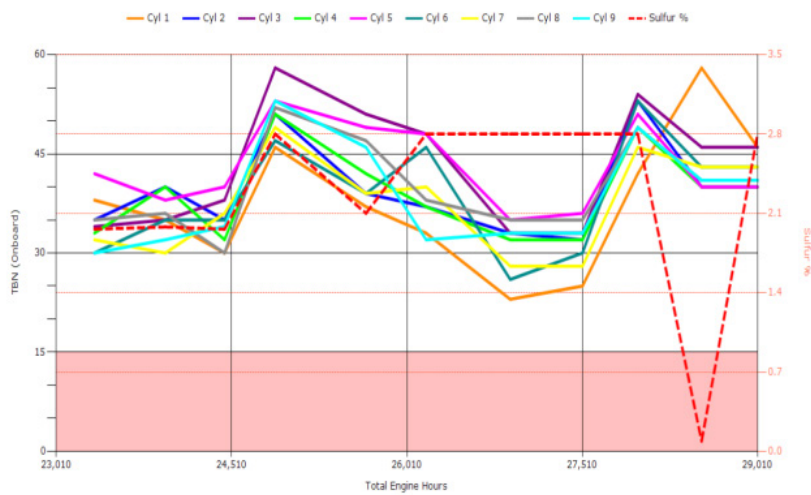
Each set of CCM testing data is analysed by the ExxonMobil CCM team and a bespoke report is produced within three working days of receiving the data.

Customised Vessel Reports

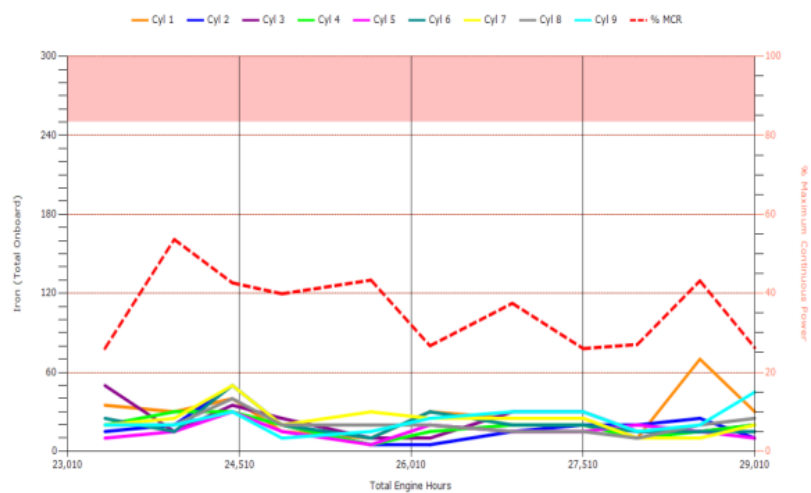
Upon each individual submission a CCM vessel report is produced with bespoke recommendations by the ExxonMobil engineers.

All findings are reported in an easy-to-understand format, including historic trend analysis for the engine, with advice on how to rectify any areas of concern and opportunities to help optimise engine operation.

TBN (Onboard)



Iron (Total Onboard) and % MCR



OEM Recommended Sweep Test Reports

The CCM service also includes sweep test analysis. Sweep tests are a five-day test recommended by MAN for their newer engine designs whereby the feed rate is reduced in steps from the maximum recommended level, once per day for five days. Each day a scrape down sample is taken and tested. The results of this multi-day test are then sent to the ExxonMobil CCM engineers.

CCM sweep test reports provide the vessel operator with a comprehensive view of the engine's reaction to a series of feed rate reductions. Each digitally delivered report includes bespoke recommendations of optimum feed rate settings for the current operating conditions.

Following the completion of an on-board sweep test, CCM vessel reports will continue to be generated with the aim of helping vessel operators react to changes in operating conditions as well as further optimising engine performance.

Comprehensive Engineering Support

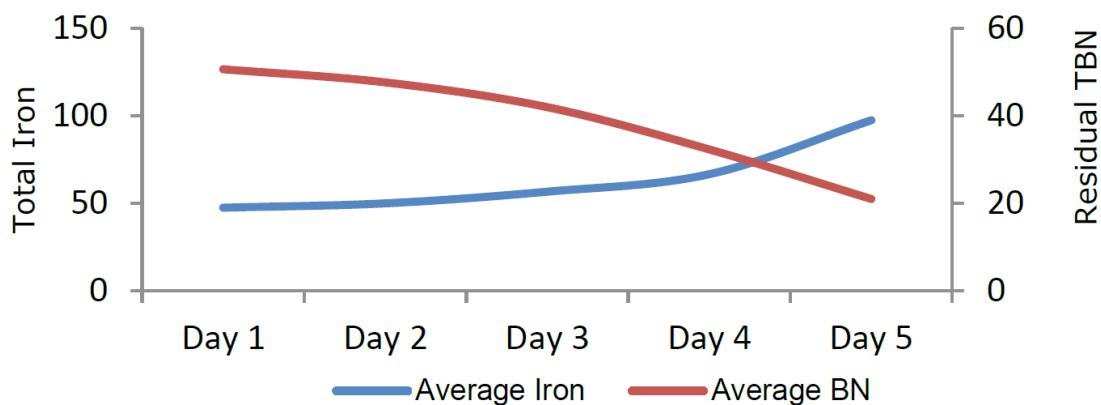
Today, more than 550 vessels rely on the MobilGard CCM programme to help enhance the performance of their engines and ExxonMobil is therefore ideally placed to support marine operators that are introducing new or retrofitted engines into their fleet.

For more than 10 years and over 200,000 test results ExxonMobil has helped customers resolve hundreds of technical queries. By enrolling in the MobilGard CCM programme each vessel operator has access to comprehensive support from the ExxonMobil CCM engineers for any main engine lubrication queries.

Used Oil Analysis Laboratory Service

In addition to the on-board checks on scrape down oil, the MobilGard CCM programme recommends the use of a full range of laboratory-based tests to give further insights into the performance of the oil and engine. These include full oil condition and wear metal analysis.

Day of testing vs. TBN and Iron



Scrape down sample analysis

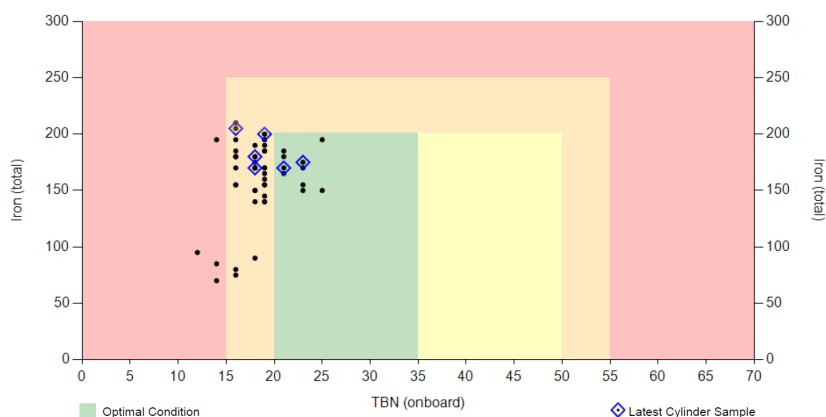
Cold corrosion

The first graph alerted ExxonMobil engineers to the early indication of cold corrosion for this six cylinder two-stroke marine engine, which, if left unchecked, could have resulted in significant damage to its cylinder liners. It was recommended that the vessel should move from a 70BN cylinder oil to Mobilgard™ 5100, a high performance 100BN alternative.

A second sample [graph 2] was taken by the crew in partnership with ExxonMobil's CCM team following the switch and 3,000 operating hours. It shows that the risk of cold corrosion has been mitigated.

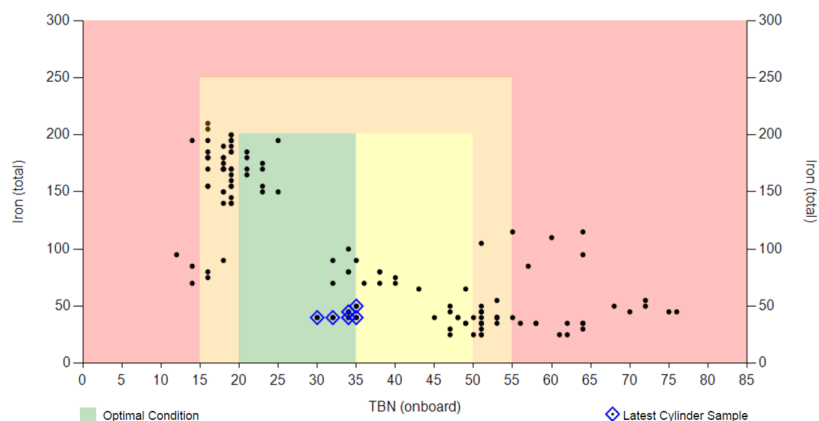
Following the switch to Mobilgard 5100 a sweep test could have been performed to realise this benefit in a shorter period of time.

Iron vs TBN (onboard)



Graph 1: An early indication of cold corrosion

Iron vs TBN (onboard)



Graph 2: Improved results following a switch to a higher BN oil

Scrape down sample analysis continued

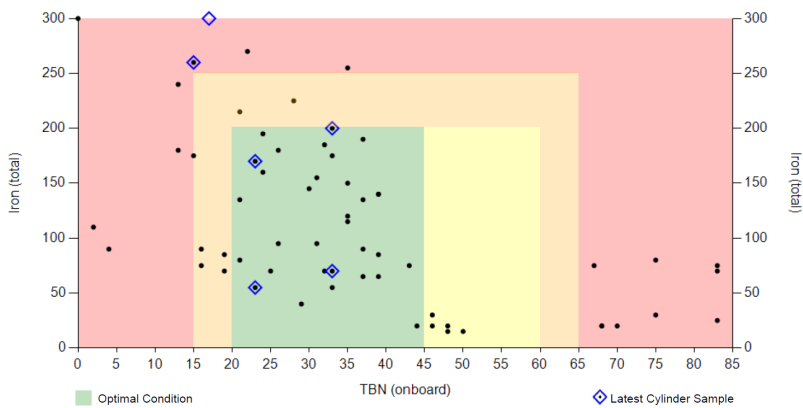
Cat fines

Disrupted fuel tank sediment and off-spec fuel can result in an increase of cat fines (aluminium and silicon) in the fuel system. If left untreated this can result in costly engine wear.

The test results (graph 3) warned ExxonMobil's engineering support team that it looked likely that a damaging concentration of cat fines was present in the fuel, which was leading to the high iron readings in the scrape down sample. With the expertise of ExxonMobil engineering teams – the vessel's fuel purifier throughput was reduced, which improved the fuel purifier performance, and an increased sampling frequency helped to monitor improvement. This issue could have gone unnoticed and resulted in significant abrasive wear if the cylinder condition monitoring programme had not been put in place. This was all achieved in close collaboration with ExxonMobil.

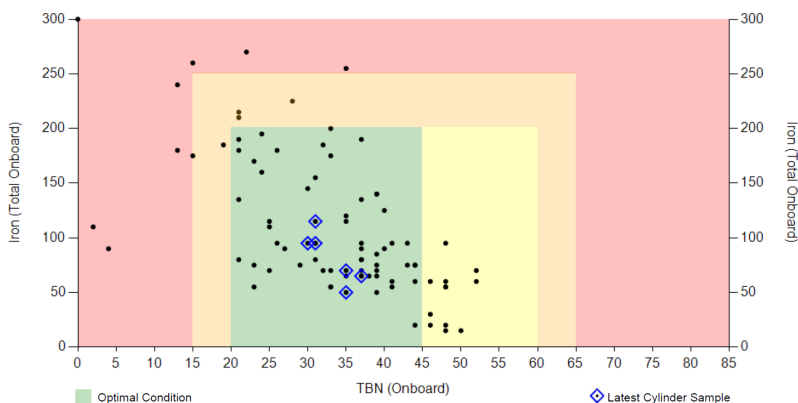
A second sample taken after 2,000 hours of increased purifier operation and close monitoring of on board test data by the ExxonMobil CCM team showed the issue had been resolved [graph 4].

Iron vs TBN (onboard)



Graph 3: Damaging concentration of cat fines

Iron vs TBN (Onboard)



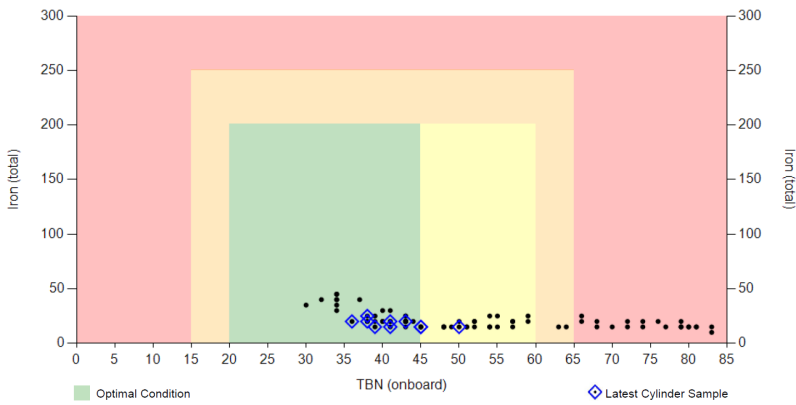
Graph 4: Reduced cat fines due to increased purifier operation

Feed rate reduction

Cylinder condition monitoring showed excessive BN in the scrape down sample when Mobilgard 5100 was used at the same rate as the 70BN industry cylinder oil. Feed rates were reduced by 50% without compromising engine performance and improved cylinder condition. The following two graphs show the result on feed rates after switching from a 70BN cylinder oil to Mobilgard 5100, a 100BN lubricant, to combat cold corrosion. On-going analysis shows that further reduction are possible [graph 6].

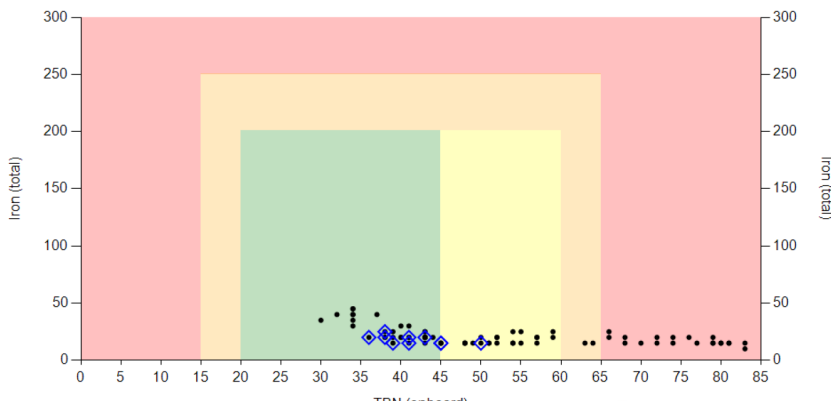
The MobilGard CCM Sweep Test could have been used in this case to ensure the maximum reduction in cylinder oil consumption was realised.

Iron vs TBN (onboard)



Graph 5: Excessive BN in the scrape down sample

Iron vs TBN (onboard)



Graph 6: Protection against cold corrosion at a reduced feed rate

© 2016 ExxonMobil. The user may forward, distribute, and/or photocopy this copyrighted document only if unaltered and complete, including all of its headers, footers, disclaimers, and other information. The information in this document relates only to the named product or materials when not in combination with any other product or materials. We based the information on data believed to be reliable on the date compiled, but we do not represent, warrant, or otherwise guarantee, expressly or impliedly, the merchantability, fitness for a particular purpose, suitability, accuracy, reliability, or completeness of this information or the products, materials, or processes described. The user is solely responsible for all determinations regarding any use and any process. We expressly disclaim liability for any loss, damage, or injury directly or indirectly suffered or incurred as a result of or related to anyone using or relying on any of the information in this document. There is no warranty against patent infringement, nor any endorsement of any product or process, and we expressly disclaim any contrary implication. The terms, "we", "our", "ExxonMobil Chemical", or "ExxonMobil" are used for convenience, and may include any one or more of ExxonMobil Chemical Company, Exxon Mobil Corporation, or any affiliates they directly or indirectly steward. The ExxonMobil Chemical Emblem, the "Interlocking X" Device, and Vistalon are trademarks of Exxon Mobil Corporation.



MP29 ExxonMobil House,
Ermyrn Way,
Leatherhead,
Surrey,
KT22 8UX
Registered in England: Number 3898950