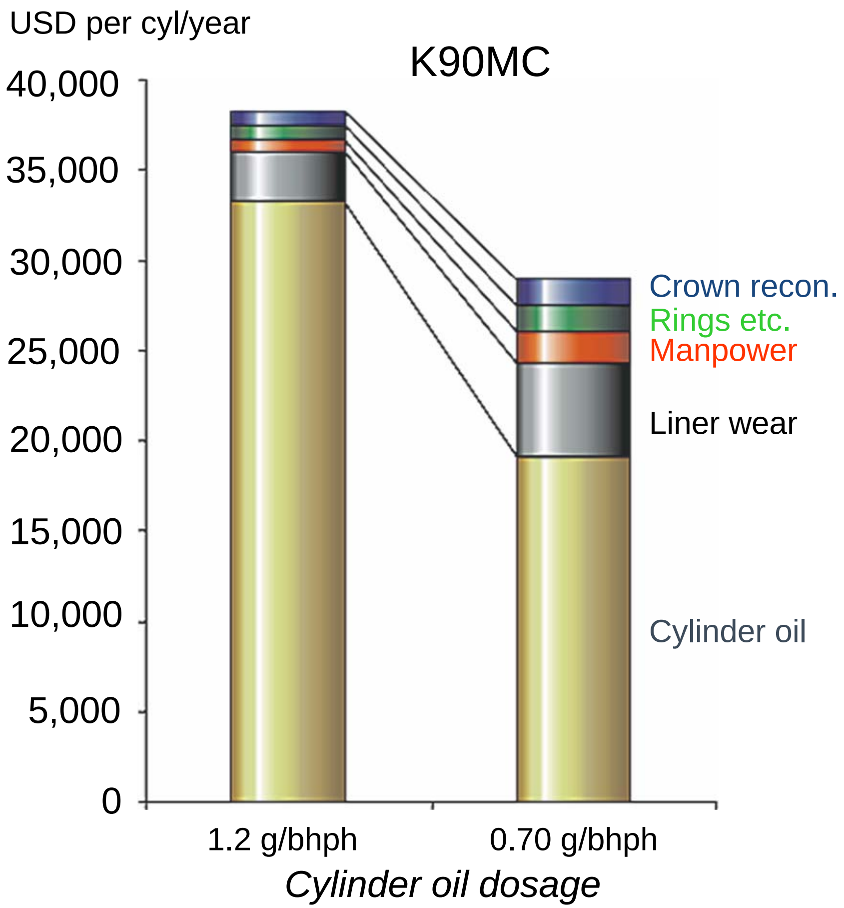
Cylinder Oil Dosage



MAN B&W Diesel A/S

Service Letter

SL00-385/HRJ
December 2000

Cylinder Oil Dosage, Marine MC-Engines
Action Code: WHEN CONVENIENT

Dear Sirs

In June 1994, 10 years after the introduction of the MC engine, we adjusted the Cylinder Lubrication Guidelines, as service experience, especially from the superlong stroke “S” engines, had shown benefits of increased oil dosages. The result was differentiated guidelines, recommending a basic feed rate of 1 g/bhph for “L” and “K” engines, and 1.2 g/bhph for the “S” engines.

Now, six years after issuing this recommendation, development has brought us in a position where we can correct the guidelines so as to bring even more benefit to the owners. While the following instructions are aimed at marine engines, special additional guidelines for stationary engines have been issued and are available on request.

Cylinder lubrication has a direct influence on the operational costs of two-stroke engines. The cost of the cylinder lube oil itself is one of the biggest contributions to the total operating costs (next to the fuel cost), while the lubrication rate has a major influence on the cylinder condition and thus, to a certain extent, on the overhauling schedules and overhauling costs.

Therefore, feed rate and overhaul predictability and cost are interrelated factors that need to be kept in balance.

Recently we have seen, with our highest loaded engines, that excessive lubrication may lead to deposit build-up on the pistons, which may disturb the cylinder condition. Therefore, excessive cylinder lubrication should be limited to situations such as the very first breaking-in (up to 15 hours), where the oil is used to flush away the wear particles formed. Otherwise, increased lubrication should only take place in cases of a very poor cylinder condition, where heavy blow-by or scuffing takes place and constantly destroys the oil film on the liner.

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Guiding Cylinder Oil Feed Rates		
Basic setting (ref. to MCR load):		**L and K-MC/MC-C : 0.9 g/bhph** **S-MC/MC-C : 1.1 g/bhph**
Minimum feed rate (ref. to MCR load):		L and K-MC/MC-C : 0.60 g/bhph S-MC/MC-C : 0.70 g/bhph
Maximum recommendable feed rate during normal operation (ref. to MCR):		L and K-MC/MC-C : 1.35 g/bhph S-MC/MC-C : 1.65 g/bhph
Breaking-in new liners and rings (Initial running-in).	Feed rate:	Alucoat rings: Basic feed rate +100% / 50% Non or hard-coated rings: Basic feed rate +100%
	Duration:	Alucoat rings: The first 5 hours +100% Remaining testbed trials +50% Non or hard-coated rings: +100% for 15 hours
	Load:	Alucoat rings: Stepwise increase to max. load over 5 hours Non or hard-coated rings: Stepwise increase to max. load over 15 hours
Running-in feed rate, new liners and rings:		Basic setting +50%, to be reduced in two steps of 25% each after an interval of 250 hours.
Breaking-in new rings in already run-in liners:		Alucoat rings: No load restrictions or demands for extra oil Non or hard-coated rings: Stepwise load increase to max. load over 5 hours. Lube oil service feed rate +50% for 24 hrs.
Service feed rate:		The “Service feed rate”, i.e. the feed rate between the “Basic setting” and the “Minimum feed rate”, is to be based on observations of the actual condition (scavenge port inspections and overhauling reports). Lowering the feed rate may be done in steps of maximum 0.05 g/bhph.

Service feed rate at part load:	All feed rates are based on the MCR load. At part load, the lubricator dosage may be regulated downwards in proportion to the mean effective pressure. Regulating downwards in proportion to the load is being practised successfully on stationary constant-speed engines. Below 25% MCR any further reduction should be regulated in proportion to the engine revolutions.
Manoeuvring and load change situations:	During starting, manoeuvring and load changes, any possible regulation in proportion to mean effective pressure or load should be replaced by rpm-proportional regulation, and the lubricator set to 125% of the MCR-service feed rate.

Basic setting

The “Basic setting” corresponds to a dosage which, after confirmation of a successful running-in, under average conditions, will ensure a safe cylinder condition and a good overall economy.

Maximum recommendable feed rate during normal operation

Excessive cylinder lubrication may lead to harmful deposit build-up in the combustion chamber, and should therefore be limited to special operation conditions such as breaking-in, re-establishment of a failed cylinder condition, sticking piston rings, etc.

Breaking-in

The running-in of new cylinder liners and piston rings is carried out during the initial running-in period, which we call the “breaking-in ”period, and during the subsequent service period in which the load is unrestricted but where extra lubrication is still needed.

During breaking-in, i.e. the very first loading up to MCR, excessive lubrication is recommended in order to flush away any wear particles generated. 200% of the basic setting is recommended in this period.
If “Alucoat” piston rings are used, the duration of the breaking-in period can be limited to about five hours.
If “hard-coated” rings (Cermet coated PM14 or similar) or non-coated rings are used, the breaking-in and loading up to MCR should be done within 15 hours.

Running-in

After the breaking-in period where ample oil has been applied, the load reductions are lifted. In order to ensure optimal oil film build-up between rings and liner, extra oil should be applied for a period. However, in order to protect the combustion chamber from harmful deposit build-up, this period should be limited to the period during which the rings and liner surfaces are forming their final operational surfaces.

We recommend that frequent scavenge port inspections are carried out during the entire running-in process.

We recommend that 150% of the basic setting is maintained during the first 250 hours. When a scavenge port inspection has proved a satisfactory condition, the feed rate should be reduced to 125%.

This setting is kept for the next 250-hour period. If the cylinder condition is again confirmed as being satisfactory, lubrication may now be reduced to the basic feed rate setting.

Service feed rate

During normal, average conditions the basic setting will result in a safe cylinder condition with reasonable overhauling intervals and a good overall economy.

However, in many cases the economic optimum can be obtained at a lower feed rate, when taking the overhauling intervals and operational cost of lube oil and maintenance into consideration.

Lowering the feed rate towards the optimal “Service feed rate” should be done in small steps not exceeding 0.05 g/bhph. Any reduction should always be based on careful evaluation of the actual cylinder condition.

Please note that the optimal service feed rate is not an absolute figure, as it varies with the environment of the engine, such as load pattern, fuel quality, weather conditions, etc.

Service at part load

All feed rate specifications are based on MCR load. Therefore, before evaluating part load lube oil consumption, the actual dosage should be recalculated to what it would have been at MCR.

On fixed-pitch propeller plants, with lubricators having a fixed relationship between engine speed and lubricator flow, any part load condition will result in an increase in the specific cylinder oil feed rate measured in g/bhph. On constant-speed engines and on engines with CP-propellers, this tendency to over-lubrication will be more predominant.

On CPP-plants and constant-speed plants, including stationary power plants, and fixed-pitch propeller plants running on part load for extended periods, it may therefore be beneficial to reduce the part load consumption from the full load consumption (in kg/cyl.) proportional to the mean effective pressure reduction ratio.

Regulation proportional to the mean effective pressure may be carried out down to 25% load, whereafter regulation proportional to RPM should take place.

Manoeuvring and load change situations

During starting, manoeuvring and during sudden load changes, the engine requires extra oil due to the changed thermal and mechanical deformations of ring grooves and rings. A possible mean effective pressure regulation should be replaced by rpm-proportional regulation, and the lubricator should be set to 125% of the service feed rate.

Cylinder condition abnormalities

It is recommended that the cylinder condition is always kept under strict observation, by combining the results of frequent scavenge port inspections with the wear results measured during routine overhauls of the pistons. If any abnormalities are observed, it is recommended to adjust the feed rate back to the “Basic setting” and, furthermore, to add extra oil on the “LCD”-actuator or on the “joint quantity adjustment” handle. This over-lubrication should be maintained until the cause of the problem has been eliminated, and scavenge port inspections have proved that a safe condition has been re-established.

Cylinder oil recommendations

The demand for high-detergency cylinder oils is increasing with the increasing load output of our latest engine designs. A satisfactory detergency level is normally ensured with a cylinder oil with a BN (Base Number) of 70-80.

Note: Some high-alkaline cylinder oils are not compatible with:

- Certain low sulphur fuels in the range of 0 to 1.5% sulphur
- Some diesel oils.

For continuous running on such fuels and high-detergency high-BN cylinder oil, special attention must be paid to the cylinder condition. In case of any irregularity, the cylinder oil may be changed to a high-detergency lower-BN cylinder oil. In such a case the engine builder or MAN B&W should be consulted.

Questions or comments regarding this SL should be directed to our Dept. 2300.

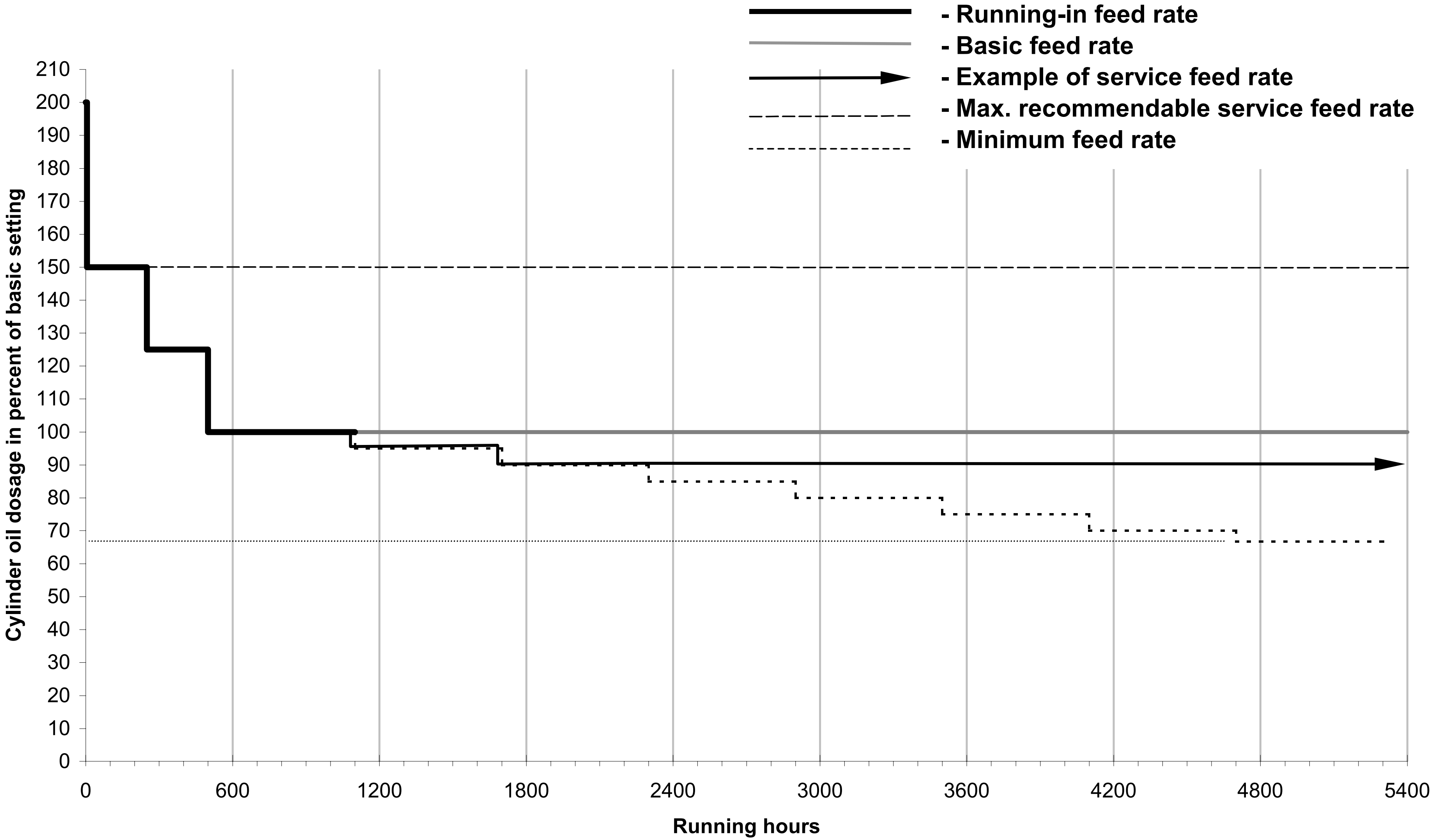
Yours faithfully

MAN B&W Diesel A/S

Carl-Erik Egeberg Uffe Mikkelsen

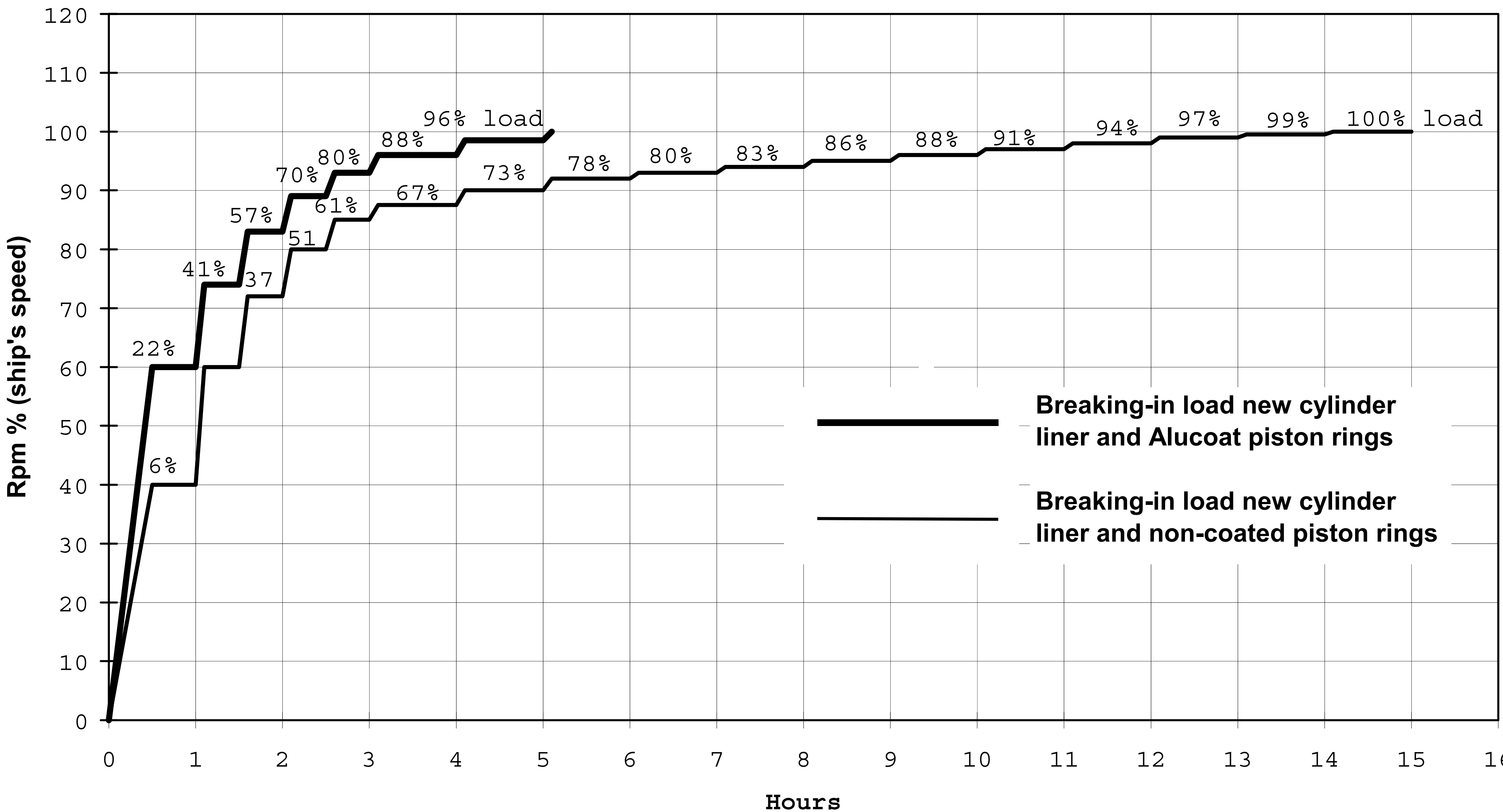
Encl.: 3 graphs

Cylinder oil feed rate during running-in



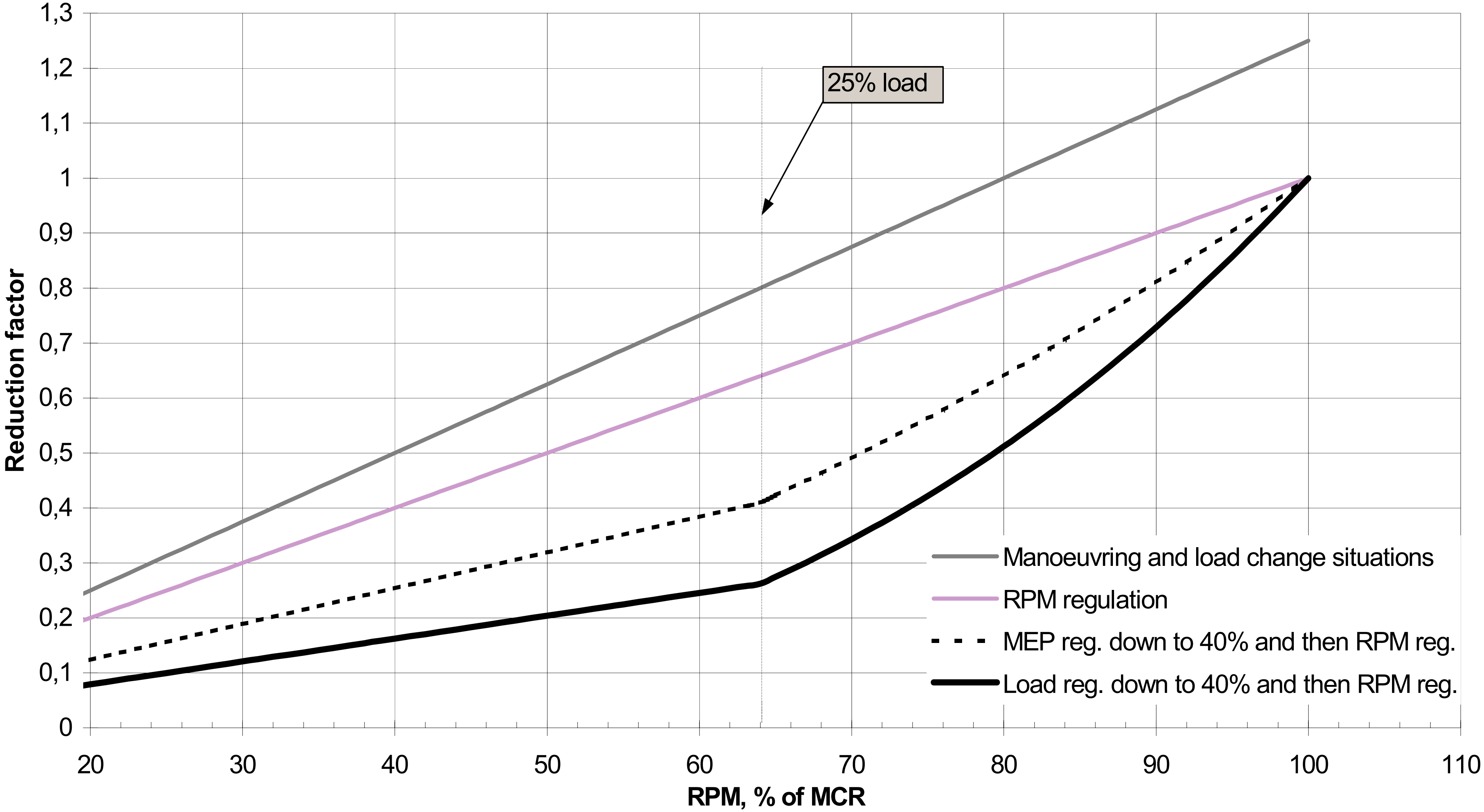
Enclosure 2

Breaking-in load programme



Enclosure 3

Cylinder oil regulation, fixed-pitch propeller



MAN B&W Diesel

SL05-452/KEA
July 2005

Heavy Fuel Oil Treatment
Action Code: WHEN CONVENIENT

Dear Sirs

Lately we have received reports of incidents of excessive abrasive wear in the combustion chamber due to inefficient operation of the fuel treatment plant. By this service letter, we wish to underline the importance of proper HFO cleaning.

Abrasive wear is mainly caused by the missing ability of the centrifuges to remove catalytic fines such as aluminium and silicon oxides from the fuel oil. Rust, sand and dust are other components which are also removed by the centrifuges, however, they are normally present in much smaller quantities.

In bunkered oil, the maximum allowed content of catalytic fines, expressed as the total content of aluminium and silicon, is 80 mg/kg according to ISO 8217:1996 (Specification of Marine Fuels). It is important that all fuels are centrifuged efficiently to minimise the level of contaminants, including catalytic fines.

For bunkered fuels containing the maximum content of catalytic fines (80 mg/kg), we expect the content of catalytic fines to be reduced to below 15 mg/kg in the fuel entering the engine. However, for bunkered fuels with a lower content of catalytic fines, a proportional reduction to an even lower content is expected.

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The following actions are necessary to ensure a proper cleaning of the HFO:

- Selection and operation of the fuel oil centrifuges according to suppliers recommendation
- Correct HFO temperature at inlet to the centrifuges
- Correct throughput of fuel through the centrifuges
- Proper density of HFO in conformance with the centrifuge specification
- Proper maintenance of the centrifuges. If properly operated, a centrifuge has a removing efficiency of close to 100% for catalytic fines larger than 5 microns, but this technique cannot completely remove catalytic fines smaller than 5 microns within the time the fuel actually stays in the centrifuge.

The enclosure shows an example of excessive wear resulting from inappropriate operation of the centrifuges.

Temperature of HFO before centrifuges

It is often seen that the HFO preheaters are too small or have too low a set-point in temperature, thereby reducing the efficiency of the centrifuge.

In order to ensure that the centrifugal forces separate the heavy contaminants to the waste drain of the centrifuge, in the limited time they are present in the centrifuge, the centrifuge should always be operated with an inlet temperature of 98°C for HFO.

The importance of adjusting the throughput if the temperature is changed is illustrated in Fig. 1, which shows an example of the relationship between temperature and throughput. For example, a centrifuge operating with an inlet temperature of 90°C would require a reduction in the throughput of min. 15% to obtain the same cleaning efficiency as with a 98°C inlet temperature.

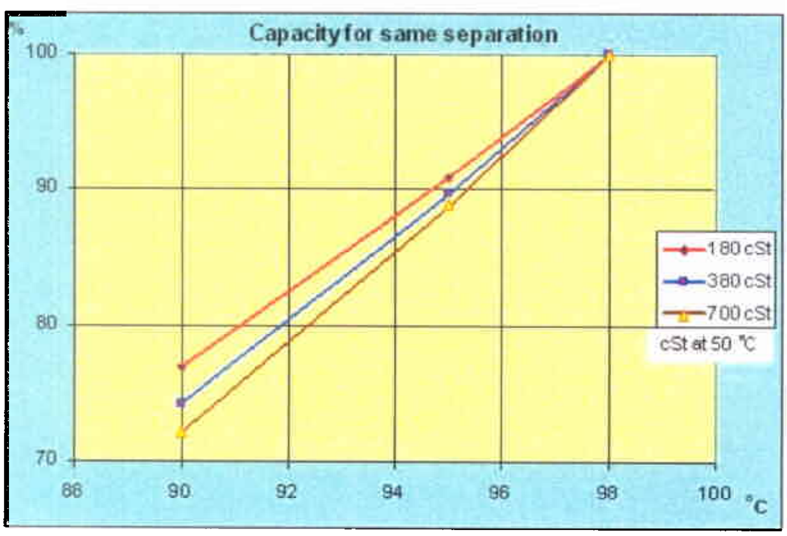

Fig. 1: Relationship between throughput and temperature

We have been in contact with different suppliers of centrifuges and, based on the information received, Fig. 1 illustrates the relationship between throughput and temperature for fuels with a viscosity of 180-700 cSt (at 50°C) for unchanged centrifuge cleaning efficiency.

As the throughput is normally controlled by a constant flow pump, it is often not possible to reduce the fuel flow to the centrifuges in case of a lower preheating temperature. **There is only one solution, i.e. to keep the 98°C inlet temperature for fuels above 180 cSt (at 50°C)**.

Operation of centrifuges – in series or in parallel

In accordance with the latest rules and recommendations, ISO 8217 and CIMAC, a water content of max. 0.5% is allowed in the fuel delivered on board.

The water content often consists of salt water, and separation of water is therefore important in order to remove the salts.

Catalytic fines are hydrophilic, i.e. in case of water in the fuel, the water will attract the catalytic fines. The separation of water is thus important also for this reason.

The centrifuges should be operated in parallel, unless the centrifuge installation comprises manually operated centrifuges, with purifier followed by clarifier. To achieve the maximum separation efficiency, we recommend to always use all available HFO centrifuges whenever possible, and to operate them in parallel with an adjusted feed rate lowering the throughput in the centrifuges. This will ensure the longest possible retention time in the centrifuges and optimal efficiency for removal of catalytic fines.

Proper maintenance

With the automatically operating HFO centrifuges of today, operators no longer have to change the gravity discs. However, proper maintenance of the centrifuges is still important, and must be carried out in accordance with the recommendations from the centrifuge manufacturers.

If the bowl is not cleaned in time, there will be deposits on the bowl discs. The free channel height will be reduced, and the flow velocity increases, which in turn tends to drag particles with the liquid flow towards the centre. This leads to a reduced separation performance.

Check of centrifuges

In order to check the efficiency of the centrifuges, we recommend that operators take samples before and after the centrifuges when operating on a bunker fuel oil with more than 25 ppm catalytic fines, or at least every four months, and send the samples to an established fuel analysing institute.

Settling and service tanks

At calm weather, the heavy components in the HFO, e.g. catalytic fines, will settle on the tank bottom, but at high seas they can be hurled up and led to the centrifuges, in a concentration exceeding the maximum of 80 ppm. This will most probably influence the efficiency of the treatment system, leading to large quantities of catalytic fines at engine inlet, and it is therefore important to drain the settling and service tanks regularly. Furthermore, it is also recommended to use the standby fuel centrifuges in heavy weather.

Standard for separation efficiency

A procedure for defining a standard for separation efficiency is under development within the European Committee for Standardization (CEN) and is expected to be finished by summer 2005. This procedure will make it possible to compare the efficiency of different types of centrifuges, when operated at a controlled flow rate, before their introduction to the market.

Questions or comments regarding this SL should be directed to our Dept. 2160.

Yours faithfully

MAN B&W Diesel A/S

Carl-Erik Egeberg

Kjeld Aabo

Encl.

Excessive wear incidents caused by inefficient operation of centrifuges

Enclosure for
SL05-452/KEA

Fig. A: Fuel valve cut-off shaft with scuffing marks

Fig. B: Magnification of scuffing marks (2.6x)

Fig. C: Further magnification of scuffing marks (7.4x)

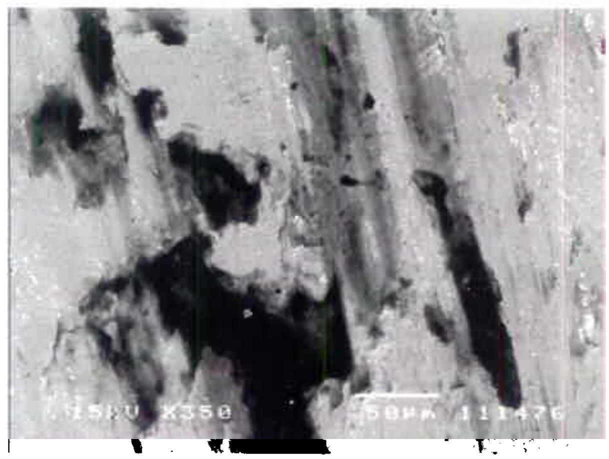

Fig. D: Magnification of scuffing marks and carbides (290x)

Fig. E: Embedded particle in the scuffed area on the cut-off shaft (1800x)

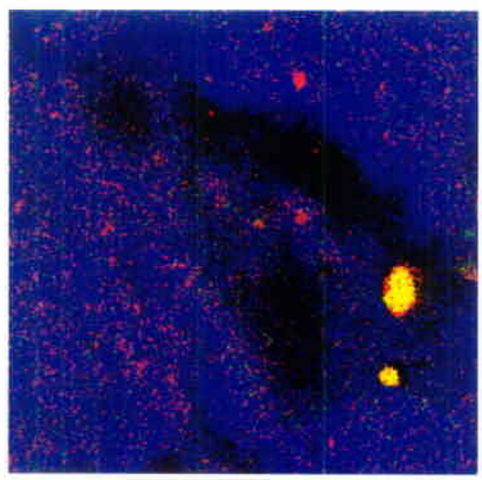

Fig. F: EDX map of the scuffed area shown in Fig. E

CXR/JCB
2005-05-22

MAN B&W Diesel

Service Letter

SL05-455/HRJ
September 2005

Cylinder Lubrication Guidelines
Operation on Fuels with Varying Sulphur Contents
All MC/MC-C and ME/ME-C type engines
Mk 6 and higher, with Alpha ACC System
Action Code: WHEN CONVENIENT

Dear Sirs

The sulphur content in heavy fuel oil may show large variations depending on the geographical area of origin, i.e. from 1% to 4%. A sulphur content higher than 4% is rare, in fact, less than 3% of all bunkers have a sulphur content above 4%.

Furthermore, environmentally-based sulphur restrictions, i.e. special demands for low-sulphur fuel operation in restricted areas, are now in force to limit SO_x emissions.

Since the launching of the ACC (Adaptive Cylinder oil Control) lubrication principle, see our service letter SL03-417 of January 2003, we have obtained comprehensive and very positive service feedback confirming this lubrication mode to be superior to others.

We have now established, by testing, that there is even more room for reductions in relation to the original ACC algorithm of 0.34 g/kWh x S%, with a corresponding further reduction of the operational costs.

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Therefore, we have revised our Guiding Cylinder Oil Feed Rates (see enclosures 1-3) for the purpose of optimising the cylinder lube oil consumption (CLOC).

Cylinder lubrication demands

The purpose of cylinder lubrication is as follows:

1. to create a hydrodynamic oil film separating the piston rings from the liner,
2. to clean the piston rings, ring lands and ring grooves,
3. to control corrosion, i.e. control the neutralisation of sulphuric acid.

Re 1: The oil amount needed to create an oil film is more or less independent of the fuel oil being used. Measurements of the oil film have also revealed that when the feed rate for optimum oil film is reached, no further increase of the oil film is obtained from an increase of the feed rate. This optimum is kept safely down to a feed rate of 0.55 g/kWh.

Re 2: Cleaning of piston rings, ring lands and grooves is essential, and relies on the detergency properties of the cylinder oil. All approved cylinder oils fulfil the requirements, even at a feed rate as low as 0.55 g/kWh.

Re 3: The combustion process creates highly corrosive sulphuric acids depending on the sulphur in the fuel. It has therefore been of paramount importance to design the combustion chamber and the cylinder lube oil so as to create the optimum balance of corrosion.

Cylinder lubrication dosage

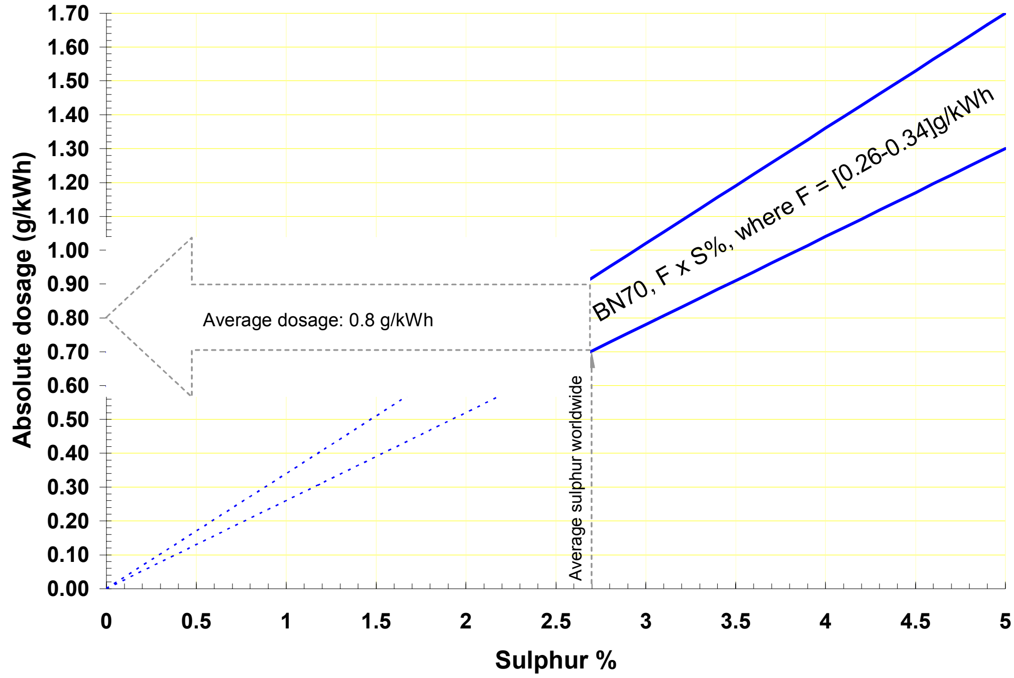
The optimal corrosion control is achieved by a combination of the cooling water design of the cylinder liner, the sulphur content in the fuel, the cylinder lube oil alkalinity, and our new lubrication principle, the ACC algorithm system (Adaptive Cylinder oil Control). The ACC system feeds the oil proportionately to the load (which is proportional to the fuel oil amount being burnt) and to the sulphur content in the fuel. By dosing the amount of oil and, thereby, the amount of alkaline additives proportionately to the total sulphur amount being burnt in the combustion chamber, a constant and controlled low corrosion level can be achieved.

The experience gained so far from a large number of vessels operating at a feed rate factor of **0.34 g/kWh x S%** has been very positive.

However, long term tests with, first **0.29 g/kWh x S%** and later **0.26 g/kWh x S%** have been successful, indicating that an optimum lubrication level is within the below algorithm:

F x S%, where "F" is in the range of 0.26 to 0.34 g/kWh

ACC algorithm with a BN 70 cylinder oil:



On the world market, the average sulphur content in fuels for large two-stroke engines is 2.7%. This would result in an average cylinder oil dosage of around 0.8 g/kWh.

The 0.8 g/kWh multiplied with the yearly production of kWh can be directly used in the calculation of the yearly cylinder oil consumption.

The ACC principle, with the algorithm F x S% where "F" is in the range of 0.26-0.34 g/kWh, satisfies the need for neutralising additives. However, due to the physical need for a certain amount of oil to create a hydrodynamic oil film, the present lower limit is set in the range of 0.60-0.70 g/kWh, which according to the above diagram will be reached with around 2% sulphur.

Running on fuels with a varying sulphur content

Although fuel sulphur levels above 4% are rather rare, running on high-sulphur fuels has accounted for a major part of cylinder wear in the past. Therefore, increasing the oil dosage according to the ACC algorithm is necessary, and very beneficial economically, to prevent the excessive wear associated with such fuels.

However, on low-sulphur fuels, below 2% sulphur content, the engine will, according to the above diagram, be overdosed with alkaline additives. This may lead to cylinder condition problems and, in severe cases, to scuffing.

Overdosing with alkaline additives has two negative effects, which may both lead to the so-called “bore-polish” phenomenon:

- A surplus of alkaline additives has a strong tendency to accumulate on the piston top land, and may grow in thickness to an extent where it interferes with the cylinder liner running surface, in spite of the PC ring (piston cleaning ring). This is most pronounced in the middle and lower part of the liner (where the liner is exposed the least to heat) and in the exhaust side (where the PC-ring is less effective). The result of this negative effect is called mechanical bore-polish.

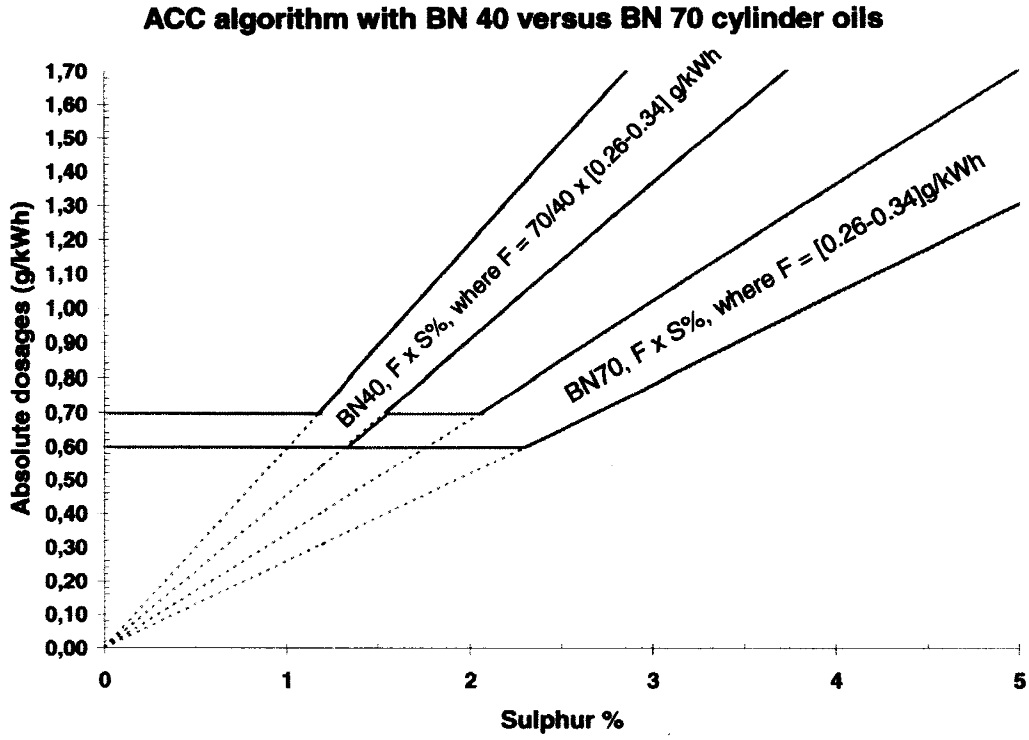
- The other negative effect of overdosing with alkaline additives may be that corrosion (so-called cold-corrosion) is suppressed completely, thereby, limiting the necessary “refreshment” (open graphite structure) of the liner surface. The result of this is called chemical bore-polish. In other words, corrosion should be controlled rather than prevented.

The occurrence of the above negative effects is time-dependent. This means that a surplus of alkaline additives can be accepted for a certain period, depending on the severity of the overdosing.

For example: when running on a fuel with 1% sulphur and using a normal BN 70 cylinder oil, theoretically, a dosage in the range of 0.26 to 0.34 g/kWh is called for according to the ACC algorithm. However, in order to fulfil the lower limit set at 0.60-0.70 g/kWh for hydrodynamic reasons, the amount of additives applied is consequently higher than needed. Such overdosing of alkaline additives should be limited to one or two weeks, and to temporary running on low-sulphur fuels in restricted areas.

If low-sulphur fuels are used predominantly, we advise using a low-BN cylinder oil, either a BN 40 or BN 50 oil.

The diagram overleaf shows the algorithm using a BN 40 cylinder oil versus a “normal” BN 70 cylinder oil.



Experience has shown that satisfactory running on fuels containing almost no sulphur (gas oil, kerosene, etc.) can be obtained using a low-BN cylinder oil.

If a BN 40 cylinder oil is used, the ACC algorithm should be:

F x 70/40 x S%, where "F" is in the range of 0.26-0.34 g/kWh

If low-sulphur fuels are bunkered regularly, in-between normal or high-sulphur fuels, a two-tank system should be considered, offering the possibility of changing between low-BN and normal-BN cylinder oils.

Questions or comments regarding this SL should be directed to our Dept. 2300.

Yours faithfully

MAN B&W Diesel A/S

Carl-Erik Egeberg

Ole Grøne

Encl.

<table>
<tr><td colspan="5">Guiding Cylinder Oil Feed Rates
S/L/K-MC/MC-C/ME/ME-C, Mk 6 and higher, with Alpha ACC lubrication system</td></tr>
<tr><td colspan="2"></td><td colspan="2">Standard BN 70 cylinder oil</td><td>BN 40 cylinder oil</td></tr>
<tr><td colspan="2">Basic setting</td><td colspan="2">0.26-0.34 g/kWh x S%
0.19-0.25 g/bhph x S%</td><td>0.26-0.34 g/kWh x 70/40 x S%
0.19-0.25 g/bhph x 70/40 x S%</td></tr>
<tr><td colspan="2">Minimum feed rate</td><td colspan="3">0.60-0.70 g/kWh
0.45-0.50 g/bhph</td></tr>
<tr><td colspan="2">Maximum feed rate during normal service</td><td colspan="3">1.7 g/kWh
1.25 g/bhph</td></tr>
<tr><td colspan="2" rowspan="2">Part-load control</td><td colspan="3">Proportional to engine load</td></tr>
<tr><td colspan="3">Below 25% load, proportional to MEP (Mean Effective Pressure)</td></tr>
<tr><td rowspan="4">Running-in new or reconditioned liners and new piston rings</td><td rowspan="2">Feed rate:</td><td>Alu-coated or hard-coated piston rings:</td><td colspan="2">First 5 hours: 1.7 g/kWh
From 5 to 250 hours: 1.5 g/kWh
From 250 to 500 hours: 1.2 g/kWh</td></tr>
<tr><td>Non-coated:</td><td colspan="2">First 15 hours: 1.7 g/kWh
From 15 to 250 hours: 1.5 g/kWh
From 250 to 500 hours: 1.2 g/kWh</td></tr>
<tr><td rowspan="2">Engine load:</td><td>Alu-coated or hard-coated piston rings:</td><td colspan="2">Stepwise increase to max. load over 5 hours</td></tr>
<tr><td>Non-coated:</td><td colspan="2">Stepwise increase to max. load over 15 hours</td></tr>
<tr><td colspan="2">Running-in new rings in already run-in and well running liners:</td><td colspan="3">Alu-coated or hard-coated piston rings : No load restrictions
Non-coated rings : Stepwise increase to max. load over 5 hours
Feed rate : Basic setting +25% for 24 hrs.</td></tr>
<tr><td colspan="2">Manoeuvring and load change situations.</td><td colspan="3">During starting, manoeuvring and load changes, the feed rate should be increased by 25% and kept at this level for ½ hour after the load has stabilised.</td></tr>
<tr><td colspan="2">Lubrication of cylinders that show abnormal conditions:</td><td colspan="3">Frequent scavenge port inspections of piston rings and cylinder liners are very important for maintaining a safe cylinder condition.
If irregularities are seen, adjustments of the lube oil rate should be considered.
In case of scuffing, sticking piston rings or high liner temperature fluctuations, the feed rate should be raised by 25-50%.</td></tr>
</table>

Adjusting Alpha Lub. using ACC, BN 40 Cylinder Oil								
ACC factor g/kWh x S%							g/kWh	HMI setting
0,26	0,27	0,29	0,30	0,31	0,33	0,34		
Sulphur content %								
0	0	0	0	0	0	0	0,61	56
1,4	1,3	1,2	1,2	1,1	1,1	1,0	0,61	56
1,5	1,4	1,3	1,3	1,2	1,1	1,1	0,65	60
1,6	1,5	1,4	1,4	1,3	1,3	1,2	0,71	66
1,7	1,6	1,5	1,5	1,4	1,4	1,3	0,77	71
1,8	1,8	1,7	1,6	1,5	1,5	1,4	0,83	77
2,0	1,9	1,8	1,7	1,6	1,6	1,5	0,89	82
2,1	2,0	1,9	1,8	1,7	1,7	1,6	0,95	88
2,2	2,1	2,0	1,9	1,8	1,8	1,7	1,01	93
2,4	2,3	2,1	2,0	2,0	1,9	1,8	1,07	98
2,5	2,4	2,3	2,2	2,1	2,0	1,9	1,13	104
2,6	2,5	2,4	2,3	2,2	2,1	2,0	1,19	109
2,8	2,6	2,5	2,4	2,3	2,2	2,1	1,25	115
2,9	2,8	2,6	2,5	2,4	2,3	2,2	1,31	120
3,0	2,9	2,7	2,6	2,5	2,4	2,3	1,37	126
3,2	3,0	2,9	2,7	2,6	2,5	2,4	1,43	131
3,3	3,1	3,0	2,8	2,7	2,6	2,5	1,49	137
3,4	3,3	3,1	3,0	2,8	2,7	2,6	1,55	142
3,6	3,4	3,2	3,1	2,9	2,8	2,7	1,61	148
3,7	3,5	3,3	3,2	3,0	2,9	2,9	1,73	160
3,8	3,6	3,4	3,2	3,1	3,0	2,9	1,70	156

Adjusting Alpha Lub. using ACC, BN 70 Cylinder Oil								
ACC factor g/kWh x S%							g/kWh	HMI setting
0,26	0,27	0,29	0,30	0,31	0,33	0,34		
Sulphur content %								
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,60	56
0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,60	56
1,0	1,0	1,0	1,0	1,0	1,0	1,0	0,60	56
1,1	1,1	1,1	1,1	1,1	1,1	1,1	0,60	56
1,2	1,2	1,2	1,2	1,2	1,2	1,2	0,60	56
1,4	1,4	1,3	1,3	1,3	1,3	1,3	0,60	56
1,6	1,6	1,4	1,4	1,4	1,4	1,4	0,60	56
1,8	1,8	1,6	1,6	1,5	1,5	1,5	0,60	56
2,0	2,0	1,8	1,8	1,6	1,6	1,6	0,60	56
2,2	2,2	2,0	1,9	1,8	1,7	1,7	0,60	56
2,4	2,3	2,1	2,0	2,0	1,9	1,8	0,60	56
2,5	2,4	2,3	2,2	2,1	2,0	1,9	0,65	59
2,6	2,5	2,4	2,3	2,2	2,1	2,0	0,68	63
2,8	2,6	2,5	2,4	2,3	2,2	2,1	0,71	66
2,9	2,8	2,6	2,5	2,4	2,3	2,2	0,75	69
3,0	2,9	2,7	2,6	2,5	2,4	2,3	0,78	72
3,2	3,0	2,9	2,7	2,6	2,5	2,4	0,82	75
3,3	3,1	3,0	2,8	2,7	2,6	2,5	0,85	78
3,4	3,3	3,1	3,0	2,8	2,7	2,6	0,88	81
3,6	3,4	3,2	3,1	2,9	2,8	2,7	0,92	84
3,7	3,5	3,3	3,2	3,0	2,9	2,8	0,95	88
3,8	3,6	3,5	3,3	3,2	3,0	2,9	0,99	91
3,9	3,8	3,6	3,4	3,3	3,1	3,0	1,02	94
4,1	3,9	3,7	3,5	3,4	3,2	3,1	1,05	97
4,2	4,0	3,8	3,6	3,5	3,3	3,2	1,10	100
4,3	4,1	3,9	3,8	3,6	3,4	3,3	1,12	103
4,5	4,3	4,0	3,9	3,7	3,5	3,4	1,16	106
	4,4	4,2	4,0	3,8	3,6	3,5	1,19	109
	4,5	4,3	4,1	3,9	3,8	3,6	1,22	113
		4,4	4,2	4,0	3,9	3,7	1,26	116
		4,5	4,3	4,1	4,0	3,8	1,29	119
			4,4	4,2	4,1	3,9	1,33	122
			4,5	4,3	4,2	4,0	1,36	125
				4,5	4,3	4,1	1,39	128
					4,4	4,2	1,43	131
					4,5	4,3	1,46	134
						4,4	1,50	138
						4,5	1,53	141