Cylinder lubrication
Purpose of cylinder oil:

- Lubrication: build up oil film between piston rings and cylinder liner

- Cleaning: additive treat contains detergency agent

- Neutralisation: Bunker oils contain varying levels of sulphur
Cylinder Lubrication

Purpose of cylinder oil:
- Stabilisation to build up oil film between piston rings and cylinder liner
- Detergency independent of BN
- Cleaning: additive treat contains varying BN agent
- Neutralisation: bunker oils contain varying levels of sulphur
- Easy feed rate adjustment

Cylinder oil requirements:
Cylinder oil requirements:

- Stability to heat
- Detergency independent of BN
- Varying BN
- Easy feed rate adjustment
Over-lubricated
Alpha ACC

Cylinder wear vs Cylinder oil amount graph.
Cylinder Condition of Large Two-Stroke Engines

High sulphur fuel (above 4%)
Medium sulphur fuel
Low sulphur fuel (below 2%)

Liner wear rate [mm/1000h]

Min. feed rate
Basic setting
Max. feed rate

Feed rate

0.15
0.07
0.01
Alpha ACC

Optimised (reduced) side and top-clearances introduced based on good experience with the MC-Compact engines.

Optimal 'lemon-shape' will give a minimum oil film thickness increase of 30-40%.

Cylinder oil dosage (g/bhph)

Sulphur %

Cylinder oil dosage (g/bhph) vs Sulphur %

0 0.25 0.50 0.75 1.00 1.25

0 1 2 3 4 5

Sulphur %
Cylinder Condition, New lube guidelines

Liner Wear
ASTRO CYGNUS 6S90MC-C

Graph showing liner wear over engine hours for different cylinders.

- Cylinder 1A
- Cylinder 2A
- Cylinder 3A
- Cylinder 4A
- Cylinder 5A
- Cylinder 6A

Max Liner Diameter (mm) vs Engine Hours (0-50,000 hours)

- ACC 0.34 g/kWh x S%
- ACC 0.29 g/kWh x S%
- ACC 0.26 g/kWh x S%
- ACC 0.23 g/kWh x S%
- ACC 0.20 g/kWh x S%

New lube guidelines for 0.1 / 1000 Hours (mm)
Cylinder Lubrication Update
Guiding ACC Feed Rates for Alpha Lubricator and ME Lube

Replaces SL07-479/HRR for large bore engines

SL09-507/HRR
April 2009

Concerns
MAN B&W two-stroke 60-98 cm large bore engines.
Types: MC/MC-C, ME/ME-C with high topland and Alpha Lubricator or ME Lube.

Summary
New cylinder lubrication recommendation
0.20 g/kWh × S%,
Absolute minimum: 0.60 g/kWh.
**Cylinder Lubrication, New guidelines and experience**

<table>
<thead>
<tr>
<th>MC/MC-C, ME/ME-C and ME-B engines with high topland and Alpha Lubricator or ME Lube</th>
<th>Standard BN70 cylinder oil</th>
<th>BN60 cylinder oil</th>
<th>BN50 cylinder oil</th>
<th>BN40 cylinder oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic setting</td>
<td>0.20 g/kWh × S%</td>
<td>0.23 g/kWh × S%</td>
<td>0.28 g/kWh × S%</td>
<td>0.35 g/kWh × S%</td>
</tr>
<tr>
<td>Minimum feed rate</td>
<td>0.60 g/kWh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum feed rate during running-in</td>
<td>1.7 g/kWh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part-load control</td>
<td>100% to 25% load: proportional to indicated engine load 25% load and lower: proportional to rpm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running-in new or reconditioned liners and new piston rings based on standard BN70 cylinder oil</td>
<td>Feed rate</td>
<td>First 5 hours</td>
<td>1.7 g/kWh 5 - 500 hours: stepwise reduction from 1.5 to 0.6 g/kWh 500 - 1,500 hours: 0.26 g/kWh × S% (absolute min. 0.60 g/kWh) 1,500 - 2,500 hours: 0.23 g/kWh × S% (absolute min. 0.60 g/kWh) From 2,500 hours: 0.20 g/kWh × S% (absolute min. 0.60 g/kWh)</td>
<td></td>
</tr>
<tr>
<td>Engine load</td>
<td>Testbed: stepwise increase to max. load over 5 hours in service: from 50% to max. load over 16 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running-in new rings in already run-in and well running liners (standard BN70 cylinder oil)</td>
<td>From 50% to max. load in 5 hours Feed rate: +25% for 24 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manoeuvring and load change situations</td>
<td>During starting, manoeuvring and load changes, increase feed rate by means of the “LCD” by 25% of the actual figure. Keep this level for ½ hour after the load has stabilised.</td>
<td></td>
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</tr>
<tr>
<td>Lubrication of cylinders that show abnormal conditions</td>
<td>Frequent scavenge air port inspections of piston rings and cylinder liners are very important for maintaining a safe cylinder condition. If irregularities are observed, consider adjustments of the lube oil rate. In case of scuffing, sticking piston rings or high liner temperature fluctuations, raise the feed rate to 1.2 g/kWh and lower ( p_{\text{max}} ) and ( \text{mep} ). As soon as the situation has been stabilised, set the lubrication feed rate and the pressures back to normal.</td>
<td></td>
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</tr>
</tbody>
</table>
History of ACC factor from the early start in 2002 by SL 398 to the latest recommendations in April 2009 by SL 507.
Cylinder Condition, New lube guidelines

Cylinder Oil feed rate history on the MC/E engines 1982 to 2009

spec. consump. g/kWh at MCR

L-MC Mk I 15 bar
KLMC-MK III 17 bar
S-MC Mk II 18 bar
KLMC SL 385
S-MC SL 385
KL5 Alpha lub
Alpha ACC
ACC 0.25 x 5% 21 bar
New SL 0.20

SULPHUR

Sulphur Content

Large Bar Graph

X

Absolute dosages (g/kWh)

Sulphur %
Cylinder Condition, New lube guidelines

### Alpha Lube ACC

<table>
<thead>
<tr>
<th>BN 70 Cylinder Oil</th>
<th>ACC factor (g/kWh x S%)</th>
<th>Specific dosages</th>
<th>HMI setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
<td>Optimising</td>
<td></td>
</tr>
<tr>
<td>0.20</td>
<td>0.23</td>
<td>0.26</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Sulphur%</th>
<th>g/kWh</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0-0.2</td>
<td>0.0-0.26</td>
<td>0.0-0.23</td>
</tr>
<tr>
<td>0.1</td>
<td>27</td>
<td>24</td>
</tr>
<tr>
<td>0.2</td>
<td>28</td>
<td>25</td>
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<td>0.3</td>
<td>28</td>
<td>25</td>
</tr>
<tr>
<td>0.4</td>
<td>29</td>
<td>26</td>
</tr>
<tr>
<td>0.5</td>
<td>31</td>
<td>27</td>
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<tr>
<td>0.6</td>
<td>32</td>
<td>28</td>
</tr>
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<td>0.7</td>
<td>32</td>
<td>29</td>
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<tr>
<td>0.8</td>
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<td>29</td>
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<tr>
<td>0.9</td>
<td>34</td>
<td>30</td>
</tr>
<tr>
<td>1.0</td>
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<td>31</td>
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<td>1.1</td>
<td>36</td>
<td>32</td>
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<td>1.2</td>
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<tr>
<td>1.3</td>
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<td>1.8</td>
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<td>1.9</td>
<td>43</td>
<td>39</td>
</tr>
<tr>
<td>2.0</td>
<td>44</td>
<td>40</td>
</tr>
<tr>
<td>2.1</td>
<td>45</td>
<td>41</td>
</tr>
</tbody>
</table>

**Note:** The values are illustrative and may not correspond to actual data.

### Diagram

- Engine speed
- Fuel index
- Oil pressure
- Coolant temperature
- Generator load
- MAN B&W

**HMI Setting:** 8.7
ACC factor 0.34 g/kWh x S% for Low top land Engines

ACC factor 0.20 g/kWh x S% for High top land Engines

Lower limit set for hydrodynamic reasons

Degree of over additivation

Japan, autumn 2009, by Henrik Rolsted
Yearly cylinder oil expense (USD)

Cylinder oil price: 1 USD/kg
Yearly operating hours: 7,100

Yearly Saving:
340,000 USD
Cylinder Condition, New lube guidelines

Operational cost for a 12K98ME-C7

- Fuel Cost: $15,564,830; 85%
- Cylinder Lube cost: $200,000; 1%
- Crew cost: $500,000; 3%
- Engine maintenance: $1,500,000; 8%
- Ship maintenance: $560,000

16% saving is equal to $90,000 per year
Cylinder Condition, New lube guidelines

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Cylinder Lube cost: $200,000; 1%
Crew cost: $500,000; 3%
Engine maintenance: $1,500,000; 8%
Ship maintenance: $560,000

30% saving is equal to $170,000 per year
Alpha ACC

Part load dosage (% of full load dosage)

Typical case: 74,640 bhp x 24h
x 1.2g/bhph x 0.91 = 1,956 kg/24h

Alpha ACC: 74,640 bhp x 24h
x 0.75g/bhph x 0.75 = 1,008 kg/24h

Example, 12K90MC:
Load (%): 75
S %: 3.0

rpm proportional (%)
mep proportional (%)
Load proportional (%)
From detailed wear-study of 12K90MC engine equipped with mechanical lubricator

Liner wear (mm/1000h)

0.04 mm/1000h
0.06 mm/1000h
0.00 mm/1000h
0.00 mm/1000h

0.48 mm/1000h
0.13 mm/1000h

0.21 mm/1000h

*: Judgement made based on fe-content in drain oil samples
Alpha ACC

Oil film thickness in the high pressure areas of the bearings was not optimal. Optimised (reduced) side and top-clearances introduced based on good experience with the MC-Compact engines. Optimal 'lemon-shape' will give a minimum oil film thickness increase of 30-40%.

Mechanical Lubricator, rpm-proportional control

Liner wear (mm/1000h)

Running hours

Alpha adaptive control
Daily consumption (litre/24h)

- Typical feed-rate (mechanical lubricator), 1.2 g/bhph, rpm-control
- Basic feed-rate (mechanical lubricator), 0.9 g/bhph, rpm-control
- Basic feed-rate (Alpha lubricator System), 0.8 g/bhph, mep-control
- Alpha ACC: 0.25 g/bhph/S%
Retrofit Alpha

1. Pump station
2. Alpha Lubricator
3. Conventional lubricator
4. T-piece
5. ALCU (Computer)
6. Non-return valves
HMI Panel

Engine speed
Fuel index
Oil pressure

°C rpm deg % bar

Oil pressure low
Index failure
Mark/trig failure
Feedback failure
Common alarm

LAMPTEST ESC ENTER
PUMP 1 PUMP 2 PRELUB

© MAN Diesel 2009/04/01
Alpha lubricator
Solenoid valve - deactivated

Outlets for cylinder liner lube oil points
Injection plungers
Capacitive feed-back sensor for control of piston movement
Signal for lubrication from control unit

Spacer for basic setting of pump stroke
Adjusting screw
Actuator piston
Cylinder lube oil outlet
Cylinder lube oil inlet
Alpha lubricator
Solenoid valve - activated

Outlets for cylinder liner lube oil points
Injection plungers
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Signal for lubrication from control unit
Spacer for basic setting of pump stroke
Adjusting screw
Actuator piston
Cylinder lube oil outlet
Cylinder lube oil inlet

CBO/4100/20020923
NON RETURN V/V and T-PIECE
NON RETURN V/V and T-PIECE
Alpha lube Control Unit (ALCU)
Retrofit
READY TO SAVE MONEY
The experience with the newest generation of engines with high topland and Oros Combustion Chamber is a very low corrosive level and consequential very low- to nearly zero liner wear.

This ensure very long component life time and long TBO.

Further the need for cylinder oil is very low compared to previous engine designs.

The disadvantages with very low liner wear is the risk of bore polish and a lower scuffing resistance, especially at low sulphur running.
Testing flat rate at 0.50 g/kWh abs.

• 8S60MC Car-carryer, 45,191 running hours
• At 15000 running hours: Cylinder Lubricator fitted with 3.5 mm pistons instead of 6 mm
• High topland piston
• Alu-coated CPR piston rings
• Slide fuel valve
• Low cyl. oil dosages 0.55 g/kWh the last 4019h
• Cylinder oil Taro special 70
• Piston (number 1) never pulled (42,773 ring hours!)
• Now running 0.50 g/kWh flat rate the last 3,000 hours
Example of very low lubrication (0.41 g/bhph)

K90MC-C retrofitted with Alpha Lubricators at 16,500h:

Cylinder 3 at 27,682 hours without overhaul, the latest 4000 h. with a cylinder lube oil feed rate at 0.41 g/bhph
Service Experience with Alpha lubricated S90MC-C

Alpha Adaptive Cylinder Oil Control (Alpha ACC). The condition at 4884 h, after 1518 hours at Alpha ACC