MAN B&W Diesel

MAN B&W Diesel A/S • Denmark

Biofriendly Corporation
622 Terrado Drive
Monrovia, CA 91016
USA

Att: Mr Michael Carroll

2100/CXR/BDN/37831-2005 14 November 2005

**Letter of No Objection for fuel additive**
**Green Plus Combustion Catalyst**

Dear Mr Carroll

Based on 4000 hours of testing of Green Plus Combustion Catalyst with supervision of MAN B&W and inspection of engine condition at the start and end of tests, MAN B&W Diesel A/S has no objection to use the Green Plus Combustion Catalyst on a two-stroke engine.

The Green Plus Combustion Catalyst has been used on the "Maersk Arun" equipped with a 7S50MC for more than 4000 hours of operation. Through the inspection by MAN B&W, it was concluded that the product does not have any harmful effect on engine components or the performance of the engine.

As fuel additives are neither produced nor sold by MAN B&W, MAN B&W cannot be kept responsible for any damage to engines or engine components that may be caused by the use of a fuel additive.

Best regards,
MAN B&W Diesel A/S

Charlotte Røjgaard

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Denmark
Reg. No.: 39661314

MAN B&W Diesel A/S

| REPORT | | | |
|---|---|---|---|
| Name of Vessel: | **MAERSK ARUN** | IMO No: | **9175779** |
| Name of Yard: | **China Shipbuilding Corp.** | Hull No: | **678** |
| Engine Type: | **7S50MC** | Sea Trial: | **199 03 01** |
| Visit by: | **GSM 2300** | Service Center: | **Copenhagen** |
| Engine Builder: | **HITACHI** | Engine No: | **3776** |
| Order No: | **40 003 320** | Run. hours: | **32906** |
| Place: | **Varna, Bulgarian** | | |
| Period: | **2005 09 17** | | |
| Owner: | **The Maersk Company Co Ltd** | | |
| Requested by: | **Biofriendly Corp.** | | |
| Reason: | **Inspection after running with Green Plus fuel Additive** | | |
| Keywords: | | | |

## *Summary and conclusion:*

As requested our Superintendent Engineer Mr. Georg Magnussen and Mr. Charles Hansard from Green Plus attended the above vessel in Varna, Bulgaria. The reason for the attendance was inspection after running with Green Plus fuel Additive.

The engine is with low piston top land, oblique cut low piston rings, without Alu-coating and without bronze band in the piston skirt. The normal running between piston overhaul is 16000 hours.

The test with green plus have been running for 4778 hours The green plus additive have been added to the fuel at one of transfer pipe in dosages of 50 ppm.

The piston No. 5 was overhauled in connection with end of test with the fuel additive Green Plus from the company Biofrendly. This piston was also overhauled at the start of the test and at that time as now the condition was good with low wear rates for all parts, see details next page and in cylinder condition report.. The scavenge port inspection shows good condition for all units.

2300/GSM/AXN/34856
2005-10-21

The cylinder oil is from the company Selenia with the name MECO 5070. At present this oil is not on our list, but confirmation test is running on other engines and the present cylinder condition indicates that the this cylinder oil is performing well. The cylinder oil consumption is the same as before start of test around 0.9 Based on the good cylinder condition and the oily pistons, the cylinder oil feed rate could be reduced.

Comparing with previous piston overhaul at start of the test, the wear rates for all parts are about the same level, and the carbon build-up is less than before, but there is also shorter time between the overhaul, but after running with Green plus for 4778 hours, the conclusion is that Green Plus fuel additive do not harm the engine.

**Unit No. 5**

Running hours since last piston overhaul: 4778.

Liner hours: 32.906.

Cylinder condition report, page 3.

The piston was in good condition with medium carbon on topland and light carbon on ringland 1. There was a yellow layer of deposit on top of the piston top, but less than at last inspection. All piston rings were in good condition with only small reduction in the tension. The max. piston ring wear was for ring No. 1 and was 1 mm, i. e. 0.2 mm/1000h. There was only small amount of deposit at the back of the rings and a thin layer at the bottom of the ring, grooves No. 1 and 2.There is only little wear for the ring grooves and no burning of piston. Piston skirt without bronze band in good condition. Spare piston was fitted with Daros RM5 Alu-coated top ring the other Riken 47

The liner was in good condition with no machining marks visible. The max. wear was found at top of liner in ring 2, top dead centre and was 0.22 mm, i. e. 0.007 mm/1000h from new and the same as since last overhaul, as seen below.. Wear edge at ring 1 in TDC was ground away.

The Exhaust valve and Cylinder cover were in good condition.

**Scavenge port inspection.**

The inspection from exhaust side shows good condition for all units as seen on the picture, all are more or less alike, but with different running hours as seen on page 4. All piston rings were in good condition and with shape as seen on page 4. All liners were with machining marks slightly visible in the inspected area, at manoeuvring side and the max. wear for all liners as seen below.

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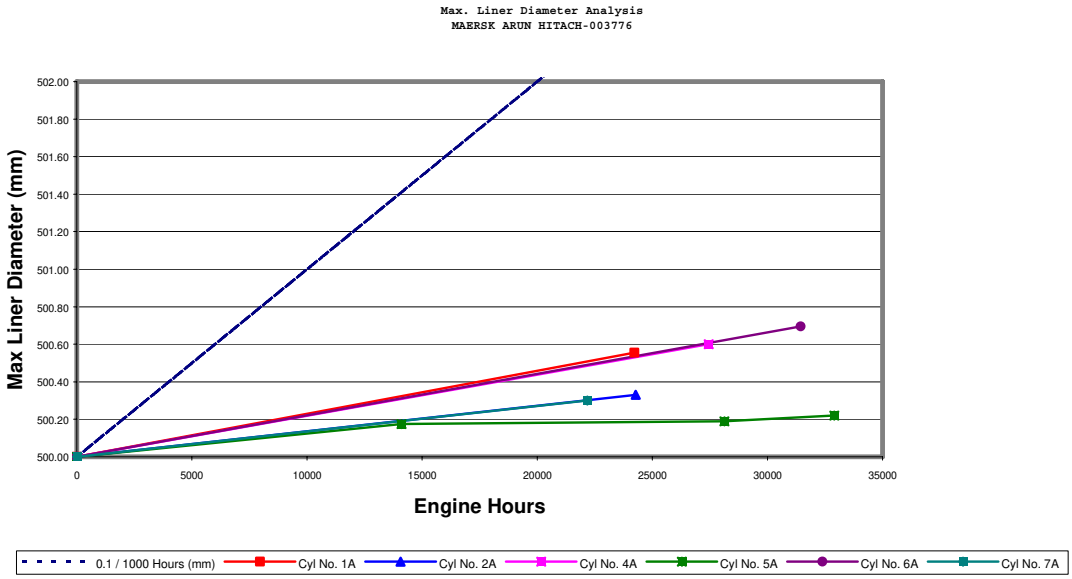


2300/GSM/AXN/34856
2005-10-20

Georg Magnussen

M/V MAERSK ARUN 7S50MC IMO 9175779
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# Cylinder Condition Report

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vessel: | M/V Maersk Arun | | IMO no: 9175779 | Eng. builder | HITACH | Eng. no.: | 003776 | Checked by: | GSM2300 |
| No. of cyl.: | 7 | Eng. type | S50MC | Eng. hrs.: | 32906 | Date (yymmdd): | 050918 | **Inspected unit no.:** | **5a** |

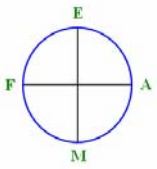
***Voyage info***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Weeks pr. port calls: | 1 | Normal service load (% of MCR): | 85(50) | Lub. part load control | RPM | Lub. type | Hans Jensen |
| Cyl. oil consumption (l/24 hrs): | 300 | at load %: | 85 | Cyl. oil type | Selenia Meco5070 | | |

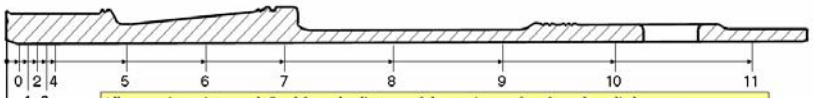
***Cylinder liner***

| | | | | | |
|---|---|---|---|---|---|
| Liner hours: | 32906 | Insulation pipe (Y/N): | N | PC ring (Y/N): | N | Liner material | TARKALLOY-C |
| Drawing no.: | | | | Frame type | Semi Cooled | Liner cool type | Slim Mk. 5, 4x1 |
| Producer/Marking: | | | | Wear type | Normal | Liner honed (Y/N): | N |
| Cyl. cover tightened (Y/N): | N | Temp. between liner and measuring tool (°C): | | | | Shims (mm): | 15 |

| Measuring point | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | A1 (Additional) | A2 (Additional) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (mm) | | 5 | 15 | 43 | 69 | 91 | 315 | 555 | 790 | 1030 | 1275 | 1515 | 2200 | | |
| Diameter (mm) | F-A | 500.00 | 500.16 | 500.19 | 500.20 | 500.18 | 500.08 | 500.09 | 500.07 | 500.09 | 500.08 | 500.08 | 500.06 | | |
| | E-M | 500.00 | 500.18 | 500.22 | 500.20 | 500.19 | 500.14 | 500.10 | 500.10 | 500.15 | 500.12 | 500.13 | 500.10 | | |




E: Exhaust M: Manoeuvre
A: Aft F: Fore



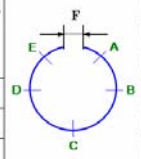

**All measuring points are defined from the distance of the *mating surface* from the cylinder cover.**
**Pos. 0: The middle of the none sliding part above the top piston ring at TDC.**
**Pos. 1-4: The middle of the rings at TDC.**
**Pos. 5 & 6: Equally positioned between pos. 4 and 7 (1/3 of distance).**
**Pos. 7: Lubrication quill level.**
**Pos. 8 & 9: Equally positioned between pos. 7 and 10 (1/3 of distance).**
**Pos. 10: 100 mm. above the scav. air ports.**
**Pos. 11: The middle of the none sliding part below the bottom piston ring at BDC.**

| Liner remarks | Measuribng tool calibrated by set measuring point 0 to 0 |
|---|---|

***Piston rings***

| | Base material | Coating | Profile | Manufacturer | Lock type | CL grooves | Broken |
|---|---|---|---|---|---|---|---|
| Ring 1 | RIK47 | No | Straight | Riken | Oblique R | No | No |
| Ring 2 | RIK47 | No | Straight | Riken | Oblique L | No | No |
| Ring 3 | RIK47 | No | Straight | Riken | Oblique R | No | No |
| Ring 4 | RIK47 | No | Straight | Riken | Oblique L | No | No |
| Ring 5 | | | | | | | |

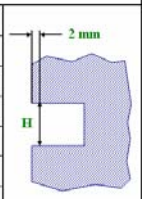
| | Width of ring (mm) | | | | | Free ring gap "F" |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | |
| Degrees | 10 | 90 | 180 | 270 | 359 | (mm) |
| Ring 1 | 16.08 | 15.99 | 15.98 | 16.01 | 16.98 | 44.00 |
| Ring 2 | 16.80 | 16.50 | 16.51 | 16.53 | 16.63 | 45.00 |
| Ring 3 | 16.71 | 16.71 | 16.70 | 16.69 | 16.77 | 52.00 |
| Ring 4 | 16.70 | 16.55 | 16.54 | 16.47 | 16.61 | 48.00 |
| Ring 5 | | | | | | |




"F" to be measured before dismantling

***Ring grooves***

| Height, H (mm) | | | | |
|---|---|---|---|---|
| F | E | A | M |
| 9.80 | 9.77 | 9.79 | 9.80 |
| 9.77 | 9.78 | 9.75 | 9.76 |
| 9.79 | 9.74 | 9.73 | 9.75 |
| 9.85 | 9.82 | 9.81 | 9.82 |
| | | | |

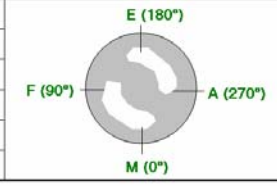



**Hours since last overhaul: 4778**

***Piston***

| | | | |
|---|---|---|---|
| Crown hours: | 30911 | High topland (Y/N): | N |
| Bronze ring (Y/N): | N | Oros piston (Y/N): | N |

| | | |
|---|---|---|
| Max burning 1 | (mm) | 0 |
| Position 1 | (degree) | |
| Max burning 2 | (mm) | 0 |
| Position 2 | (degree) | |
| Max burning 3 | (mm) | 0 |
| Position 3 | (degree) | |




| Piston remarks | Spare piston fitted, see report. |
|---|---|

***Reason for examination***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Routine piston overhaul | ☐ | | | Test | ☒ | | |
| Check of liner condition | ☐ | | | (If either of these boxes are ticked, below boxes must be kept blank) | | | |
| Liner | | Piston Crown | | Piston Rings | | Piston Skirt | |
| Cracks | ☐ | Burning | ☐ | Broken | ☐ | Leaking | ☐ |
| Scuffing | ☐ | Cracks | ☐ | Collapsed | ☐ | Scuffing | ☐ |
| Leak | ☐ | Leaking | ☐ | Scuffing | ☐ | Piston Rod | |
| | | High Groove Wear | ☐ | Sticking | ☐ | Stuff. box | ☐ |

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# Inspection through Scavenge Ports

| | | | | | |
|---|---|---|---|---|---|
| Vessel: Maers Arun | | IMO no.: 917579 | | Builder/no.: Hitachi 3776 | |
| Number of cylinders 7 | Eng. type: S50MC | Eng. hrs.: 32.906 | Checked by: GSM 2300 | Date (yymmdd): 050918 | |
| Weeks pr. port calls: | Normal service load (% of MCR): 75 | | | MEP lubricator type (Y/N): N | |
| Cyl. oil consump. (l/24 hrs): 250 | at load % 70 | Cyl. oil type: | | Position: ☐ Exhaust | ☐ Manoeuvre |

| | Condition and Symbol | Engine Part | Cylinder No. 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Intact - *<br>Burning - BU<br>Leaking oil - LO<br>Leaking water - LW | Piston crown | * | * | * | * | * | * | * | | | | | |
| Deposits | No deposit - *<br>Light deposit - LC<br>Medium deposit - MC<br>Excessive deposit - EC<br>Polished deposit - PC | Topland | MC | MC | MC | MC | MC | MC | MC | | | | | |
| | | Ringland 1 | MC | MC | MC | LC | MC | LC | LC | | | | | |
| | | Ringland 2 | LC | LC | * | * | * | * | * | | | | | |
| | | Ringland 3 | * | * | * | * | * | * | * | | | | | |
| Ring breakage | Intact - *<br>Collapsed - C<br>Broken opposite ring gap - BO<br>Broken near gap - BN<br>Several pieces - SP<br>Entirely missing - M | Ring 1 | * | * | * | * | * | * | * | | | | | |
| | | Ring 2 | * | * | * | * | * | * | * | | | | | |
| | | Ring 3 | * | * | * | * | * | * | * | | | | | |
| | | Ring 4 | * | * | * | * | * | * | * | | | | | |
| Ring movement | Loose - *<br>Sluggish - SL<br>Sticking - ST | Ring 1 | * | * | * | * | * | * | * | | | | | |
| | | Ring 2 | * | * | * | * | * | * | * | | | | | |
| | | Ring 3 | * | * | * | * | * | * | * | | | | | |
| | | Ring 4 | * | * | * | * | * | * | * | | | | | |
| Surface condition | Clean, smooth - *<br>Running surface, Black,overall - B<br>Running surface, Black, partly - (B)<br>Black ring ends > 100 mm - BR<br>Scratches (vertical) - S<br>Micro-seizures (local) - mz<br>Micro-seizures (all over) - MZ<br>Micro-seizures, still active - MAZ<br>Old MZ - OZ<br>Machining marks still visible - **<br>Wear-ridges near scav. ports - WR<br>Scuffing - SC<br>Clover-leaf wear - CL<br>Rings sharp-edged Top/Bot. - T/B | Ring 1 | T/B | T/B | T/B | T/B | T/B | * | T/B | | | | | |
| | | Ring 2 | T/B | T/B | T/B | * | * | * | T/B | | | | | |
| | | Ring 3 | T/B | T/B | T/B | * | * | * | T/B | | | | | |
| | | Ring 4 | T/B | T/B | T/B | T/B | T/B | * | T/B | | | | | |
| | | Piston skirt | * | * | * | * | * | * | * | | | | | |
| | | Piston rod | * | * | * | * | * | * | * | | | | | |
| | | Cylinder liner abv. scav. ports | * | * | * | * | * | * | * | | | | | |
| | | Cylinder liner near scav. ports | * | * | * | * | * | * | * | | | | | |
| Lubrication condition | Optimal - *<br>Too much oil - O<br>Slightly dry - D<br>Very dry - DO<br>Black oil - BO | Ring 1 | * | * | * | * | * | * | * | | | | | |
| | | Ring 2 | * | * | * | * | * | * | * | | | | | |
| | | Ring 3 | * | * | * | * | * | * | * | | | | | |
| | | Ring 4 | * | * | * | * | * | * | * | | | | | |
| | | Piston skirt | * | * | * | * | * | * | * | | | | | |
| | | Piston rod | * | * | * | * | * | * | * | | | | | |
| | | Cylinder liner | * | * | * | * | * | * | * | | | | | |
| Deposits | No Sludge - *<br>Sludge - S<br>Much sludge - MS | Scavenge box | S | S | S | S | S | S | S | | | | | |
| | | Scav. receiver | S | S | S | S | S | S | S | | | | | |
| | Intact - * | Flaps and non-return valves | * | * | * | * | * | * | * | | | | | |
| Running hours since last overhaul | | | 8620 | 7712 | ##### | 5415 | 4778 | 1455 | ##### | | | | | |

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