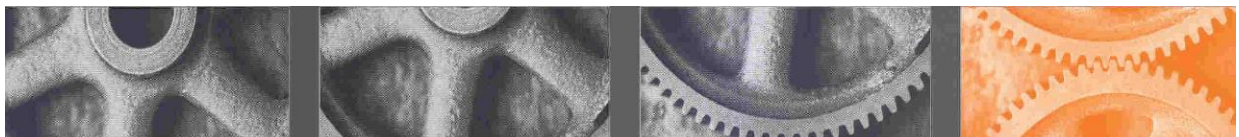


SGS Report No. 1820/OGC21/031
SGS Order No. 7002
SGS Test No. M102-21 023
Customer Order No. VIF/20210416
Customer Test ID. ULG95 + SBA 1000 ppm (V/V)

Test Report

**Inlet Valve Cleanliness in the MB M 102 E Engine
according to procedure CEC F-05-93, including combustion
chamber deposits evaluation according to procedure
CEC F-20-98**

27. 4. 2021



SGS Czech Republic s.r.o.
Engine Test Centre Kolín
Ovčárecká 314
280 13 Kolín, CZ

1 General Information:

Test Laboratory:

SGS Czech Republic s.r.o., Engine Test Centre Kolín
Ovčárecká 314, 280 13 Kolín, Czech Republic

Test Identification:

Test Method:

CEC F-05-93 Issue No. 12.1, including combustion chamber deposits evaluation according to CEC F-20-98

Test Description:

Inlet Valve Cleanliness in the MB M 102 E Engine including combustion chamber deposits evaluation

Test Duration:

60 hours

Test Number:

M102-21 023

Start of Test:

22.04.2021

End of Test:

25.04.2021

Technician:

P. Smutný

Test Rating:

Valid

Comments:

No unexpected occurrences

Customer:

Customer:

VIF s.r.o. / LANG CHEMIE

Contact:

Ing. Boris Božuk / DI Gerhard Stöger

Address_1:

Volutová 2523/14

Address_2:

158 00 Praha 13

Address_3:

Česká republika

Fuel Data:

Receipt of Test Fuel:

21.04.2021

Fuel:

ULG95 + SBA 1000 ppm (V/V)

Comments:

Base fuel by SGS, additive added by SGS

Test Fuel ID:

2483

Engine Data:

Engine Type:

Daimler Chrysler M102E (2,3L; 100kW @ 5100 rpm)

Engine ID:

391 171

Engine Hours SOT:

555,0

Cylinder Head ID:

M102E_005

Cylinder Head Hours SOT:

921,0

Engine Test Oil:

RL254, Batch 5

Test Results:

Inlet Valve Deposits

0 mg per Valve

Average Rating Inlet Valve

10,00

Total Combustion Deposits after KC

9 407 mg

Kolín, 27. 4. 2021

Ing. Ivo Krajiček
Engine Test Centre Manager



Testing laboratory no. 1152.1, accredited by Czech Accreditation Institute in accordance with ČSN EN ISO/IEC 17025:2018 and QMS certified in accordance with ČSN EN ISO 9001:2016.

* = Test Method not accredited

(1) = Analysis performed in another accredited laboratory

(2) = Analysis performed in another non-accredited laboratory

The test results refer to the tested samples only. The partial publication of this report is a subject to a written acceptance of the testing laboratory. Retain samples are provided upon a special request by the customer only.

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2 Operational Data

Average operational data obtained for stage 1 to 4 of the test cycle

| | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Limits |
|---|---------|---------|---------|---------|---------------------------|
| | average | average | average | average | |
| Speed [min^{-1}] | 998,7 | 1299,7 | 1849,9 | 2999,8 | ± 25 |
| Torque [Nm] | 11,4 | 29,1 | 32,5 | 35,0 | ± 2 |
| Coolant outlet temperature [$^{\circ}\text{C}$] | 92,7 | 91,7 | 91,6 | 91,6 | 89 ± 5 Stage 2-4 only |
| Oil temperature gallery [$^{\circ}\text{C}$] | 99,0 | 96,7 | 97,1 | 98,9 | 96 ± 4 |
| Exhaust temperature cyl. 1 [$^{\circ}\text{C}$] | 511,3 | 546,6 | 589,3 | 673,2 | |
| Exhaust temperature cyl. 2 [$^{\circ}\text{C}$] | 502,6 | 525,7 | 568,9 | 682,6 | |
| Exhaust temperature cyl. 3 [$^{\circ}\text{C}$] | 529,4 | 553,9 | 613,4 | 720,6 | |
| Exhaust temperature cyl. 4 [$^{\circ}\text{C}$] | 507,6 | 550,4 | 606,6 | 676,2 | |
| Intake air temperature [$^{\circ}\text{C}$] | 31,0 | 30,8 | 30,7 | 31,0 | 30 ± 5 |
| Fuel temperature [$^{\circ}\text{C}$] | 26,2 | 26,3 | 26,0 | 26,1 | 27 ± 5 |
| Oil pressure [bar] | 0,7 | 1,0 | 1,7 | 3,1 | $> 0,5$ Stage 1 only |
| Fuel pressure [bar] | 5,51 | 5,50 | 5,50 | 5,49 | $5,45 \pm 0,2$ |
| Exhaust back pressure [mbar] | 0,0 | 4,2 | 4,5 | 25,3 | 16 - 36 Stage 4 only |
| Ambient pressure [mbar] | 1000,4 | 1000,4 | 1000,4 | 1000,4 | |
| Fuel flowrate [kg/hr] | 1,00 | 1,75 | 2,53 | 4,49 | |
| Oil consumption [g/test] | 167,0 | | | | < 500 |
| Fuel consumption [l/test] | 212,5 | | | | 230 ± 20 |

Instances of operations outside specific limits and unusual occurrences:

- none

3 Test Evaluation according to CEC F-05-93

| | | | | |
|--------------------|----------------------------|--------------------------------|-------|------------|
| Test no. | M102-21 023 | Inlet valve deposits per valve | 0 | mg / valve |
| Test lubricant: | RL254, Batch 5 | RATING | 10,00 | |
| Cylinder head no.: | M102_005 | Oil consumption: | 167 | g |
| Test fuel: | ULG95 + SBA 1000 ppm (V/V) | ID: | 2483 | |

| Valve no. | M 102 E / IVD rating | | | | | | | | | | | | | |
|---------------------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|-------|
| 1 | 4,5 | 5,0 | 5,5 | 6,0 | 6,5 | 7,0 | 7,5 | 8,0 | 8,5 | 9,0 | 9,5 | 10,0 | | |
| s e g m e n t | 1 | | | | | | | | | | | | 10 | 10 |
| | 2 | | | | | | | | | | | | 10 | 10 |
| | 3 | | | | | | | | | | | | 10 | 10 |
| | 4 | | | | | | | | | | | | 10 | 10 |
| | 5 | | | | | | | | | | | | 10 | 10 |
| | 6 | | | | | | | | | | | | 10 | 10 |
| | 7 | | | | | | | | | | | | 10 | 10 |
| | 8 | | | | | | | | | | | | 10 | 10 |
| | 9 | | | | | | | | | | | | 10 | 10 |
| | 10 | | | | | | | | | | | | 10 | 10 |
| total % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 |
| rating | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 10,0 | 10,00 |

| | | |
|--|----------|-----------|
| EoT, Port & Combustion Side contaminated | 88705 | mg |
| EoT, Port Side contaminated, Combustion Side cleaned | 88642 | mg |
| SoT, New Valve | 88642 | mg |
| Inlet Valve Deposit | 0 | mg |

| Valve no. | M 102 E / IVD rating | | | | | | | | | | | | | |
|---------------------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|-------|
| 2 | 4,5 | 5,0 | 5,5 | 6,0 | 6,5 | 7,0 | 7,5 | 8,0 | 8,5 | 9,0 | 9,5 | 10,0 | | |
| s e g m e n t | 1 | | | | | | | | | | | | 10 | 10 |
| | 2 | | | | | | | | | | | | 10 | 10 |
| | 3 | | | | | | | | | | | | 10 | 10 |
| | 4 | | | | | | | | | | | | 10 | 10 |
| | 5 | | | | | | | | | | | | 10 | 10 |
| | 6 | | | | | | | | | | | | 10 | 10 |
| | 7 | | | | | | | | | | | | 10 | 10 |
| | 8 | | | | | | | | | | | | 10 | 10 |
| | 9 | | | | | | | | | | | | 10 | 10 |
| | 10 | | | | | | | | | | | | 10 | 10 |
| total % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 |
| rating | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 10,0 | 10,00 |

| | | |
|--|----------|-----------|
| EoT, Port & Combustion Side contaminated | 89228 | mg |
| EoT, Port Side contaminated, Combustion Side cleaned | 89208 | mg |
| SoT, New Valve | 89208 | mg |
| Inlet Valve Deposit | 0 | mg |

| Valve no. | M 102 E / IVD rating | | | | | | | | | | | | | |
|---------------------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|-------|
| 3 | 4,5 | 5,0 | 5,5 | 6,0 | 6,5 | 7,0 | 7,5 | 8,0 | 8,5 | 9,0 | 9,5 | 10,0 | | |
| s e g m e n t | 1 | | | | | | | | | | | | 10 | 10 |
| | 2 | | | | | | | | | | | | 10 | 10 |
| | 3 | | | | | | | | | | | | 10 | 10 |
| | 4 | | | | | | | | | | | | 10 | 10 |
| | 5 | | | | | | | | | | | | 10 | 10 |
| | 6 | | | | | | | | | | | | 10 | 10 |
| | 7 | | | | | | | | | | | | 10 | 10 |
| | 8 | | | | | | | | | | | | 10 | 10 |
| | 9 | | | | | | | | | | | | 10 | 10 |
| | 10 | | | | | | | | | | | | 10 | 10 |
| total % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 |
| rating | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 10,0 | 10,00 |

| | | |
|--|----------|-----------|
| EoT, Port & Combustion Side contaminated | 88890 | mg |
| EoT, Port Side contaminated, Combustion Side cleaned | 88864 | mg |
| SoT, New Valve | 88864 | mg |
| Inlet Valve Deposit | 0 | mg |

| Valve no. | M 102 E / IVD rating | | | | | | | | | | | | | |
|---------------------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|-------|
| 4 | 4,5 | 5,0 | 5,5 | 6,0 | 6,5 | 7,0 | 7,5 | 8,0 | 8,5 | 9,0 | 9,5 | 10,0 | | |
| s e g m e n t | 1 | | | | | | | | | | | | 10 | 10 |
| | 2 | | | | | | | | | | | | 10 | 10 |
| | 3 | | | | | | | | | | | | 10 | 10 |
| | 4 | | | | | | | | | | | | 10 | 10 |
| | 5 | | | | | | | | | | | | 10 | 10 |
| | 6 | | | | | | | | | | | | 10 | 10 |
| | 7 | | | | | | | | | | | | 10 | 10 |
| | 8 | | | | | | | | | | | | 10 | 10 |
| | 9 | | | | | | | | | | | | 10 | 10 |
| | 10 | | | | | | | | | | | | 10 | 10 |
| total % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 |
| rating | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 10,0 | 10,00 |

| | | |
|--|----------|-----------|
| EoT, Port & Combustion Side contaminated | 89729 | mg |
| EoT, Port Side contaminated, Combustion Side cleaned | 89709 | mg |
| SoT, New Valve | 89709 | mg |
| Inlet Valve Deposit | 0 | mg |

Rated by: P. Smutný

Date: 25.04.2021

Approved by: J. Mistr

The test precision is defined in the precision statement of the test method F-05-93 in Section 11: Precision for F-05-93 is ± 43 mg per valve for deposit of fuels without additives and 12 mg/valve for deposit of fuels with additives.

The precision is evaluated during the latest round robin.

Extended measurement uncertainty is a product of standard measurement uncertainty and an extension coefficient $k=2$ which corresponds to about 95% probability coverage for standard distribution. Standard measurement uncertainty was determined in accordance with document EA 4/02.

4 Combustion Chamber Deposits according to CEC F-20-98

| | | | |
|---------------|-----------------------------------|----------------------------|-----------------------|
| Test no.: | M102-21 023 | Cylinder head no.: | M102_005 |
| Date: | 25.04.2021 | Test lubricant: | RL254, Batch 5 |
| Rated by: | P. Smutný | Oil Consumption [g/Test]: | 167 g |
| Test fuel: | ULG95 + SBA 1000 ppm (V/V) | Fuel Consumption [l/Test]: | 212,5 l |
| Test fuel ID: | 2483 | | |

| | Valve/Cylinder no. 1 | Valve/Cylinder no. 2 | Valve/Cylinder no. 3 | Valve/Cylinder no. 4 |
|--|----------------------|----------------------|----------------------|----------------------|
| Filter clean [mg] | 1842 | 1998 | 2012 | 1844 |
| Filter loaded [mg] | 4114 | 4480 | 4471 | 4038 |
| Deposits (incl. Combustion Side Deposits) [mg] | 2272 | 2482 | 2459 | 2194 |

| | Piston Top | Fire Land+ Head Gasket | Cylinder Head w/o V. | Inlet Valves Comb. Side | Outlet Valves Comb. Side | Inlet Valves Port Side | Outlet Valves Port Side |
|---------------------------------------|-------------|------------------------|----------------------|-------------------------|--------------------------|------------------------|-------------------------|
| Deposits [mg] | 3554 | 2196 | 3527 | 129 | 1 | 0 | 0 |
| Inlet Valve Deposits per Valve [mg] | | | | | | 0 | |
| Piston Top Deposits [mg] | 5750 | | | | | | |
| Cylinderhead Combustion Deposits [mg] | | | | 3657 | | | |
| Total Combustion Deposits [mg] | | | | 9407 | | | |

| Inlet Valves | | Valve 1 | Valve 2 | Valve 3 | Valve 4 |
|---------------------------------|--|-----------|-----------|-----------|-----------|
| S.O.T. | [mg] | 88642 | 89208 | 88864 | 89709 |
| E.O.T. | Port & Combustion Side contaminated [mg] | 88705 | 89228 | 88890 | 89729 |
| E.O.T. | Port Side contaminated, Combustion Side cleaned [mg] | 88642 | 89208 | 88864 | 89709 |
| Deposits Combustion Side | [mg] | 63 | 20 | 26 | 20 |
| Deposits Port Side | [mg] | 0 | 0 | 0 | 0 |

| Outlet Valves | | Valve 1 | Valve 2 | Valve 3 | Valve 4 |
|---------------------------------|--|----------|----------|----------|----------|
| S.O.T. | [mg] | 89855 | 89634 | 89749 | 89623 |
| E.O.T. | Port & Combustion Side contaminated [mg] | 89855 | 89634 | 89749 | 89624 |
| E.O.T. | Port Side contaminated, Combustion Side cleaned [mg] | 89855 | 89634 | 89749 | 89623 |
| Deposits Combustion Side | [mg] | 0 | 0 | 0 | 1 |
| Deposits Port Side | [mg] | 0 | 0 | 0 | 0 |

5 Pictures

Inlet Valve 1



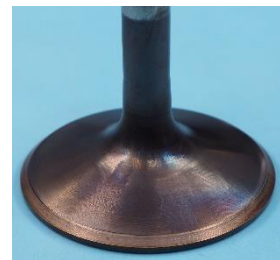
Inlet Valve 2



Inlet Valve 3



Inlet Valve 4



Spark Plugs



Cylinder Head:

Cylinder 1



Cylinder 2



Cylinder 3



Cylinder 4

