SCANIA DT12 02 470 Euro 3 engine
Emission measurements for VTI and COST 346

Anders Hedbom
Ulf Hammarström (Editor)
Preface

VTI has on commission of VINNOVA and the Swedish Road Administration (SRA) participated in COST 346: "Emissions and fuel consumption from heavy duty vehicles". In this commission VTI has engaged AVL MTC Motortestcenter AB. The research efforts at AVL MTC have been executed by Anders Hedbom. This report, VTI notat 48A-2005, constitutes a documentation of exhaust emission measurements for one turbo compound engine, SCANIA DT12 02 470 Euro 3. In the COST 346 project AVL MTC has performed exhaust emission measurements on three engines.

Project leader at VTI has been Ulf Hammarström. Contact persons: Carl Naumburg at VINNOVA and Håkan Johansson at SRA. Gunilla Sjöberg, VTI, has performed the final revision of this document.

Linköping, December 2005

Ulf Hammarström
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1 Engine
SCANIA DT12 02 470 ENGINE

• 6 INLINE CYLINDER DIESEL ENGINE
• TURBOCOMPOUND
• AIR/AIR INTERCOOLER
• SCANIA HPI, HYDRAULIC UNIT INJECTORS
• 4 VALVES PER CYLINDER
• COMPRESSION RATIO 18:1
• SWEPT VOLUME 11.7 LITRES
• MAX. POWER 470 hp (345 kW) @ 1900 rpm
• MAX. TORQUE 2200 Nm @ 1050-1350 rpm
• MAX. EXHAUST BRAKE 229 kW @ 2300 rpm
2 Facilities
3 Program
MEASUREMENT PROGRAM

ARTEMIS PROGRAM

FULLLOAD PERFORMANCE
STEADY STATE CYCLES
- ECE R49
- ESC
- ARTEMIS SS 29 POINTS
- ARTEMIS SS 15 POINTS

TRANSIENT CYCLES
- ETC
- ELR
- TNO-REAL WORLD CYCLE
- TUG-REAL WORLD CYCLE

AVL MTC PROGRAM

FULLLOAD PERFORMANCE
STEADY STATE CYCLES
- ECE R49
- ESC
- ARTEMIS SS 29 POINTS + 10
- ARTEMIS SS 15 POINTS

TRANSIENT CYCLES
- ETC
- ELR
- TNO-REAL WORLD CYCLE
- TUG-REAL WORLD CYCLE

ALL CYCLES RUN TWICE
PROGRAM PERFORMED WITH SWEDISH EC1 DIESEL FUEL
UNDERLINED CYCLES ALSO RUN AS SINGLE TESTS WITH REFERENCE FUEL

SCANIA DT12 02 470 EURO3 ENGINE

FUEL KEY PARAMETERS

<table>
<thead>
<tr>
<th>ANALYSIS</th>
<th>UNIT</th>
<th>RESULT</th>
<th>CEC RF-06-99</th>
<th>EC1</th>
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<tr>
<td>Cetan Number</td>
<td></td>
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<td>54.0</td>
<td>53.0</td>
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<td>Cetan Index</td>
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<td>53.6</td>
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<td>Density @ 15°C</td>
<td>kg/m³</td>
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<td>815.4</td>
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<tr>
<td>Viscosity @ 40°C</td>
<td>cSt</td>
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<tr>
<td>Calorific Value</td>
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<td>CFPP</td>
<td>°C</td>
<td>-25</td>
<td>&lt; -37</td>
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<td>Flash Point</td>
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<td>Sulphur content</td>
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<td>IBP</td>
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<tr>
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<td>HFRR</td>
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</table>

Figure 12

Figure 13

SCANIA DT12 02 470 EURO3 ENGINE
4 Results
FULL LOAD PERFORMANCE
SCANIA DT12 02 470 MK1 FUEL

Based on measurements 6219Q003

Figure 14 (mg/st: milligram per stroke)

FULL LOAD PERFORMANCE
SCANIA DT12 02 470 MK1 AND REFERENCE FUEL

Based on measurements 6219Q003 + 6219Q004

Figure 15 (mg/st: milligram per stroke)
**FULLLOAD PERFORMANCE**

SCANIA DT12 02 470 MK1 FUEL

**Figure 16** (delta, mg/st: amount of fuel injected per stroke)

**STEADY STATE CYCLE MEASUREMENT POINTS**

SCANIA DT12 02 470

**Figure 17**
Figure 18

SCANIADT12 02 470 EURO3 ENGINE

Figure 19

SCANIADT12 02 470 EURO3 ENGINE

VTI notat 48A-2005
Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 10 extra points (X-file).

Figure 20

Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 10 extra points (X-file).

Figure 21
Figure 22

Figure 23
Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 10 extra points (X-file).

Test id: 6219A002.AAD
Test date: 22-JUN-04
Test time: 19:41:42
Operator: U.S./M.A./A.S.

Figure 24

Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 10 extra points (X-file).

Test id: 6219A002.AAD
Test date: 22-JUN-04
Test time: 19:41:42
Operator: U.S./M.A./A.S.

Figure 25
Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 10 extra points (X-file).
Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 10 extra points (X-file).

Figure 28

SCANIA DT12 02 470 EURO3 ENGINE

Figure 29

SCANIA DT12 02 470 EURO3 ENGINE
Figure 30

SCANIA DT12 02 470 EURO3 ENGINE

Figure 31

SCANIA DT12 02 470 EURO3 ENGINE
Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 13 extra points (X-file).

Figure 32

SCANIA DT12 02 470 EURO3 ENGINE

Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 13 extra points (X-file).

Figure 33

SCANIA DT12 02 470 EURO3 ENGINE
Scania DT12 02 470 Euro3 Engine

PM measured by TEOM instrument.

Figure 34

Scania DT12 02 470 Euro3 Engine

PM measured by TEOM instrument.

Figure 35

VTI notat 48A-2005
Figure 36

PM measured by TEOM instrument.

Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file) and ESC (S-file) measurements.

Figure 37

PM measured by TEOM instrument.

Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file) and ESC (S-file) measurements.
**Figure 38**

SCANIA DT12 02 470 EURO3 ENGINE

LAMBDA measured by ETAS instrument.

- Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 10 extra points (X-file).

**Figure 39**

SCANIA DT12 02 470 EURO3 ENGINE

LAMBDA measured by ETAS instrument.

- Map calculations based on Artemis SS29 (A-file), Artemis SS15 (B-file), full load (Q-file), ECE R49 (M-file) and ESC (S-file) measurements together with 10 extra points (X-file).
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Figure 40 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (S=ESC; M=ECE R49). For the EC1 quality double tests have been performed.)

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Figure 41 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (S=ESC; M=ECE R49). For the EC1 quality double tests have been performed.)
Figure 42 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (S=ESC; M=ECE R49). For the EC1 quality double tests have been performed.)

Figure 43 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (S=ESC; M=ECE R49). For the EC1 quality double tests have been performed.)
Figure 44 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (S=ESC; M=ECE R49). For the EC1 quality double tests have been performed.)

Figure 45 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (S=ESC; M=ECE R49). For the EC1 quality double tests have been performed.)
Figure 46 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (S=ESC; M=ECE R49). For the EC1 quality double tests have been performed.)

Figure 47
Figure 52 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (R=ETC; TNO=spec.transient). For the EC1 quality double tests have been performed.)

Figure 53 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (R=ETC; TNO=spec.transient). For the EC1 quality double tests have been performed.)
Figure 54 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (R=ETC; TNO=spec.transient). For the EC1 quality double tests have been performed.)

Figure 55 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (R=ETC; TNO=spec.transient). For the EC1 quality double tests have been performed.)
Figure 56 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (R=ETC; TNO=spec.transient). For the EC1 quality double tests have been performed.)

Figure 57 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (R=ETC; TNO=spec.transient). For the EC1 quality double tests have been performed.)
Figure 58 (fuel quality for RF and EC1 is described in figure 13. Below fuel quality sign the code for the actual test is presented (R=ETC; TNO=spec.transient). For the EC1 quality double tests have been performed.)

Figure 59
Figure 60

Scania DT12 02 470 Euro3 Engine

Lambda Fuel Consumption at High Idle Using Different Engine Fan Operation

- Fan operated at fixed position, engine load simulating maximum fan slip (dynamometer engaged)
- Fan operated at fixed position (dynamometer disengaged)
- Fan at temperature controlled operation (dynamometer disengaged)
- Fan power (fixed fan – fan at max slip), kW

Figure 61

(Measurements have been made with the fan in fixed position but with a correction of the dynamometer simulating fan at max slip. In order to check the representativity of this correction three types of fuel consumption measurements, the first three types of dots, have been performed. Data points, black, describing the power demand of the fan is also included (from the manufacturer. The error in the correction, the dynamometer settings, is expressed of the difference in fuel consumption between yellow and blue data points. The difference between violet and yellow data points expresses the extra fuel for the fan in fixed position.)