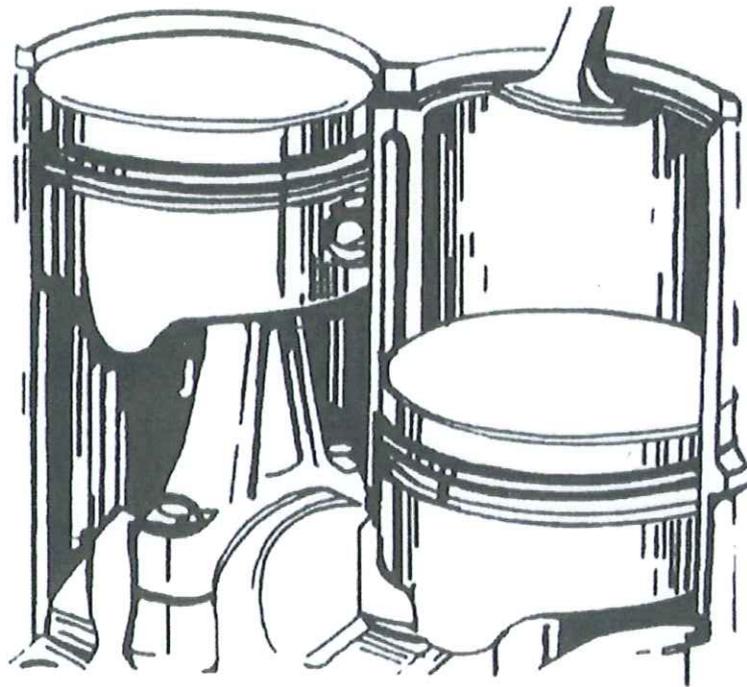




TEST REPORT

Truck Emissions Tests - Firepower



Emissions / Fuel Economy Tests with Volvo FM 12
Hamburg, 27. January 2004

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Hamburg

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Customer:

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Garden Studios
11-15 Betterton Street
Covent Garden
London
WC2H 9BP

Project No.: 5383 0169

Date of Measurements: 21. – 26. January 2004

Test Type: Emissions/FE tests with a truck on chassis dyno

Vehicle Type: Volvo FM 12, reg. BX 02 ZVL (UK)

Test Products: Fuel additive "Polyfuel Type #1"

Test Procedure: Truck emissions test in European Transient Cycle "ETC" before and after 1000 miles mileage accumulation. FE calculated from c-Balance

Summary of Results:

Date:

27.01.2004

Signature:



1. Test description

Emissions tests were conducted with a Volvo truck provided by the customer.

The test cycle chosen for the emissions tests was the "European Transient Cycle (ETC)" also known as FIGE 3-phase cycle.

After initial tests with European market fuel the additive provided by the customer was blended into the fuel according to manufacturers prescription. Tests were repeated on the same day as the initial tests.

A mileage accumulation run was conducted over 1000 miles in constant gear at 60 km/h in variable loads. Final emissions tests, at the end of the mileage accumulation, were conducted in the same way as the initial tests.

2. Test vehicle, Preconditioning

A Volvo FM 12, registration BX 02 ZVL from UK, was collected from the ferry in Cuxhaven on the 20th Jan. 04 and driven on the road to Hamburg, PAE-Laboratory.

On arrival the tyres of the driven axle were exchanged to chassis dyno tyres (slicks) to ensure constant rolling resistance on the chassis dynamometer over the driven test distance of about 1200 miles on the chassis dynamometer. Safety trips were installed for unmanned mileage accumulation over 1000 miles.

The exhaust tailpipe was connected to the full-stream dilution tunnel for exhaust emissions measurements.

3 CD operation and Measurement equipment

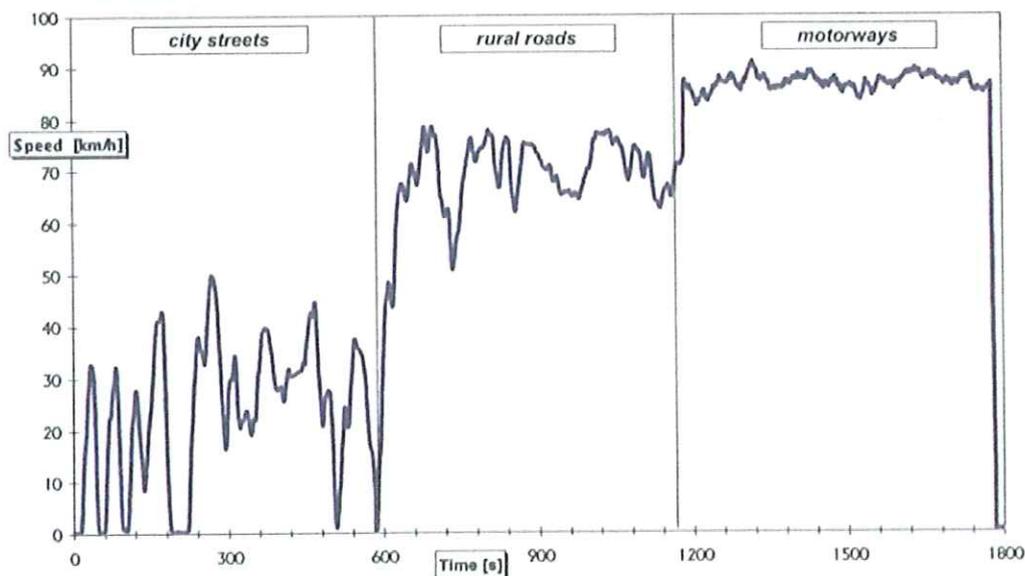
The chassis dynamometer, an AVL- Zoellner twin roller design with 20" roller diameter and 330 kW nominal brake power, was setup to simulate road load conditions for a 20 tons truck.

Road load parameters: $F_0 = 15000 \text{ N}$; $F_1 = 0.8 \text{ N} \cdot \text{m}/\text{sec}$; $F_2 = 1.55 \text{ N} \cdot \text{m}^2/\text{sec}^2$.

The truck was driven by an operator, trained in driving the European Transient Cycle (ETC) with a variety of trucks and buses including Volvo models.

The ETC cycle, shown in the following graph, consists of 3 phases representing city driving, rural roads and motorway traffic.

ETC Cycle





Emissions were measured in each of the 3 cycles using the full-stream dilution tunnel with a CVS (constant volume sampler) volume stream of 60 m³/minute. Emissions analysers were Horiba 9000 series with analysers for CO, CO₂, NO_x and THC (total hydrocarbons). Particulates were sampled and analysed gravimetrically.

The fuel consumption was calculated from the carbon balance, based on the principle that all the carbon from the emissions components CO, CO₂ and THC has been fed into the engine as carbon from the fuel.

The standard equation, as described in the European regulations 80/1268/EC for fuel economy measurements with diesel vehicles is as following:

$$FC = (0.1155/D) * [(0.866*THC)+(0.429*CO)+(0.273*CO_2)]$$

FC fuel consumption [L/100km]

D fuel density

THC, CO, CO₂ emissions concentrations [g/km]

4 **Fuel and Additive, preparation and blending**

The fuel used was a marketed EN590 specification winter grade containing usual additive as found in the market place with standard fuels.

Key fuel parameters:

Density 0.8367 kg/L

Sulphur content 10 ppm

Total fuel volumes used: 600 Litres.

A 250 ml plastic container with a very high viscous liquid, description:

Polyfuel Type #1

Date 1-6-04 10 oz

With a dosing prescription:

Use as 1 ounce of Polyfuel to 15 gallons of diesel fuel

Was delivered to PAE Laboratory on the 20th January 2004 in the late afternoon. As too viscous to treat as described above, the customer asked us to pre-dilute the product 1:1 with the test fuel and store over night at +30°C, which resulted in a gelly-like composition. This was further diluted to 2.5 litres but did not dissolve homogenously. Finally a pre-dilution of 254,4 grams of the additive in 10 litres of diesel fuel gave a satisfactory solution. This solution was used to treat total 509.33 litres Diesel fuel with the treat rate of 1 oz at 56.76 litres (15 gallons).

5 **Test results**

The emissions and fuel economy data for the 3 phases of the drive cycle are shown in the Attachment 1 and 2.

The average of the 3 repeat tests is calculated. The differences of the 3 test series (base-Polyfuel-polyfuel after 1000 mls) are calculated from the averages.

The data has been verified as valid tests, but not been statistically analysed. Any differences shown in the data summary may be within the repeatability of the method.



Abgas - Rollenprüfstand 3

Deutsche Shell GmbH - PAE-Labor - OGME/ 32

Projekt	: 220258	Car Model	: Volvo FM12 Zugm.
Test Type	: Fige4 04004	Vehicle Code	: 220355
Auftrag Nr.	: 04004	Odometer	: 264463
Test Number	: 3004012105	Engine Displ. [ccm]	:
Oil Code	: 229999	Operator	: E. Meyer
Fuel Code	: 221695	Fuel Density [Kg/l]	: 0.837
Fuel Serie	:	H/C-Ratio	: 0.000
		Driving Cycle	: Fige 4 04004

Remarks: Einmessung additiviert

Testparameter		Phase 1	Phase 2	Phase 3
Ambient Pressure	[hPa] :	1021	1021	1021
Ambient Temperature	[°C] :	19.9	20.6	20.6
Relative Humidity	[%] :	18.1	17.5	16.7
Absolute Humidity	[g/Kg air]:	2.57	2.61	2.48
NOX - corr. factor	[-] :	0.789	0.790	0.787
Dilution Factor	[-] :	32.444	19.245	16.112
Corr. CVS-Volume	[m ³]:	595.650	606.120	608.970
Avg. CVS Pressure	[kPa] :	100.8	100.8	100.8
Avg. CVS Temperature	[°C] :	24.1	31.0	37.8
Blower Position	[-] :	4	4	4
max. Tunnel Temperature	[°C] :			
Avg. HFID-Line Temperature	[°C] :			
Avg. HFID-Temperature	[°C] :			
Avg. Presampler Temperature	[°C] :			
Corr. PMU-Volume	[l] :	219.64	248.01	252.90
Start Oiltemperature	[°C] :			
Aldehyde volume Line 1	[l] :	0.00	0.00	0.00
Aldehyde volume Line 2	[l] :	0.00	0.00	0.00
Testdistance	[m] :	3845	11301	14595
Testtime	[sec] :	586	602	612

Volume corrected for 273.15 K and 1013.25 hPa

Analysis results		THC	CO	CO2	NOx	FC [l/100Km] mit C-Anteil	FC [l/100Km] nach 80/1268
Phase 1							
Concentration		4.759	44.674	3607	42.721	0.00	42.20
g/Phase		1.755	33.263	4247.09	41.142		
g/km		0.456	8.652	1104.85	10.701		
Phase 2							
Concentration		6.676	72.797	6381	77.687	0.00	25.82
g/Phase		2.505	65.155	7646.86	76.210		
g/km		0.222	4.880	676.64	6.744		
Phase 3							
Concentration		8.960	38.516	7720	64.291	0.00	24.15
g/Phase		3.378	29.319	9294.86	63.162		
g/km		0.231	2.009	636.86	4.328		
Summary [g/km]		0.257	3.959	712.45	6.070	0.00	27.11



Abgas - Rollenprüfstand 3
Deutsche Shell GmbH - PAE-Labor - OGME/ 32

Projekt	: 220258	Car Model	: Volvo FM 12
Test Type	: Fige4 04004	Vehicle Code	: 220355
Auftrag Nr	: 04004	Odometer	: 266502
Test Number	: 304012604	Engine Disp. [ccm]	:
Oil Code	: 229999	Operator	: E. Meyer
Fuel Code	: 221695	Fuel Density [Kg/l]	: 0.837
Fuel Serie	: 2	H/C-Ratio	: 0.000
		Driving Cycle	: Fige4 04004

Remarks: Rückmassung nach Dauerlauf 1600 km

Testparameter		Phase 1	Phase 2	Phase 3
Ambient Pressure	[hPa]	1008	1008	1008
Ambient Temperature	[°C]	20.3	20.8	21.1
Relative Humidity	[%]	19.0	18.1	17.2
Absolute Humidity	[g/kg air]	2.31	2.74	2.67
NOX - corr. factor	[-]	0.794	0.792	0.791
Dilution Factor	[-]	33.648	19.435	16.367
Corr. CVS-Volume	[m³]	592.280	593.470	596.300
Avg. CVS Pressure	[kPa]	99.4	99.5	99.4
Avg. CVS Temperature	[°C]	29.7	35.3	41.0
Blower Position	[-]	4	4	4
max. Tunnel Temperature	[°C]			
Avg. HFID-Line Temperature	[°C]			
Avg. HFID-Temperature	[°C]			
Avg. Presampler Temperature	[°C]			
Corr. PMU-Volume	[l]	223.98	220.01	225.16
Start Oiltemperature	[°C]			
Aldehyde volume Line 1	[l]	0.00	0.00	0.00
Aldehyde volume Line 2	[l]	0.00	0.00	0.00
Testdistance	[m]	3828	11306	14004
Testtime	[sec]	666	602	612

Volume corrected for 273.15 K and 1013.25 hPa

Analysis results					FC [l/100km]	FC [l/100km]
Phase 1	THC	CO	CO2	NOx	mit C-Anteil	nach 80/1268/EW
Concentration	4.126	40.222	3446	39.112	0.00	39.55
g/Phase	1.487	29.276	3997.19	37.052		
g/km	0.389	7.648	1036.34	9.679		
Phase 2						
Concentration	6.830	72.121	6280	76.298	0.00	24.67
g/Phase	2.509	63.602	7368.11	73.581		
g.km	0.222	4.732	651.70	6.508		
Phase 3						
Concentration	8.755	30.638	7602	61.309	0.00	23.33
g/Phase	3.243	22.917	6993.58	59.472		
g/km	0.222	1.569	615.84	4.072		
Summary [g/km]	0.243	3.554	683.61	5.719	0.00	26.00