Technical Univerzity of Liberec

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Internal Combustion Engine Test Laboratory

TEST REPORT

No. P 26/10/07

authorized measurement of engine performance and exhaust emissions of a spark-ignition engine Škoda 1.4 MPI with BIO PERFORMANCE fuel additive

Project submitter:	ENROL CZ spol. s r.o., Nová Ves 190
Laboratory :	Laboratory of internal combustion engine Technical univerzity of Liberec
Date measurements:	25. a 26. 10. 2007
Emission:	CO, NO_x, THC, CO_2
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AKREDITOVANÁ ZKUŠEBNÍ LABORATOŘ
Technická univerzita v Liberci
Zkušební laboratoř pístových spalovacích motorů

SUMMARY

Report contains description of tests and measurements of the engine Š 1.4 MPI with fuel standard gasoline NATURAL 95 and standard gazoline NATURAL 95 plus additive BIO PERFORMANCE which were carried out in Laboratory of internal combustion engine Technical university of Liberec.

1.0 Type and purpose of the test

The goal of the test was a comparison of engine operating characteristics and concentrations of pollutants in the exhaust during operation on standard gasoline and gasoline with additive **BIO PERFORMANCE** at various operating conditions. The tests were carried on a Š 1.4 MPI engine. The tests were done according to the methodology of tests no. 1 and no. 8 listed in the appendix of the Decision of Accreditation no. 3962/740/03 issued by the Czech Republic Ministry of Environmental Protection.

2.0 Engine data

Engine company :	ŠKODA AUTO a.s.
Type:	**Š 1.4 MPI**
Type of construction :	spark-ignition engine
Application :	care engine
Construktion:	water cooling, four-stroke, OHV, four cylinder, gazoline range engine with catalyzer

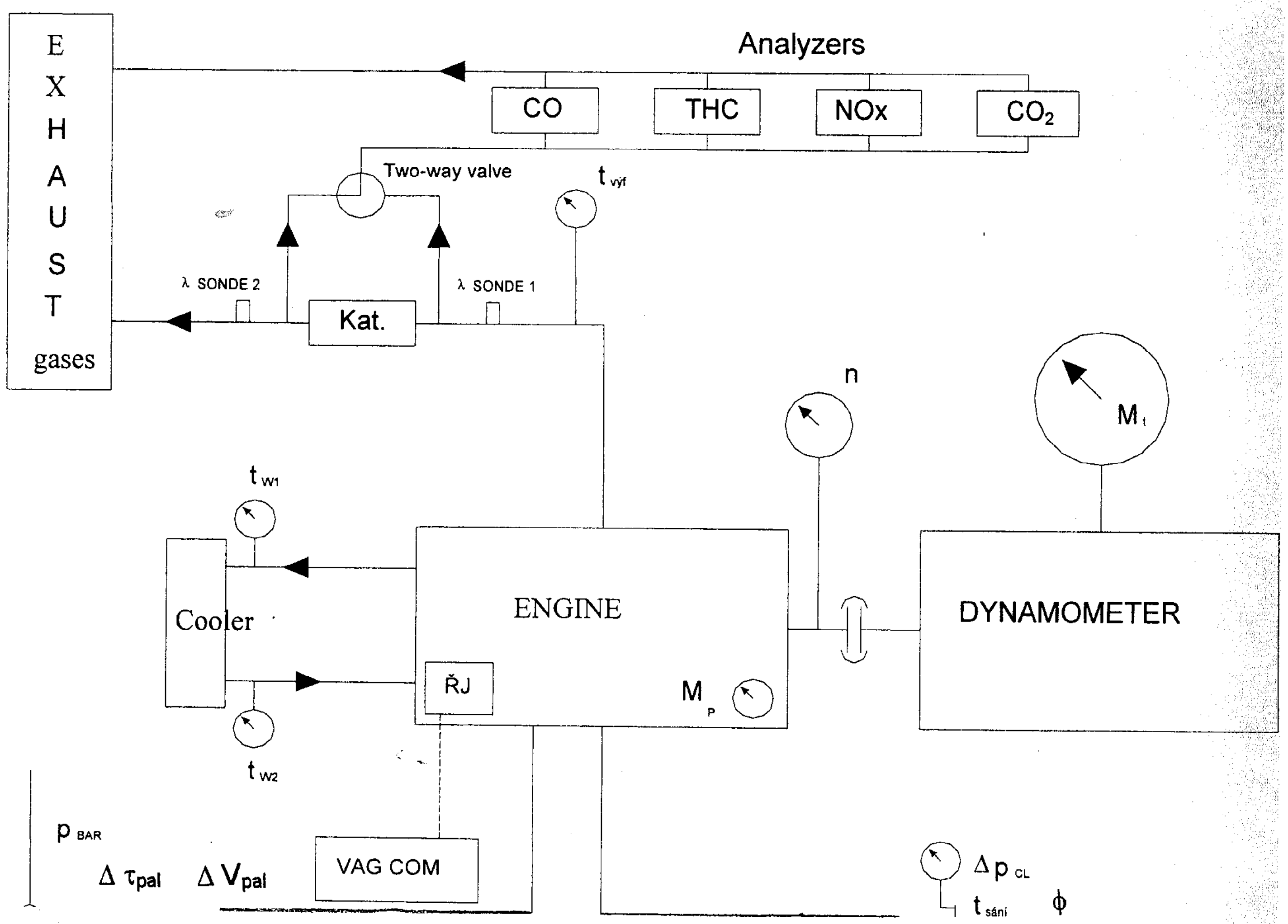
Basic data of the engine

numer of engine	*003 237*	
displacement volume	1,396	dm^3
bore	75,5	mm
stroke	78	mm
cylinder number	4	
rated power of engine	50	kW
RPM nominal-speed	4300	rpm
RPM_{min} - idle run	860	rpm
Compression ratio	10,5 : 1	

3.0 Ordering of measuring systém on the testing site

ENGINE - ŠKODA 1.4MPI

Ordering of measuring system on the testing site- value notation



The tests were carried on an eddy-current engine dynamometer Schenck W150, equipped with a tensometric sensor for torque measurement and incremental engine rpm sensor. The desired engine load was set manually by the test operator, and automatically maintained by a Siemens 6RA70 controller.

The tests were done on a Škoda 1,4 MPi inline four-cylinder spark-ignition gasoline fueled engine with OHV valvetrain. The radiator was placed in a water bath. The coolant temperatures were measured at the inlet (t_{W1}) and outlet (t_{W2}) of the radiator by Pt100 resistive temperature detectors (RTD). Ignition timing advance /£/, engine rpm /n/, coolant temperature inside of the engine /t_{vody}/, catalyst temperature /t_{VAGKAT}/, air-fuel ratio /l/, and other parameters were acquired through the engine OBD diagnostic link using VAG-COM unit and software. Exhaust temperature at the catalyst inlet $t_{výt}$ was measured using a type J thermocouple.

Intake air mass flow was measured by a frontal orifice located in an elongated intake pipe. Intake air temperature, humidity and pressure drop across the orifice were measured at the inlet. Pressure drop was measured using a digital manometer MRU DM 9200 equipped with temperature-compensated pressure sensor capable of accurate measurement even at low pressures. An exhaust sampling port was installed upstream of the catalytic converter. The concentrations of total hydrocarbons were measured in wet exhaust, sampled through a heated sample line. The concentrations of other gases were measured in dry exhaust, from which most of the water vapor was removed by passing the sample through a chiller.

Fuel consumption was measured on a volumetric basis using a LIMIT DR 200 meter, serial no. 3045, with ADAST 85 flowmeter, serial no. 37914. Independent fuel consumption measurement on a gravimetric basis was conducted using a Sartorius IC 64 balance, serial no. 11004926

4.0 Fuel and lubricants

Fuels:

A) Commercially available 95-octane gasoline NATURAL 95, density 762 kg/m^3

B) Commercially available 95-octane gasoline NATURAL 95, density 762 kg/m^3 plus additive BIO PERFORMANCE 0.12% by weight, fuel density 762 kg/m3

Note: Both gasolines were taken from the same fuel stand BENZINA

Lubricant: Ordinary mineral motor oil, SAE 15W-40

5.0 Analytical equipment

Analyzers used for gas concentration measurements in exhaust gases:

Emission	Analyzer	Number	Range	Accuracy
THC	analyzer HORIBA FIA 321K – (FID)	851023021	0-6000 ppm	± 2%
NO_x	analyzer NOx – (CLA) Emerson NGA 200P	25063833215	0-4000 ppm	± 5%
CO	analyzer CO - (NDIR), HORIBA VIA 510, analyzer HB –(NDIR) URAS 2T	56923901	0-5000 ppm 0-16%	± 5% ± 5%
CO_2	analyzer CO_2 – (NDIR) Hartman-Braun URAS 3E	30665742	0-16 %	± 5%

The gas analyzers were calibrated immediately prior and during the measurements with the following gases (Linde Technoplyn, Inc.):

Emission	Standard materiál LINDE-Technoplyn	Concentration	Certificate of calibration	Accuracy ε
NO_x	NO	2800 ppm	57507/07	± 2 %
CO	CO	888 ppm	44626/06	± 2 %
T.HC	C_3H_8	913 ppm	44627/06	± 2 %
CO_2	CO_2	10,0 %	788/06	± 1 %

Note: Uncertainty of the certified calibration gas concentration is expressed as the expanded combined uncertainty multiplied by a factor of 2.

A calibration check was conducted after the measurement for the following parameters:

- Atmospheric pressure, station barometer no. DP 1148/3
- Relative humidity, psychrometer PM 821 L, serial no. 024/88
- Time measurement, technical stopwatch Pragotron DTS-11 no. DP 1507-28.

Uncertainties of the individual measured parameters:

- Brake-specific fuel consumption

  Determined using partial uncertainties of the measured volume, time, rpm and torque

$$\varepsilon = \sqrt{\varepsilon^2_{Vpal} + \varepsilon^2_t + \varepsilon^2_n + \varepsilon^2_{Mt}} = \sqrt{2^2 + 0{,}3^2 + 1^2 + 2^2} = 3{,}0\%$$

- Volumetric concentrations of pollutants in exhaust gases

  Determined using partial uncertainties of gas analyzers and reference calibration gases

$$\varepsilon_{cs} = \sqrt{\varepsilon^2_{anal} + 2.\varepsilon^2_{refmat}} = \sqrt{2^2 + 2.2^2} = 3{,}46\%.$$

6.0 Conditions measurement

Basic conditions measurement:

- torque engine 0 - 100 %,
- speed engine 2000, 3500 rpm
- atmospheric pressure 97,10 kPa,
- relative humidity 31 % ,
- intake air temperature 24 °C ,
- coolant temperature 75 - 89 °C.

7.0 Test conditions and results

The following tests were carried on the engine dynamometer test stand with Š 1.4 MPI engine, in this order :

a) Load characteristics at 2000 and 3500 rpm with Fuel A (standard gasoline Natural 95)

b) Operation of the engine at 2900 rpm and nominal torque of 65 Nm on Fuel B (standard gasoline Natural 95 with 0.12% by volume BIO PERFORMANCE additive) until approximately 31 liters of this fuel were consumed

c) Load characteristics at 2000 and 3500 rpm on Fuel B with BIO PERFORMANCE additive

The summary of the measured and calculated values is given in Appendix P-01. The comparison of the selected parameters during the operation of the engine on standard gasoline and on gasoline with the additive (after consumption of 31 34 liters of fuel with additive) are listed in the following tables.

T 1 Specific fuel consumption - enginespeed 2000 rpm

Power engine (kW)	BSFC (g/kWh)		
	N 95 FUEL A	N 95 +addition FUEL B	Deviation ratio (%)
3,6/3,4	492,5	481,8	-2,17
6,3/6,4	367,9	365,5	-0,65
10,5/10,4	314,4	306,3	-2,58
13,9/14,5	295,3	285,4	-3,35
18,1/17,8	310,6	315,5	+1,58

T 2 Specific fuel consumption - enginespeed 3500 rpm

Power engine (kW)	BSFC (g/kWh)		
	N 95 FUEL A	N 95 +addition FUEL B	Deviation ratio (%)
3,6/3,4	509,2	515,7	+1,28
6,3/6,4	364,8	377,4	+3,45
10,5/10,4	318,2	310,8	-2,33
13,9/14,5	309,3	310,1	+0,03
18,1/17,8	316,3	316,7	+0,01

T 3 Specific volume concentration of NO_x - enginespeed 2000 rpm

Power engine (kW) Fuel A/B	Specific volume concentration of NO_x before catalyzer (ppm/kW)		
	N 95 FUEL A	N 95 + addition FUEL B	Deviation ratio (%)
3,6/3,4	324	291	-10,2
6,3/6,4	353	378	+7,1
10,5/10,4	221	258	+16,7
13,9/14,5	172	164	-4,7
18,1/17,8	81	54	-33,3

T 4 Specific volume concentration of NO_x - enginespeed 3500 rpm

Power engine (kW) Fuel A/B	Specific volume concentration of NO_x before catalyzer (ppm/kW)		
	N 95 FUEL A	N 95 + addition FUEL B	Deviation ratio (%)
3,6/3,4	244	250	+205
6,3/6,4	218	213	-2,3
10,5/10,4	147	145	-1,4
13,9/14,5	61	58	-4,9
18,1/17,8	32	21	-34,4

T 5 Specific volume concentration of THC - enginespeed 2000 rpm

Power engine (kW) Fuel A/B	Specific volume concentration of THC before catalyzer (ppm C_3H_8/kW)		
	N 95 FUEL A	N 95 + addition FUEL B	Deviation ratio (%)
3,6/3,4	201	175	-12,5
6,3/6,4	118	107	-9,3
10,5/10,4	71	65	-8,5
13,9/14,5	45	40	-12,5
18,1/17,8	38	41	-7,9

T 6 Specific volume concentration of THC - enginespeed 3500 rpm

Power engine (kW) Fuel A/B	Specific volume concentration of THC before catalyzer (ppm C_3H_8/kW)		
	N 95 FUEL A	N 95 + addition FUEL B	Deviation ratio (%)
3,6/3,4	62	82	+32,3
6,3/6,4	40	50	+25,0
10,5/10,4	23	30	+30,4
13,9/14,5	21	24	+14,3
18,1/17,8	19	20	+0,7

T 7 Specific volume concentration of CO - enginespeed 2000 rpm

Power engine (kW) Fuel A/B	Specific volume concentration of CO before catalyzer (ppm/kW)		
	N 95 FUEL A	N 95 + addition FUEL B	Deviation ratio (%)
3,6/3,4	1490	1050	-29,5
6,3/6,4	950	640	-32,6
10,5/10,4	439	382	-12,9
13,9/14,5	327	255	-22,0
18,1/17,8	981	1830	+86,5

PŘÍLOHA P 01 Mean values of parameters obtained during load characteristics measurements of the Š 1.4 MPI engine

pb = 97,1 kPa vlhkost 31 %

hustota 762 kg/m3

otáčky	moment	Pe	p_sání	p_výf	t_s	t_v	t_výf	C3H8	CO	NOX	CO2	Mp	Mp	mpe	pe	r air	M air
[1/min]	[Nm]	[kW]	[kPa]	[kPa]	[°C]	[°C]	[°C]	[ppm]	[%]	[ppm]	[%]	[l/h]	[kg/h]	[g/kWh]	[kPa]	[kg/m3]	[kg/h]
2000	17	3,6	0,020	0,935	24	75	434	741	0,538	1165	14,46	2,33	1,78	492,5	154,82	1,14	25,65
2000	30	6,3	0,035	1,460	24	79	482	745	0,601	2224	14,40	3,03	2,31	367,9	269,47	1,14	33,35
2000	50	10,5	0,069	2,684	24	86	543	748	0,461	2318	14,26	4,33	3,30	314,4	451,04	1,14	47,71
2000	66	13,9	0,128	4,875	24	88	628	629	0,454	2391	14,44	5,39	4,11	295,3	597,99	1,14	59,39
2000	86	18,1	0,258	7,575	24	87	683	693	1,777	1460	13,93	7,36	5,61	310,6	775,43	1,14	73,89
3502	16	6,0	0,071	2,900	23	82	608	371	0,471	1465	14,32	4,03	3,07	509,2	147,82	1,14	44,35
3503	30	11,1	0,127	4,875	24	84	635	448	0,520	2418	14,35	5,33	4,06	364,8	272,80	1,14	58,64
3503	50	18,2	0,241	8,790	24	88	698	419	0,585	2678	14,44	7,60	5,79	318,2	446,26	1,14	83,67
3503	74	27,2	0,423	14,943	24	88	750	557	2,124	1662	13,76	11,02	8,40	309,3	665,83	1,14	121,35
3503	94	34,4	0,645	22,035	24	89	775	638	3,404	1092	12,96	14,29	10,89	316,3	844,17	1,14	140,37

pb = 97,2 kPa vlhkost 32 %

hustota 762 kg/m3

otáčky	moment	Pe	p_sání	p_výf	t_s	t_v	t_výf	C3H8	CO	NOX	CO2	Mp	Mp	mpe	pe	r air	M air
[1/min]	[Nm]	[kW]	[kPa]	[kPa]	[°C]	[°C]	[°C]	[ppm]	[%]	[ppm]	[%]	[l/h]	[kg/h]	[g/kWh]	[kPa]	[kg/m3]	[kg/h]
2000	16	3,4	0,015	0,939	24	78	486	595	0,359	989	14,50	2,17	1,65	481,8	147,16	1,14	23,86
2000	31	6,4	0,031	1,539	24	81	512	687	0,411	2422	14,44	3,06	2,34	365,5	274,36	1,14	33,74
2000	50	10,4	0,065	2,807	24	87	570	672	0,398	2679	14,47	4,19	3,19	306,3	447,54	1,14	46,11
2000	69	14,5	0,120	4,824	24	88	646	576	0,371	2376	14,56	5,42	4,13	285,4	621,26	1,14	59,65
2000	85	17,8	0,265	7,312	24	87	666	727	3,262	961	13,08	7,36	5,61	315,5	765,41	1,14	72,96
3502	16	6,0	0,063	2,873	24	83	627	489	0,373	1497	14,57	4,06	3,09	515,7	146,97	1,14	44,65
3502	31	11,2	0,116	4,760	24	87	657	561	0,431	2382	14,52	5,54	4,23	377,4	274,60	1,14	61,05
3502	51	18,5	0,228	8,990	24	88	717	550	0,497	2686	14,53	7,56	5,76	310,8	454,55	1,14	83,23
3502	69	25,2	0,367	13,371	24	88	729	599	2,809	1469	13,38	10,25	7,81	310,1	617,78	1,14	112,84
3502	94	34,4	0,647	21,973	24	89	757	687	5,035	705	11,99	14,29	10,89	316,7	843,46	1,14	141,78

Technická univerzita v Liberci
Katedra chemie
Hálkova 6
C-461 17 Liberec

Procesní zakázka:	**103000044626**
Číslo lahve:	8120492
Ražení:	Lahev Linde
Objem lahve [l]:	10

Certifikát referenčního materiálu Kalibrační plyn tř. 1
Sekundární referenční materiál

Složka	Požadovaná hodnota	Skutečná hodnota 1)	Rel. nejistota + - % rel.) 2)
Oxid uhelnatý	890 ppm	888 ppm	± 2
Dusík	Zbytek		

1) Hodnota složky je vyjádřena jako molární podíl (mol/mol). Všechny údaje jsou vztaženy na normální stavové podmínky plynu (101,3 kPa a 273,15 K)
2) Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu rozšíření K = 2, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí asi 95 %. Standardní nejistota měření byla v souladu s dokumentem EA4/02.

Plnicí tlak [15° C]:	ca 150 bar	min. teplota skladování:	Odpadá
Množství náplně:	1.500 l	min. použitelný tlak:	5 bar
Stabilita	12 měsíců	doporučená teplota při použití:	10 °C - 30 °C
Přípojka ventilu:	14	Hmotnost netto [Kg]:	1,724
číslo zakázky:	315030595 / 000020		
číslo objednávky:	KVM/6/2370/102		

Návaznost:
Referenční materiál je navázán přímým porovnáním
s certifikovaným referenčním materiálem č.8003
Kalibrace referenčního materiálu nebyla provedena
jako akreditovaný výkon dle ČSN EN ISO/IEC 17025.
Platnost certifikátu referenčního materiálu do:6.12.2007

Datum výroby: **06.12.2006** Pracovník: **Jan Smejkal**
Po kontrole obsahu byl tento certifikát vystaven automaticky a je platný bez podpisu.
Linde Gas a.s. - Výroba speciálních plynů - U Technoplynu 1324 , 198 00 Praha 9.
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