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ECOLOGICAL ASPECTS OF DIESEL WORKS

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Summary. The paper presents some problems connected with a negative influence of a diesel start on the environment. Stoichiometric calculations were made for start doses of a fuel, both diesel oil and methyl ester of rapeseed oil.

Key words: diesel engine, start-up device

INTRODUCTION

The start of a diesel requires an increase of a start dose of the fuel by 50 to 100% of a rated dose. Obviously, the a/m fact shall result in an excessive exhaust of toxic compounds into the atmosphere. Such a situation might be compared to a rapid drive-off from the intersection. Results recorded by the automatic emission monitoring station, [Rewaj 1995] located in the urban area next to the road of traffic density as high as 48,000 vehicles per day can illustrate the case in question. The station monitored the instantaneous concentration of the following pollutants:

– nitrogen dioxide, NO_2,
– carbon monoxide, CO,
– sulphur dioxide, SO_2.

The measuring point was situated far from any local sources of emission whereas the noise level corresponded to the high traffic density.

The principle of the measuring station is shown in Fig.1. The annual test results are shown in Fig. 2 and Tab. 1.

Table 1. Average annual concentration at measuring point

Pollutant	Average annual concentration, μg/m^3		Sa/Da
	recorded (Sa)	admissible (Da)	
Solphur dioxide	17.8	32.0	0.56
Nitrogen dioxide	129.8	50.0	2.60
Carbon monoxide	1049.1	120.0	8.74

As shown, the concentration of sulphur dioxide does not exceed the average annual limits whereas the concentration of carbon monoxide and nitrogen dioxide goes far beyond the limit.

The average annual concentration of nitrogen dioxide reached 129.8% equivalent to 259.6% of the admissible value of 50. Petrol engines cause the exceeding of admissible limits of CO concentration whereas diesels are responsible for higher values of NO_2 concentration. It must be pointed out that Polish requirements are stricter as compared to German ones for instance (see Tab. 2).

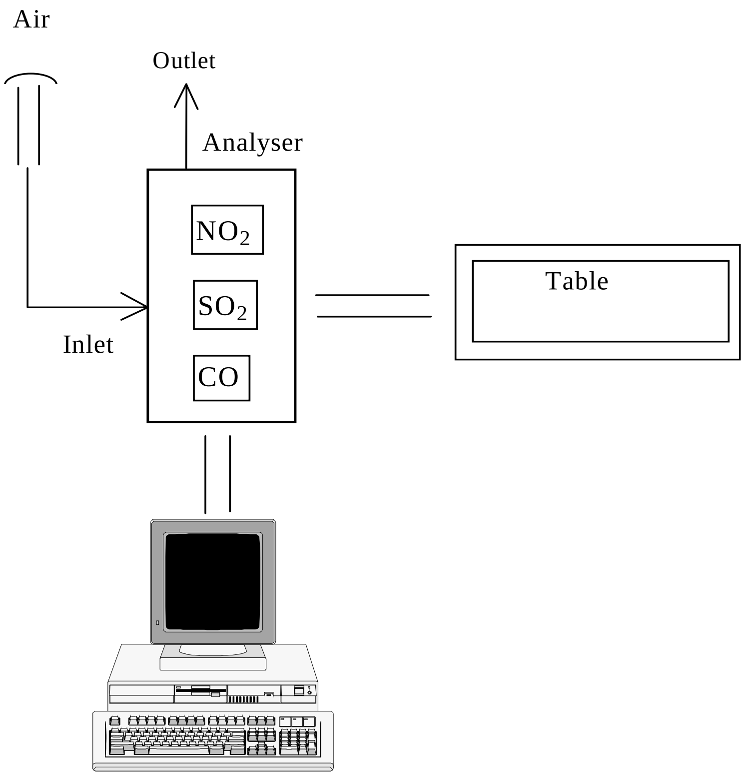

Fig. 1. Measuring station [Rewaj 1995]

Table 2. Admissible annual concentration (Da)

Country	Concentration (Da) µg/m^3		
	SO_2	NO_2	CO
Poland	32	50	120
Germany	140	80	10000

American requirements in turn are more severe as far as SO_2 and NO_2 are concerned. The concentration of SO_2 is closely related to the contents of sulphur in the fuel and the concentration of NO_2 reflects the process of generating air: fuel mixture and combustion in diesel, the latter issue being discussed in the further part of the paper.The best solution in the case in study is to lead lorries along the ring-road which bypasses the city centre – this has been suggested for a long time now.

SIMULATION CALCULATIONS OF COMBUSTION IN DIESELS

The start of a diesel is similar to a rapid drive-off while leaving the intersection so the assumption was made to adopt the a/m results of the air pollution by diesel driven vehicles for the purpose of a comparison study.

The combustion simulation was made for the 359 engine, (Star 200,1142) supplied with two types of fuel, i.e.diesel oil and environmentally-friendly ester of rapeseed oil [Kowalewicz 1980, Zabłocki 1990], the results are shown in Fig. 3 and Tab. 3.

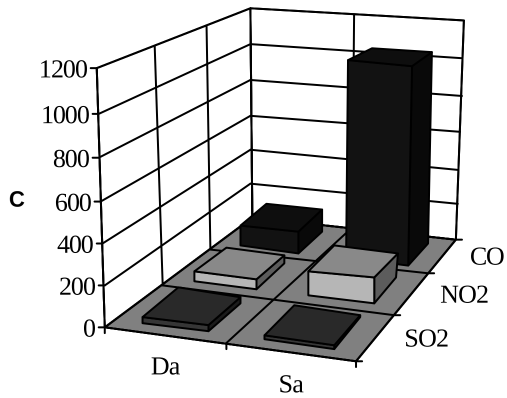

Fig. 2. Average annual concentration of pollutants at measuring station, C – concentration, μg/m^3 [Rewaj 1995]

Table 3. Products of combustion in diesels

Parameter	Diesel oil ON		Methyl ester of rapeseed oil RME	
	Nm^3/kg fuel	%	Nm^3/kg fuel	%
Exhaust gas volume	14.3535	100	5.7339	100
N_2 volume	12.0461	83.9	4.6143	80.48
CO_2 volume	1.5682	10.92	0.8364	14.58
O_2 volume	0.7392	5.14	0.2832	4.94

Another feature which is characteristic for the generation of air: fuel mixture is the smokiness of the exhaust gas.The relevant values of smokiness for diesel oil and methyl ester of rapeseed oil are shown in Fig. 4 and Tab. 4.

Table 4. Smokiness of exhaust gas, diesel under study

Fuel	Smokiness and percentage of urburnt fuel		
	2 Bosch	3 Bosch	4 Bosch
Diesel oil ON	0.13	0.20	0.40
Methyl ester of rapeseed oil RME	0.22	0.34	0.68

An analysis of results shows that the rapeseed-oil-based fuel is 1.7 times more advantageous in terms of exhaust gas smokiness. Smokiness of 2 Bosch results in 0.22% of the unburnt fuel in case of the RME and 0.13% in case of the ON. This leads to lower smokiness while supplying the engine with rapeseed-oil-based fuel at the same contents of unburnt fuel in the exhaust gas.

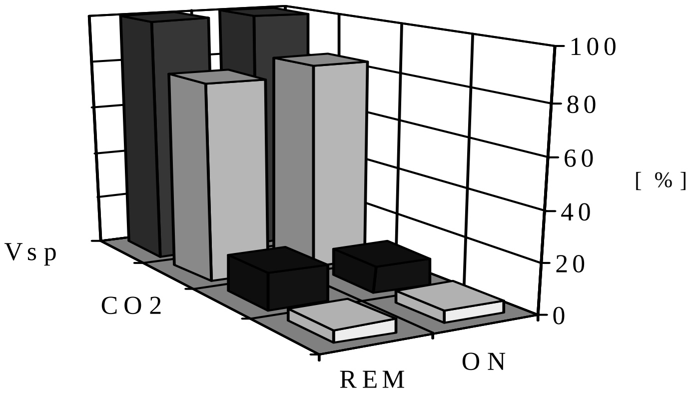

Fig. 3. composition of exhaust gas for diesel under study, percentage V_{sp} – exhaust gas volume

The results of test-bench study of the 359 published by Lotko and Luft [1995], seem to be consistent with the a/m conclusion, that is the smokiness of a diesel supplied with diesel oil was 1.5 Bosch and only 0.5 Bosch in case of the supply with methyl ester of rapeseed oil. The contents of NO_2 in exhaust gas while supplying the engine with the rape-oil-based fuel was lower by 4.3% and further investigation aimed at an improvement seems to be essential.

Considering the course of light absorption ratio (fumigation ratio) in function of rotation velocity of the diesel engine 359, we can mark out two brackets: for lower rotation velocities (range 1200-1800 1/min), and highter rotation velocities and high loads (range 1800–2700 1/min).

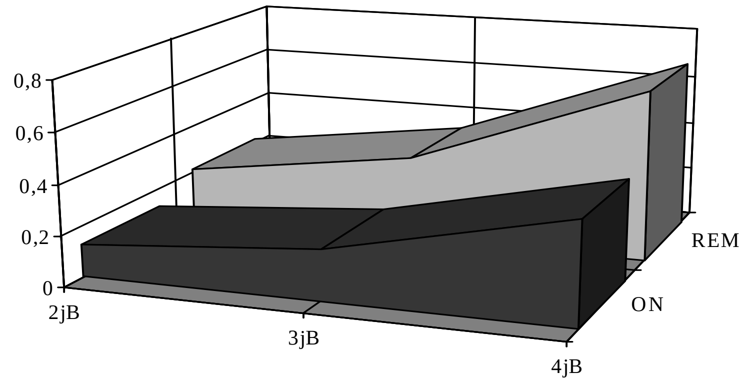

Fig. 4. Smokiness of exhaust gas

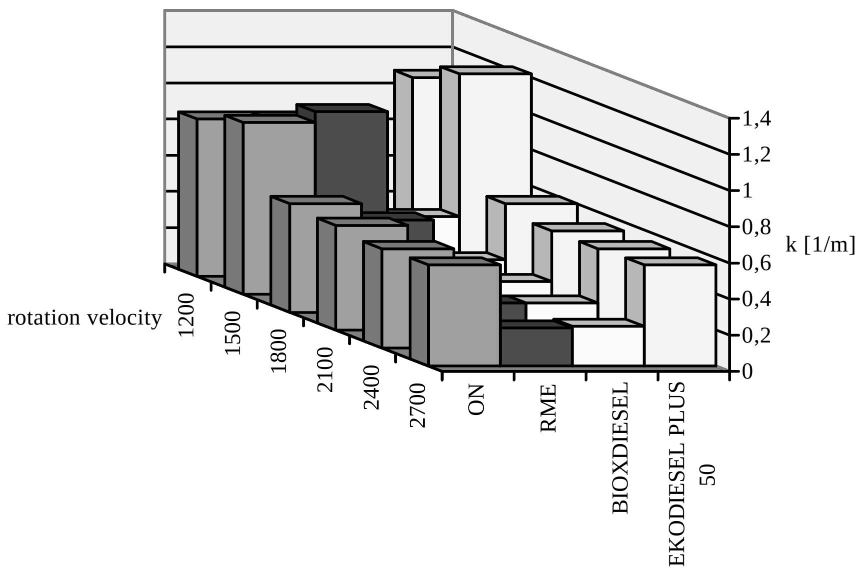

Fig. 5. Summary of external characteristics of infrared radiation absorption ratio k in the function of rotation velocity n of engine 359

The first of the above mentioned brackets is characterized with irregular course and high value of fumigation ratio. With rotation velocity equaling 1500 1/min, the values of the analyzed ratio reach maximum independently of the applied kind of fuel. In this bracket diesel oil EKODIESEL PLUS 50 is characterized by the highest values of the fumigation, and BIOXDIESEL – by the lowest.

Work of an engine charged with fuels ON and RME is characterized with average values of the mentioned ratio (Fig. 5 and 6)

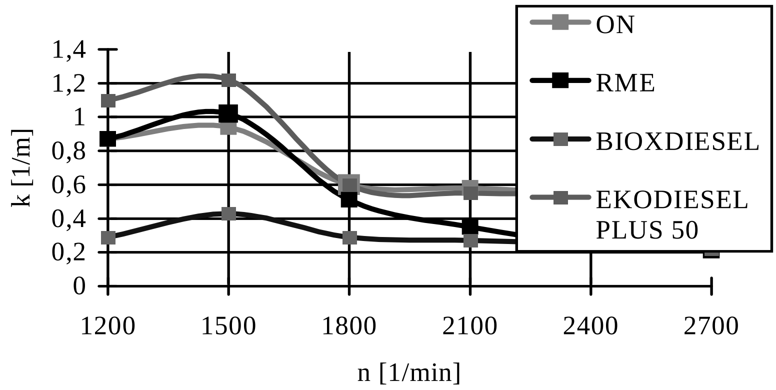

Fig. 6. Summary of external characteristics of infrared radiation absorption ratio k in the function of rotation velocity n of engine 359

In the second bracket it is visible that the fumigation ratio is on the constant level for fuels: ON, EKODIESEL PLUS and BIOXDIESEL. There is also, along with an increase of speed, a constant decrease of this ratio value for fuel RME (values from 0.53 to 0.21 1/m). Diesel oil ON as well as EKODIESEL PLUS 50 are characterized by higher values of fumigation ratio (0.54 to 0.56 1/m). The lovest value of that ratio occurs in the work of an engine charged with BIOXDIESEL fuel (0.23 to 0.28 1/m).

Reassuming, the most frequent result of applying BIOXDIESEL fuel for charging an engine is a decrease in the level of fumigation by 50% in relation to diesel ON.

FINAL REMARKS

There are a number of possibilities to reduce the negative influence of increased doses of fuel, namely:

– restrictions regarding the traffic density (a ban in case of densely populated urban zones),
– use of environmentally-friendly fuels,
– fine adjustment of fuel injection system,
– reducing the cranking time of a cold start,
– use of catalysts, (especially reducing catalysts de No_x, Oxikad).

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