AN EFFECT OF PHYSICAL & CHEMICAL PROPERTIES OF COMMERCIAL DIESEL FUELS ON ENGINE PARAMETERS

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Abstract

This paper is focused on problem of quality of diesel commercial fuels in Polish market and an effect of their properties as well on engine parameters as environment The academic staff from Wrocław University of Technology put the own experience to the huge discussion by making research in the Wroclaw-city, where some probes of fuels were taken from six different commercial fuel stations. Chemical and physical properties of fuels were checked. A real diesel engine VW 1,9 TDI was investigated in university lab of Division of Motor Vehicles and Internal Combustion Engines. Typical engine performances were built including power, torque, fuel consumption, toxicity levels due to different fuels.

The IC engine on the test bench, oxygen content in fuels, example of full load performance of VW1,9 TDI for fuel Bio D20-type, differences of mean effective pressure for different fuels, differences of carbon monoxide in exhaust for different fuels, differences of nitric oxides in exhaust for different fuels, differences of smog level in exhaust for different fuels, differences of heat release for different fuels, relation between engine torque and oxygen content in fuels vs. engine rotation are presented in the paper.

Keywords: *combustion engine, diesel engine, engine fuels engine performances*

1. Introduction

Nowadays man could not image present life without motor vehicles. Car is everywhere: in the trip to the job, to school, for holiday, in cargo, in agriculture etc. More than 97% of whole amount of vehicles in the world are driven by combustion engines – petroleum fueling [2]. Engines and next all vehicles are depended on fuel energy and its quality. That second aspect is often considering in media and vehicle expert reports. There are many refilling stations to choose by drivers and there are still questions existed: Why are there so many different fuels? What kind of fuel does it use? Are there any additives in fuels? Why are the various process? Does the fuel influence on engine components?

2. Fuel samples and lab tests

In this project, diesel oil from different six suppliers were tested. Investigation was done in Wroclaw city. There were four stages of the project, as follow:

- fuel samples collection,
- lab tests for chemical and physical properties of fuels,
- tests in engine bench,
- results analysis.

Selection of fuel suppliers belonged to hazard. According to diesel engine lab tests, the six diesel oil samples were taken as follow:

A – Bio-diesel Bio D10 from PPH Dexpol S.A. enterprise,
B – Oil diesel from PKN Orlen S.A. consortium,
C – Oil diesel ON from BP station,
D – Bio-diesel Bio D20 from PPH Dexpol S.A. enterprise,
E – Oil diesel from Swojec store,
F – CityDiesel from MPK Wrocław enterprise.

Samples in volume of $20dm^3$ (each of them) were taken from station tanks following standard rules of PN -EN ISO 3170:2002. Each of the sample was divided into two parts: $1dm^3$ for chemical tests and the rest for real operating engine tests in the lab bench. The chemical components and physical properties of the duels were measured in the Division of Chemistry and Fuel Technology at the Wroclaw University of Technology (WUT). Real engine tests were organized at the Division of Motor Vehicles and internal Combustion Engines WUT. Object of research was well known diesel engine VW1,9TDI. For its loading, electrodynamometer AVL Alpha 240 was applied (fig. 1). All measurement data was recorded and analyzed directed in computer [1].

Fig. 1. IC engine on the test bench

3. Test results

Chemical analyses have given results as in table 1. There are elementary composition of the fuels and energetic factors, first of all. At engine bench, different engine parameters like revolution, power, load, temperature, toxicity etc. were measured to build engine performances. For example full load of characteristic for Bio-Diesel D20 were tested and shown on fig. 3. Based on measured engine parameters and fuels properties some mathematical relationships were estimated.

Tab. 1. Physical and chemical properties of tested fuels

Fuels	Carbon	Hydrogen	Nitrogen	Sulfur	Oxygen	Density at 20^oC	Calorific value
	%	%	%	%	%	g/cm3	kJ/kg
Bio D10	85,07	13,44	0,05	0,0004	1,44	0,8384	45033
Orlen	85,09	13,78	0,09	0,0004	1,04	0,8251	46000
BP	85,82	13,78	0,09	0,0004	0,31	0,8362	46169
Bio D20	84,84	13,57	0,10	0,0004	1,49	0,8404	44605
Swojec	86,12	13,13	0,11	0,0004	0,64	0,8347	46110
CityDiesel	86,18	13,64	0,08	0,0004	0,10	0,8243	46193

Analysis of data presented in table 1 shows various chemical compositions of each of the fuel. The differences in oxygen content more than hundred percentage were measured (fig. 2). There is between standard fuel and blends with RME (Rape Methyl Ester) [3]. Differences of calorific values were also noticed.

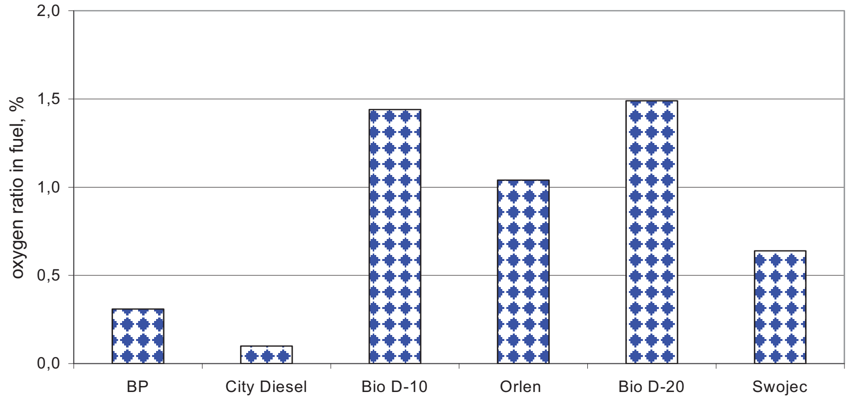

Fig. 2. Oxygen content in fuels

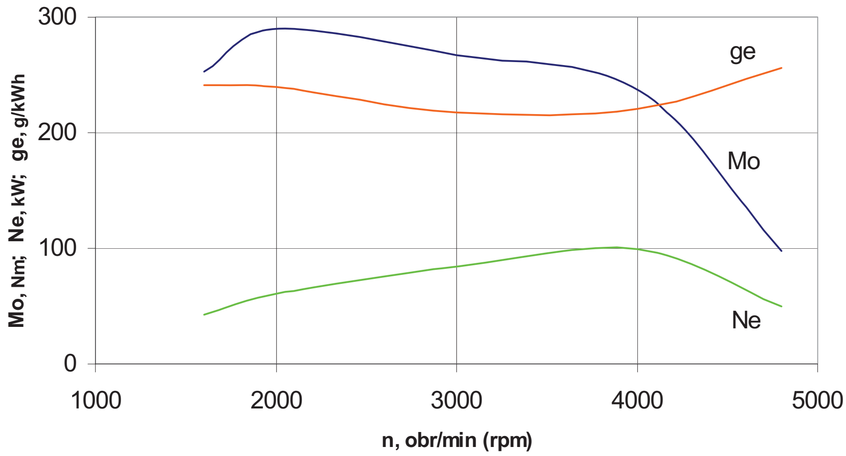

Fig. 3. Example of full load performance of VW1,9 TDI for fuel Bio D20-type

Full load performances for different fuel samples are very closed one to another, except characteristics of specific fuel consumption. It is because control unit made compensation of differences in calorific values and oxygen content to keep stechiometric combustion process.

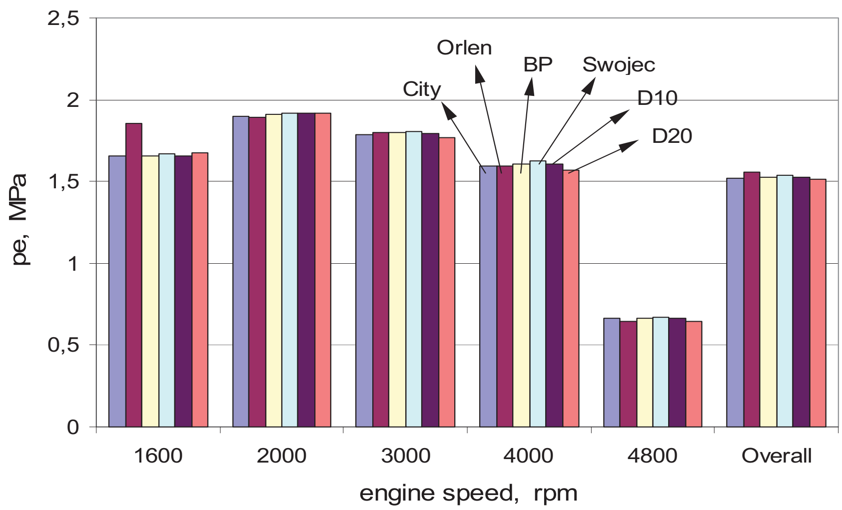

Fig. 4. Differences of mean effective pressure for different fuels

Next figures show results of measurement of toxic parameters of exhaust gases for different fueling. Each of the performances has got own drift, depends on engine revolution. The biggest differentiation belongs to nitric oxides levels – fig. 6. Follow the fuel properties, it can be explained by high temperature of charge taken from oxygen and calorific value.

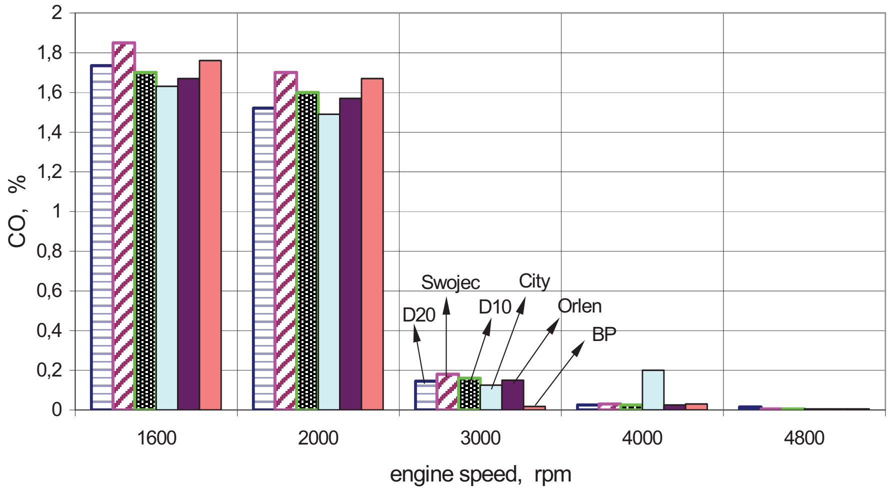

Fig. 5. Differences of carbon monoxide in exhaust for different fuels

Differentiations of calorific values as well as oxygen contents give the reason to calculate the heat release of fuel dose and to built any regression function to other parameters. For example fig. 8. presents bars of heat release and average mathematical equation with R^2 ratio at 0,7 level.

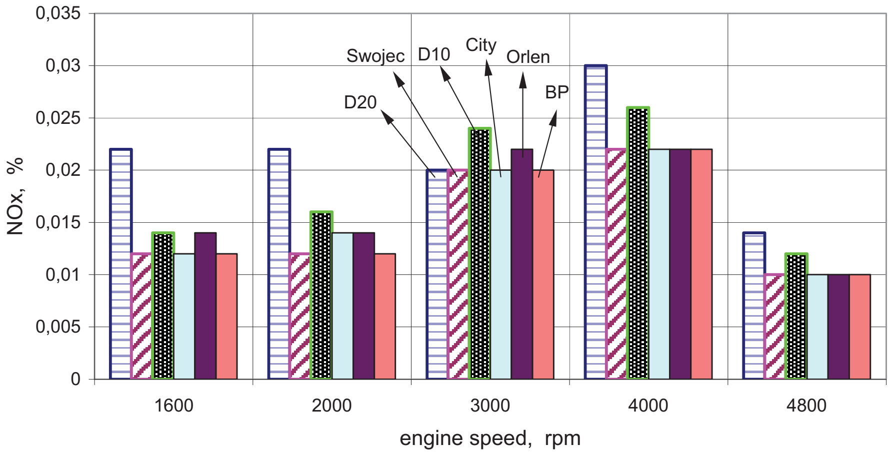

Fig. 6. Differences of nitric oxides in exhaust for different fuels

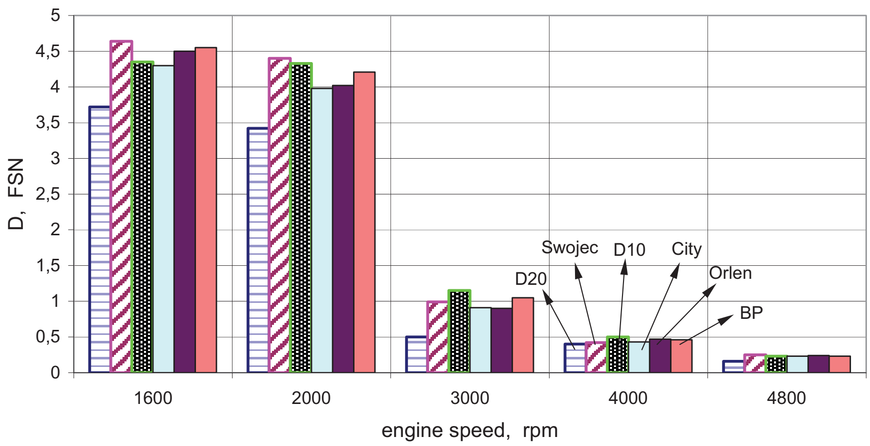

Fig. 7. Differences of smog level in exhaust for different fuels

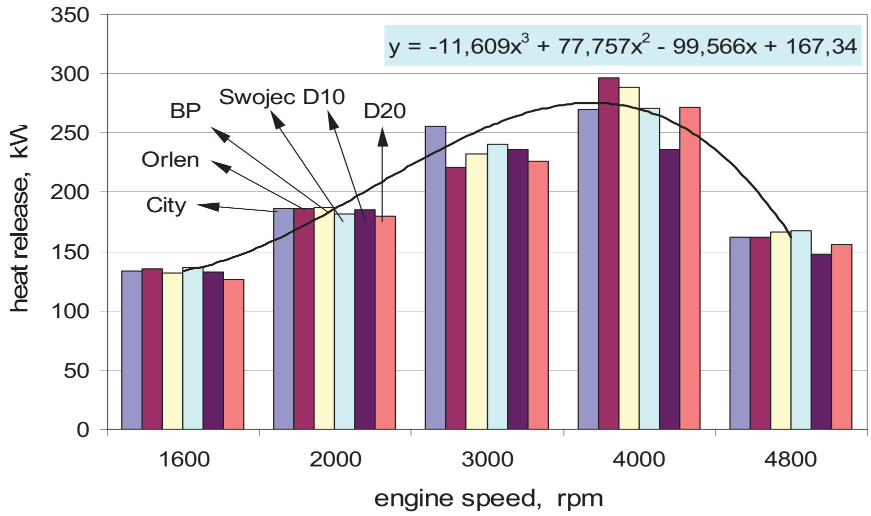

Fig. 8. Differences of heat release for different fuels

The another example of analysis is shown on fig. 9 and table 2 where relations between torque and calorific values were obtained.

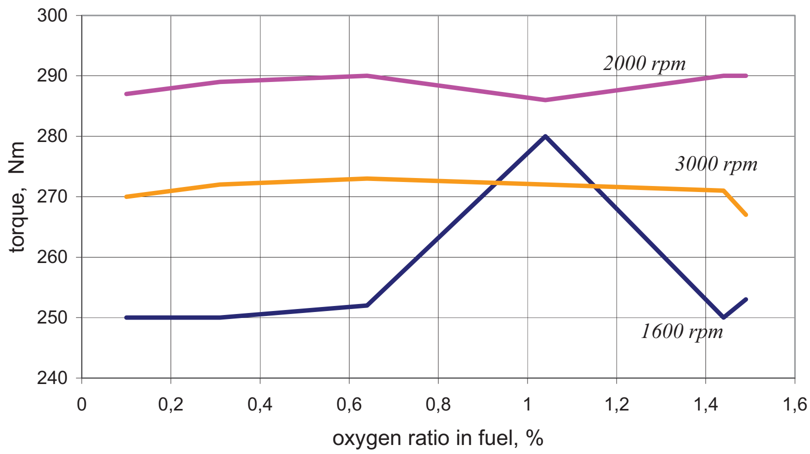

Fig. 9. Relation between engine torque and oxygen content in fuels vs. engine rotation

Tab. 2. Regression function for torque vs. oxygen content in fuel

Engine speed Rpm	Regression functions for torque (y) vs. oxygen content in fuel (x)	R^2
1600	y = -117,49x3+246,92x2-115,34x+260,91	0,82
2000	y = 21,88x3+51,07x2+31,84x+284,05	0,87
3000	y = -7,77x2+11,26x+269,05	0,76
4000	y = 9,73x3-31,41x2+25,94x+238,47	0,52

4. Summary

The aim of the project, recognition of differences between fuels taken from different suppliers and estimation of their effect on engine parameters has been reached. Researches have showed differences in chemical and physical properties of fuels, but there is no statistics effect on engine parameters – as on fig. 10. In this context, miss important effect of tested fuels on engine parameters give the big advantage to Bio-Diesel fuels D10 and D20 as alternative fuels.

References

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