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Investigation of the Indicated Parameters of a Diesel Engine Operating With Alcohol Additives

Radostin Dimitrov Dimitrov, Daniel Zdravkov Ivanov, Velichka Rosenova Georgieva, Daniel Krasimirov Kostadinov, Aurora Cătălina Ianăşi , Stanimir Bojidarov Tsanov

Department of Transport Engineering and Technologies, Technical University of Varna, r_dimitrov@tu-varna.bg

GOAL OF THE STUDY

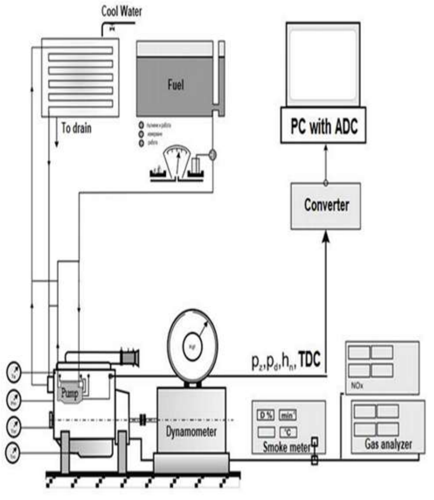
Alcohol additives are seen as a promising alternative for internal combustion engines running on conventional fossil fuels, as they have the potential to improve fuel efficiency and reduce emissions of harmful substances. Diesel engines, despite their widespread use in transport and industry, continue to be a significant source of pollution. Although alcohols are actively used as fuels, their impact on the operating process of diesel engines is not yet fully understood and requires further research. This article presents a study of the change in the indicator indicators of a diesel engine with direct injection when alcohol is added to traditional diesel fuel.

METHODOLOGY OF THE INVESTIGATION

The object of the study is a Fiat 1.9 JTD diesel engine, with technical specifications presented in Table 1:

Table 1. Investigated engine

№	Parameter	Value
1	Manufacturer	Fiat
2	Year	2002
3	Engine code	188 A2.000
4	Generation	Palio Weekend
5	Engine displacement [dm³]	1,91
6	Cylinder bore [mm]	82
7	Piston stroke [mm]	90,4
8	Compression ratio	18,5
9	Rated power at crankshaft speed [kW/min⁻¹]	60/4000
10	Rated torque at crankshaft speed [Nm/min⁻¹]	196/1500
11	Firing order	1-3-4-2
12	Cooling type	Forced, water-cooled
13	Stroke cycle	Four-stroke
14	Mixture formation	Direct (internal)
15	Charging system	Turbocharged (forced induction)
16	Fuel system	Common-rail
17	Number and arrangement of cylinders	4-cylinder, inline



MAIN RESULTS FROM THE STUDY

Figures 2 to 5 present the results for the indicated power (p_i). The graphs clearly show that, at all engine speeds, conventional diesel fuel exhibits the highest values of indicated power. With the addition of n-butanol, a decrease in this parameter is observed, with the largest deviations recorded for blends with higher alcohol content. For N30, the reduction reaches up to –22% at 3000 min⁻¹ under high load.

The N10 blend shows results closest to conventional diesel, with average differences in the range of –4% to –10%, while for N20 the deviations increase to approximately –15%. At lower speeds (1500 and 2000 min⁻¹), the differences between the fuels are smaller and grow with increasing load and engine speed. The smallest deviations were reported for N10 at low speed, reaching up to –3.7% compared to diesel without additive.

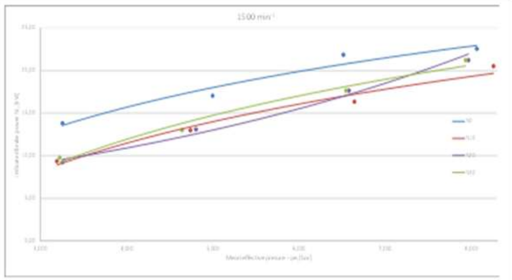


Fig. 2. Variation of indicated brake power at 1500 min⁻¹ [Bar]

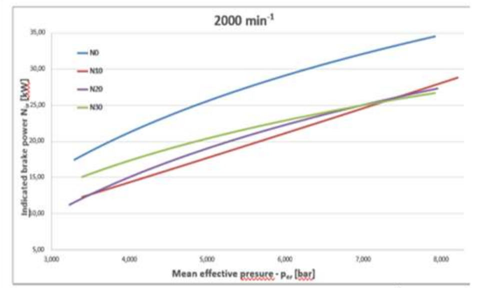


Fig. 3. Variation of indicated brake power at 2000 min⁻¹ [Bar]

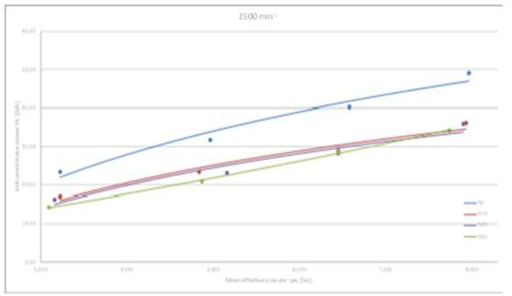


Fig. 4. Variation of indicated brake power at 2500 min⁻¹ [Bar]

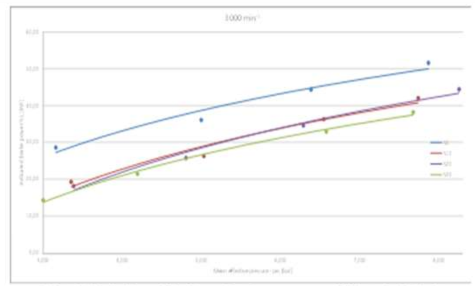


Fig. 5. Variation of indicated brake power at 3000 min⁻¹ [Bar]

CONCLUSIONS

The use of n-butanol as an additive moderately increases the indicated efficiency of the engine, on average by about 6–7%, with the maximum difference reaching approximately 14% (blend N30, 2000 min⁻¹). As engine speed increases, these differences diminish. This effect is attributed to improved mixture formation and more complete combustion, supported by the presence of oxygen in the butanol molecule.

ACKNOWLEDGMENT

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