THE INFLUENCES OF ULTRASONIC IRRADIATION PROCESS ON BIOETHANOL- GASOLINE BLENDED FUELS ON SI ENGINE FUNCTIONAL PARAMETERS

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Abstract: *To reduce emissions caused by SI engines, gasoline-ethanol blends (bioethanol) represents not only an alternative as well as an immediate response to current and future policies related to reducing pollution [10]. There are numerous scientific studies have shown that bioethanol-gasoline blends has several disadvantages. Functional parameters such as engine power, torque and BSFC are much inferior to the use of gasoline (in particular the use of fuel blends containing a higher volume of bioethanol 20%). One way to reduce these major drawbacks is the conditioning (reforming) of biofuels by external energy intake [6] in the form of direct ultrasonic irradiation, which represents an original approach in the biofuels research domain. The purpose of the experiments is to improve the energetic possibilities of biofuels, to can be use in a great proportion as blended fuel with fossil fuels. The paper presents the experimental results and data's obtained studying the influence of ultrasonic irradiation process on BE5-BE20 bioethanol-gasoline blends. To determine the influence of external energy on functional parameters of a spark ignition (SI) engine fueled with gasoline and ethanol blends was use an experimental stand equipped, developed and adjusted in accordance with the methodology of research in the field. Parameters considered in carrying out the experimental research are effective power, effective engine torque and brake specific fuel consumption. Experiments show possibilities in improving the energetic potentials of bioethanol-gasoline blends fuels for use in SI engines. Improvements exist for all considered parameters (power, torque and BSFC) for the entire range of engine speeds. For a full understanding of the phenomena that occur during the process of ultrasonic irradiation, future research is needed to determine the chemical transformations that may occur in the frame of this process. Possibilities to appear new class of peroxide compounds during ultrasonic irradiation process (due to the existence of OH radical in the molecular structure of bioethanol) may worsen the long-term storage properties of this class of fuels. Studies are also needed to establish the existence of an optimal-frequency and intensity of radiation to establish the optimum point, linked directly with the economic aspect in the development and application possibilities of such devices on SI engines.*

Key words**:** *ultrasonic irradiation, bioethanol, SI engine, power, torque, BSFC.*

INTRODUCTION

Biofuels are a renewable energy source with an increasing use in fueling internal combustion engines, both of those fitted to motor vehicles and to equip machines and stationary machines.

Benefits from the lower level of emissions (CO, CO_2, HC) in the case of biofuels (than compared to fossil fuels) are overshadowed by a series of major issues related to physico-chemical characteristics [1, 2, 4].

Parameters such as viscosity, density and surface tension (in the case of biofuels based on vegetable oils) and high heat of vaporization and small heating value (in the case of alcohol-based biofuels), worsening the air-fuel mixture formation, and further influence thermodynamics of the combustion process [3, 5].

Thus, there are relatively high emissions of nitrogen oxides (NOx) and particulate matter (HC and smoke) higher than for fossil fuels. In particularly way, the SI engines fueled with bioethanol-gasoline blends functional parameters are more reduced especially because bioethanol smallest calorific value as widely was presented by numerous researches in their experiments [3,5,7-9].

MATERIAL AND METHODS

To determine the influence of external energy on functional parameters of a spark ignition (SI) engine fueled with gasoline and ethanol blends was use an experimental stand equipped, developed and adjusted in accordance with the methodology of research in the field. Parameters considered in carrying out the experimental research to determine the influence of external energy intake are effective power, P_e [kW]; effective engine torque, M_e [Nm] and brake specific fuel consumption, BSFC [g / kWh], and the obtained results are presented as characteristic variation.

- Experimental stand (figure 1) is composed of:
- Mercedes Benz Engine M111 (016 3301) type;
- Dynamometer Weinlich MP80/6000 type;
- Kingship electronic balance GEW-6 type;
- Fuel tank;
- External power conditioning devices;
- Experimental data acquisition system.

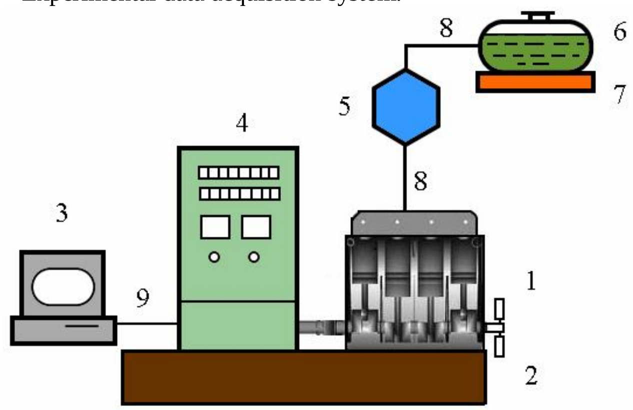

Figure 1: Experimental stand structure for characteristics determination (1 - engine, 2 - frame, 3 - data-acquisition system, 4 – dynometer (brake), 5 - external energy ultrasonic irradiation conditioning device, 6 - fuel tank, 7 - electronic balance, 8 - supply pipelines, 9 - data acquisition cable)

Structural parameters and functional characteristics of Mercedes Benz M 111 engine are presented in Table 1 and the physical and chemical properties of gasoline and ethanol mixtures used in experiments are presented in Table 2.

Table 1

Engine characteristics

Parameter	Value
Type	4 cylinders in line
Ignition order	1-3-4-2
Bore x Stroke	86x85 mm
Displacement	1976 cm^3
Compression Ratio	9.7
Maximum engine torque	240Nm at 3500 rpm
Maximum engine power	120 kW at 5500 rpm
Maximum engine speed	6200 rpm

Table 2

Tested blends characteristics

Property	**Fuel**				
	Gasoline	BE5	BE10	BE15	BE20
Vapor pressure [kPa]	48	55	55	55	55
RON number	85	90	92	94	98
Calorific value [MJ / kg]	45	44	43	42	40
Distillation curves (at a pressure of 760 mmHg)					
10%	59	54	53	58	55
50%	93	94	72	71	72
90%	146	148	144	145	142
100%	177	184	175	182	177

Bioethanol-gasoline blended fuels ultrasonic conditioning was achieved by converting an ultrasonic bath Sonorex Bandelin RK31 type (ultrasonic emitter: 35 kHz frequency and 240W ultrasound peak output) obtaining a 300 cm^3 effectively conditioning volume (of a resonance tank) [6].

Before the start of SI engine fueling, fuel was conditioned by ultrasounds for 300 seconds.

RESULTS AND DISCUSSIONS

The results for the external ultrasonic energy conditioning the gasoline-ethanol fuel mixtures in the experiments are presented in tables 3-5 and figures 2-7. The “Base” case is for bioethanol-gasoline blends without any external intervention and “Us irrad.” case is for 300 seconds ultrasonic irradiated bioethanol-gasoline blends.

Based on the below presented results (figures 2-7) it is observed that are beneficial influence of ultrasound irradiation bioethanol-gasoline blends in that they improve functional performance of the SI engine fueled with alcohols blends. Improvements exist for all considered parameters (power, torque and BSFC) for the entire range of engine speeds.

The biggest difference (compared to using a blend was not subjected to ultrasonic conditioning) were reported for engine power (- 4.45% for BE20 blends at 3000 rpm), torque (- 2.58% for BE15 blends at 5000 rpm) and for BSFC (- 2.86% for BE10 blends at 5000 rpm).

Table 2

Engine power variations [kW]

	Engine speed [rot/min]									
	1000		2000		3000		4000		5000	
Fuel	Base	Us irrad.	Base	Us irrad.	Base	Us irrad.	Base	Us irrad.	Base	Us irrad.
Gasoline	8.7	8.7	20.1	20.1	33.7	33.7	41.2	41.2	45.8	45.8
BE5	8.6	8.7	20	20.05	33.6	33.63	41.1	41.17	45.5	45.69
BE10	8.5	8.6	19.5	19.7	31.9	32.48	38.7	39.66	42.7	44.06
BE 15	8.4	8.5	19.2	19.5	31.6	32.05	38.2	39.18	41.8	43.4
BE20	8.1	8.12	18.3	19	30.2	31.7	36.6	37.77	40.3	41.96

Table 3

Engine torque variations [Nm]

	Engine speed [rot/min]									
	1000		2000		3000		4000		5000	
Fuel	Base	Us irrad.	Base	Us irrad.	Base	Us irrad.	Base	Us irrad.	Base	Us irrad.
Gasoline	86.4	86.4	100.2	100.2	103.9	103.9	101.1	101.1	84.6	84.6
BE5	86.1	86.2	99.7	99.8	102.7	103.1	100.0	100.4	83.9	84.2
BE10	84.5	84.8	97.6	98.4	97.8	98.4	94.7	95.3	78.7	80.6
BE 15	82.6	83.1	95.5	96.3	96.5	97.0	93.0	93.8	76.5	78.7
BE20	79.3	80.0	91.8	92.7	93.1	94.2	89.8	91.0	74.8	76.2

Table 4

Engine BSFC variation [g/kWh]

Fuel	Engine speed [rot/min]									
	1000		2000		3000		4000		5000	
	Base	Us irrad.	Base	Us irrad.	Base	Us irrad.	Base	Us irrad.	Base	Us irrad.
Gasoline	257	257	256	256	247	247	275	275	314	314
BE5	257	257	258	258	250	249	279	277	319	317
BE10	259	258	263	262	257	255	291	284	335	326
BE 15	265	262	269	266	264	262	301	295	345	338
BE20	271	269	275	271	272	266	307	300	352	346

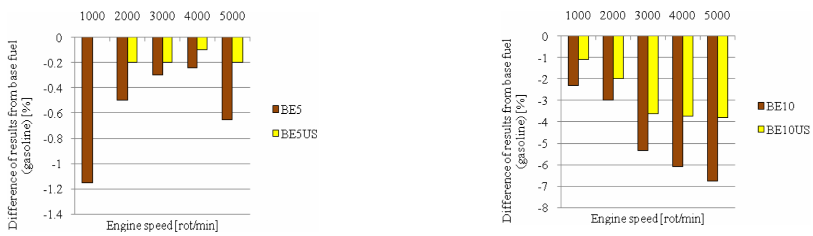

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Figure 2:Engine power variation (a-BE5, b-BE10)

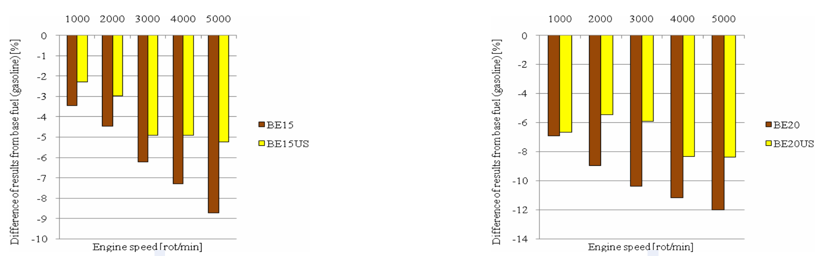

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Figure 3: Engine power variation (a-BE15, b-BE20)

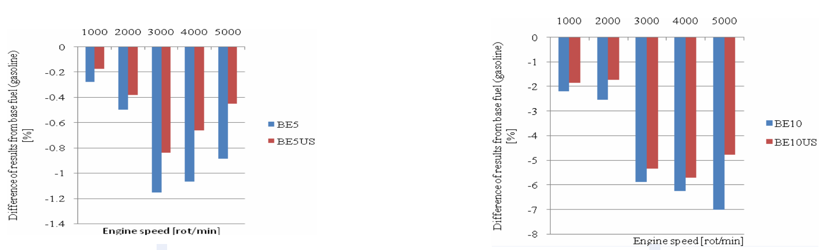

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Figure 4: Engine torque variation (a-BE5, b-BE10)

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Figure 5: Engine torque variation (a-BE15, b-BE20)

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Figure 6: Engine BSFC variation (a-BE5, b-BE10)

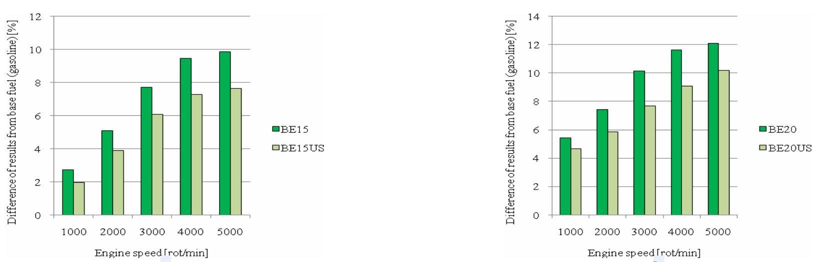

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Figure 7: Engine BSFC variation (a-BE15, b-BE20)

CONCLUSIONS

- Experiments show possibilities in improving the energetic potentials of bioethanol-gasoline blends fuels for use in SI engines. For a full understanding of the phenomena that occur during the process of ultrasonic irradiation, future research is needed to determine the chemical transformations that may occur in the frame of this process.
- Possibilities to appear new class of peroxide compounds during ultrasonic irradiation process (due to the existence of OH radical in the molecular structure of bioethanol) may worsen the long-term storage properties of this class of fuels.
- Studies are also needed to establish the existence of an optimal-frequency and intensity of radiation to establish the optimum point, linked directly with the economic aspect in the development and application possibilities of such devices on SI engines.

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