EXTERNAL ENERGY CONDITIONING AND THE INFLUENCES ON BIOFUELS PHYSICALLY PARAMETERS

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Abstract: *Even though currently the future use of biofuels in road transport (in terms of fossil fuel crisis) is much debated by specialists, biofuels can be successfully used on the farm by the ease with which they may be obtained and especially due to the effect polluter much lower than the fossil fuels. Reducing pollution from agriculture technological operations is a necessary condition to develop in the future agricultural development on a sustainable basis. To truly become a competitive fuel market, compared with fossil fuels, biofuels must optimize parameters related to characteristics of density, viscosity, freezing point and especially the specific calorific value. Global research about the efficient use of biofuels have emphasized only the immediate results of their use in supplying engines that equip tractors and agricultural machinery, related to consumption, pollution and wear of engines component parts. Theme and direction of research addressed in the paper represents an innovation in the field of national and global research on biofuels. Also, the degree of novelty of the work is defined by the methods and materials used in the research, managing to highlight first, the importance of parameters like speed of sound in biofuels (with subsequent implications in the possible development of "flex-fuel" systems) and isotropic adiabatic coefficient (with direct implications in determining the exact time of injection process). This paper presents findings related to the influence of external energy intake in the form of ultrasound, electromagnetic field and ionization on the physical parameters of biofuels (biodiesel and bioethanol), the main parameters considered are (speed of sound, density, isotropic adiabatic coefficient, pH index). Practical implications of the work are found in the immediate applicability in the possibility of increasing the performance of agricultural tractors powered by biofuels and also open new directions in applied research on ways of streamlining the use of biofuels. Results and conclusions issued in the work are possible due to the unfolding of the first phase of research project PNII2008ID175, financed by CNCSIS.*

Key words**:** *biofuels, physical parameters, external energy, conditioning, IC engine.*

INTRODUCTION

From the outset it is worth to emphasize that world there are plenty of projects and patents related to the possibility of increasing performance internal combustion engines with fuel filling with external energy sources (mainly by ionization and magnetic field) but application of 80% of spark ignition engines [1]. However there is evidence relating to changes in physical-chemical parameters of the fuel under these devices, only (less than 10% of cases) the results achieved and the direct and singular indicators of fuel consumption and emissions of combustion [6]. Experiments were conducted on a wide range of engines and the benefits period to certify the proposed solution. The more so, the study literature (over 500 items) and a relatively large number of patents in the field (1657 and EPO patents USPO [6]) data were not linked to the existence of conditioning devices biofuels, which provides the premises of this researches to open new avenues of research and scientific development of biofuels [2,5].

MATERIALS AND METHOD

Experimental research conducted to determine the effects of external energy input on the physical properties of biofuels on the basis of bioethanol and vegetable oils were mixed as the purpose determining the following physical parameters: speed of sound in the environment studied, density, viscosity, pH index (E), conductivity [4].

Table 1

The characteristics of fuels used in experiments

	Gasoline	***Diesel fuel***	***Bioethanol***	***Rapeseed methylester***
Formula	C_7H_{16}	$C_{14}H_{30}$	C_2H_5OH	C_{16}-C_{18}
Molecular weight [g/mol]	100.2	198.4	46.77	209.6
Density at 20^{o}C [kg/m^3]	751	831	809/	879
Cinematic viscosity at 40^{o}C [mm^2/s]	0.71	2.7	1.29	4.9
Boiling point [^{o}C]	166	278	78	322
Calorific heat value [MJ/kg]	47.46	46.94	29.42	37.5
Carbon content (%)	85.5	87	52.3	78.7
Sulphur content (ppm)	197	233	0	0.036
Water content [mg/kg]	12	64	100	86
Cetan index	-	54.1	-	52.7
Octan index	96	-	87	-

Samples of fuel subject to testing for alcohol-based biofuels mixed with gasoline had the following composition:

- fuel control - B (gasoline),
- fuel 1 - BE5 (gasoline 95% + 5% bioethanol),
- fuel 2 - BE10 (gasoline 90 % + 10% bioethanol),
- fuel 3 - BE15 (gasoline 85% + 15% bioethanol),
- fuel 4 - BE20 (gasoline 80% + 20% bioethanol),
- fuel 5 - Bioethanol (100%).

For biofuels based diesel mixed with vegetable oils had the following composition:

- fuel control - Diesel fuel,
- 1 - B25 (diesel rape methylester 75% + 25%),
- 2 fuel - B50 (50% diesel + rape methylester 50%),
- fuel 3 - B75 (25% diesel + 75% rape methylester),
- fuel 4 - B100 (100% rape methylester).

The experimental devices to study the influence of external energy intake based bioethanol and plant-based oils biofuels consisted of:

• ultrasonic (U.S.) - experiment conducted by making a stand bath type ultrasonic Sonorex Bandelin RK11, system type PZT oscillator frequency emissions 35 kHz, power 30/120 W, 220V power, tank capacity 0.9 liter, stainless steel tank, adjustable timer programmable 1 ... 15min (∞).

• Microwave (MU) - external energy intake via an air-cooled magnetron type MMS06 (producer Hey Lin Manufactures Ltd.), 2.45 GHz transmission frequency, power adjustable 0 ... 700W.

• Electromagnetic field (EMF) - experiment conducted using a stand EDMC-2100 system with electromagnetic coils that produce an electromagnetic field with intensity adjustable from 0 ... 2x104 H · A. Electronic control and fine tuning possibilities.

• Ionization (IO) - using an Elion 15 experimental stand system. Technical data: 0-40^{o}C working temperature, ozone 0.04 ppm, 1.5 x 106 negative ions/cm^3, 12V, power consumption 2.5 W.

Analytical equipment for determining the physical properties of biofuels subject experiments was chosen to determine the variation of parameters considered as:

• *Speed of sound and viscosity* of samples was determined using biofuels Optel system Opcard 1 / 100, system that provides these features through software embedded [3].

• *Density* of fuel (gasoline and diesel) and blended biofuels based bioethanol and vegetable oils (rapeseed oil methylester) were determined by Anton Paar apparatus 5000. Determinations were carried out as specified DIN EN ISO 3675 [5] measurement standard, the reference temperature of 20° C.

• *pH index* is a relatively important indicator in the study of physical-chemical parameters change biofuels mixed undergoing external compliance that may be caused because of the constituent molecule of biofuel use of hydroxyl radical (OH) [4,5]. Experimental apparatus was based on the stand shown in Figure 1 and multiparameter WTW350i system (enables connection of several types of electrodes that can measure simultaneously measuring pH, oxygen, conductivity, temperature).

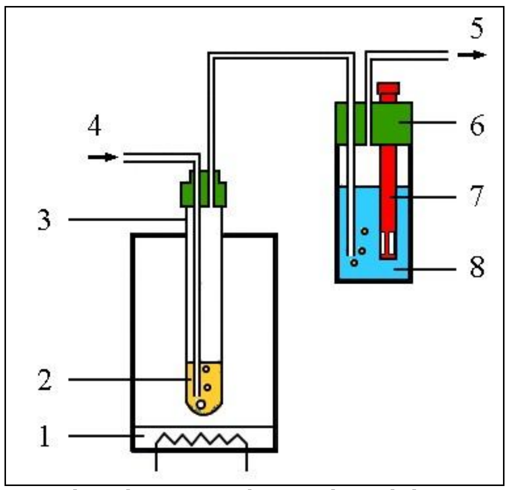

Figure1. Experimental stand to measure the pH index and electric conductivity with potential cells (1-heating system t=120-140°C; 2-biofuel; 3-glass tube; 4-air-in; 5-air-out; 6-dilution vessel;7-measuring cell; 8-water solution)

RESULTS AND DISCUSSION

The experiments carried out have obtained results about the external energy conditioning on biofuels and were followed as changes in variation of physical parameters considered in the mixtures of biofuels (Tables 2-9).

Table 2.

The influence of ultrasonic conditioning on bioethanol based biofuels

Parameter	Variation [%]					
	Gasoline	BE5	BE10	BE15	BE20	Bioethanol
Speed of sound	-0.56	-0.56	-0.54	-0.54	-0.52	-0.46
Density	-1.06	-1.06	-1.05	-1.04	-0.90	-0.75
Viscozity	-30.95	-27.65	-23.52	-21.42	-19.67	-7.19
pH index	+2.34	+3.79	+3.04	+2.68	+2.59	+2.45
Electric conductivity	-59.33	-56.04	-52.84	-50.47	-48.86	-6.92

Table 3.

The influence of microwave conditioning on bioethanol based biofuels

Parameter	Variation [%]					
	Gasoline	BE5	BE10	BE15	BE20	Bioethanol
Speed of sound	-2.79	-2.78	-2.78	-2.77	-2.72	-2.67
Density	-5.28	-5.23	-5.14	-5.13	-5.10	-4.79
Viscozity	-40.47	-36.17	-33.34	-30.35	-27.86	-21.58
pH index	+0.74	+1.77	+1.78	+2.30	+2.33	+6.98
Electric conductivity	-27.07	-8.76	-6.75	-4.20	-3.79	-2.72

Table 4.

The influence of electromagnetic field conditioning on bioethanol based biofuels

Parameter	Variation [%]					
	Gasoline	BE5	BE10	BE15	BE20	Bioethanol
Speed of sound	-0.47	-0.35	-0.32	-0.31	-0.31	-0.30
Density	-1.07	-0.95	-0.79	-0.78	-0.77	-0.63
Viscozity	-16.67	-8.51	-5.88	-3.57	-2.91	-1.43
pH index	+2.34	+3.79	+3.04	+2.68	+2.59	+2.25
Electric conductivity	+48.01	+44.56	+43.96	+43.67	+34.48	+10.03

Table 5.

The influence of ionization conditioning on bioethanol based biofuels

Parameter	Variation [%]					
	Gasoline	BE5	BE10	BE15	BE20	Bioethanol
Speed of sound	-0.41	-0.59	-0.56	-0.54	-0.53	-0.46
Density	-0.54	-0.53	-0.38	-0.38	-0.37	-0.34
Viscozity	+42.85	+34.04	+25.49	+25.00	+19.67	+6.47
pH index	+1.97	+3.16	+3.12	+3.07	+2.59	+1.11
Electric conductivity	+85.72	+44.25	+43.37	+42.26	+38.94	+7.83

Table 6.

The influence of ultrasonic conditioning on plant-oil based biofuels

Parameter	Variation [%]				
	Diesel	B25	B50	B75	B100
Speed of sound	-5.28	-4.32	-3.22	-2.18	-2.09
Density	-1.61	-1.33	-0.74	-0.65	-0.62
Viscozity	-37.36	-28.25	-21.95	-19.80	-17.47
pH index	+7.40	+6.50	+7.10	+7.16	+6.53

Table 7.

The influence of microwave conditioning on plant-oil based biofuels

Parameter	Variation [%]				
	Diesel	B25	B50	B75	B100
Speed of sound	-13.25	-13.16	-13.03	-12.93	-12.83
Density	-4.04	-3.99	-3.91	-3.87	-3.83
Viscozity	-60.98	-49.00	-40.95	-35.18	-30.79
pH index	+8.88	+9.00	+9.39	+9.48	+10.20

Table 8.

The influence of electromagnetic field conditioning on plant-oil based biofuels

Parameter	Variation [%]				
	Diesel	B25	B50	B75	B100
Speed of sound	-1.10	-1.10	-1.09	-1.08	-1.07
Density	-0.33	-0.33	-0.32	-0.32	-0.31
Viscozity	-9.34	-7.50	-6.27	-5.38	-4.71
pH index	-0.12	-0.17	-0.21	-0.25	-0.51

Table 9.

The influence of ionization conditioning on plant-oil based biofuels

Parameter	Variation [%]				
	Diesel	B25	B50	B75	B100
Speed of sound	-1.22	-1.22	-1.21	-1.19	-1.19
Density	+0.30	+0.70	+1.11	+1.69	+2.03
Viscozity	-9.34	+14.56	+23.24	+26.30	+34.41
pH index	+2.71	+3.62	+4.69	+4.98	+5.87

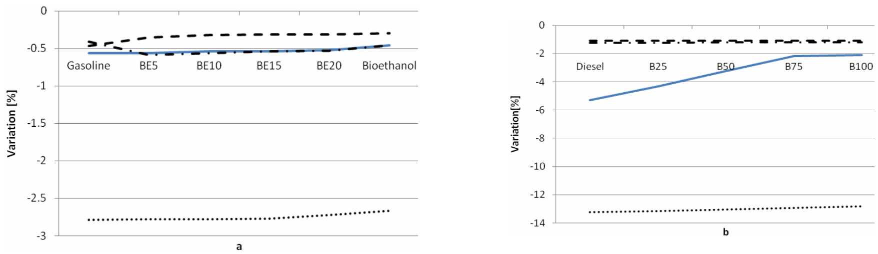

Fig. 2 The external energy types influence on speed of sound variation *

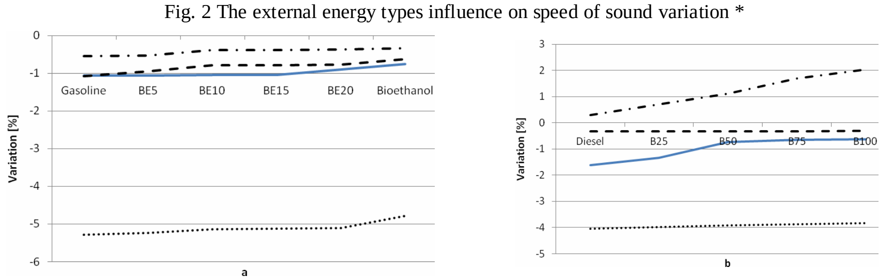

Fig. 3 The external energy types influence on density variation *

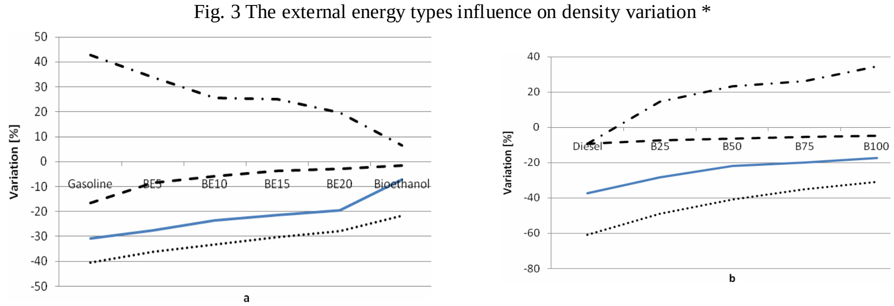

Fig. 4 The external energy types influence on viscosity variation*

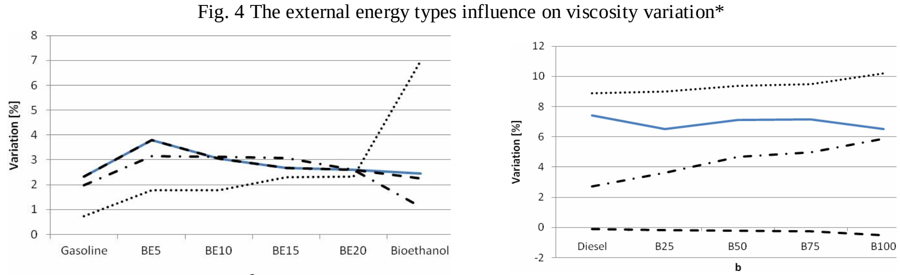

Fig. 5 The external energy types influence on pH index variation *

(*)Note: a-biofuels based on bioethanol; b- biofuels based on vegetable plant-oil (— ultrasound; ··· microwave; - - - electromagnetic field; - · - · - ionization)

CONCLUSIONS

Following experiments on the basis of their analysis can be concluded about the effect of energy intake outside on the variation of physical parameters of mixed biofuels:

► From the point of view of biofuels external energy conditioning, microwave achieved highest energy transfer (heat recovered as a direct contribution), but there is difficulty present about the possibility of miniaturization of the equipment used (such as gauge and in terms of energy consumption) and its implementation in the engine systems and limitations related to temperature limit that can be supported by certain engine components (components designed and manufactured on the grounds of type cost / benefit).

► Conditioning biofuels by energy intake as external electromagnetic field and ionization only, provide the premises of changing the degree of electric polarization of the molecules of biofuel with effect on the injection (average droplet diameter, cone angle of injection, the liquid phase penetration length inside the combustion chamber, the stage of coalescence of droplets, etc.) injection parameters to be studied and experienced in the future stages of the researches.

Linking the future these things can state the final conclusions about the effectiveness of the use of one or other of the conditioning devices used.

► In terms of energy intake compared to the types of biofuels used in conditioning (taking account of the experiments and considering the initial conditions of experiments) is observed that (Fig. 2-5) the biggest effect in terms of variation of physical parameters directly related to the need to optimize the fuel injection process and further the process of ignition and combustion of fuel within the combustion chamber of an internal combustion engine, it provides the ultrasonic conditioning process.

► Variation of isotropic adiabatic coefficient values and molar specific heat is a need to study in the future as correlation of functional parameters of the engine (injection law, duration of injection, etc.) and to take account of them in particular related to changes in functional parameters engine powered by biofuels conditioned by external energy intake.
► Primary and important conclusion that can be emitted from experiments, is that there is a significant decreasing viscosity variation mixtures studied (an average of -17% to -27% mixture of bioethanol and biodiesel mixtures conditioning ultrasound and an average of -5% to -6% mixtures of bioethanol and biodiesel mixtures for conditioning by electromagnetic field), change in offering a first premise about the possibility of optimizing the fuel injection process inside the combustion chamber.

► In compliance with ionization conditioning of vegetable oil based biofuels is a singular phenomenon that is manifested by increasing viscosity (average + 24%) leading to the hypothesis that the conditioning process occurring chemical reaction processes leading to formation of new chemical compounds.

► Future research directions aimed at the chemical analysis of biofuels conditioning activity that will determine whether new compounds are formed or not useful as fuel injection process and the combustion process itself.

► Worth to note that from the conditioning of biofuels with external energy intake, may develop a new research study in the field of external energy conditioning influence on the duration of storage of biofuels, knowing that today for biofuels based vegetable oil is the recommendation that it not exceed 3 months of storage days and for based bioethanol biofuels is necessary to reduce emissions into the atmosphere as vapor free.

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