THE PROPERTIES OF DIESEL FUEL WITH ADDITIVES BASED ON VEGETABLE OILS

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Abstract

The results of the analysis of diesel fuel properties with special additives such as vegetable oils, which can be used as combustion activators of motor fuel, are presented in this paper. The mixtures of diesel fuel with 15 kinds of vegetable oils was investigated. The studies presented in this paper confirmed the possibility of influence the cetane number, viscosity and freezing temperature of diesel fuel by the addition of vegetable oils with and without cumene hydroperoxide. The significant influence of some vegetable oils on increasing cetane number and complete combustion of diesel fuel is also shown.

Key words: diesel fuel , vegetable oils, cumene hydro peroxide, cetane number, freezing temperature T_{fr}, combustion activators.

Introduction

The use of fuel for diesel engines is considered as a way to increase fuel resources, rational use and economy of hydrocarbon raw materials, therefore heavier than petroleum fractions of oil - diesel, gas, gas-oil, and their mixtures are used to produce efficient diesel fuel. But the use of higher fractions of petroleum as motor fuel requires the use of additives to increase the cetane number, reduce the viscosity and the freezing temperature ., Natural vegetable oils can be used as such additives [1]. Not all oilseeds are grown for oil production. Often, oil is a byproduct in the processing of cotton, flax and hemp for fiber, soya and peanut - for protein, mustard grown food. Raw material for the production of oils is also a lot of waste that remains after the food industry and contains a lot of oils: cerebellum embryos, pumpkin seeds, tomatoes, tobacco, tea, grape pits, etc. [2].

Research results

The properties of diesel fuel with additives of 14 varieties of natural oils was investigated. Some of them such as rapeseed, sunflower and palm oil already widely used but the following 11: sesame, hemp, soya, pumpkin, linen , mustard, castor, olive, hipschina, rasteropsheva, and sea buckthorn were extracted from the following plants by us. Their characteristics are presented in table 1 and compared with the properties of diesel fuel [3].

Table 1

Characteristics of some natural vegetable oils

№	Vegetable oil source	Yield from raw materials	Density, d_D^{20}	Yield of vegetable oil per unit area of plantings	Freezing temperature	The main components
		%	g/cm^3	l/ha	^{0}C	composition
1	Sunflower seeds (Helianthusannuus)	47-52 %	0,924-0,926	952	−16−19	Sunflower oil
2	Flax seeds (LinumUsitatissimum)	30-48 %	0,930–0,938	750	-10-20° C	Flax oil

№	Vegetable oil source	Yield from raw materials	Density, d_D^{20}	Yield of vegetable oil per unit area of plantings	Freezing temperature	The main components
3	Rape seeds (Brassicanapus L. var. oleiferaMetzg.)	48-52 %	0,913–0,917	1190	0 -10° C	Rape oil
4	Ricinus seeds, boxes (Ricinuscommunis L.)	35-55 %	0,945–0,961	550	−17 −25 ° C	Ricinus oil
5	Soybean (Glycinemax)	17—25%	0,924–0,927	446	-15 …. -18°	Soy oil
6	Eleusis Guinean flesh pericarp (Elaeisguineensis)	22—70 %	0,924	5950	+ 19 ... +24°C	Palm oil
7	Pumpkin seeds	32-44%	0,866–0,880	850	-16 …. -18°	Pumpkin oil
8	Hemp seeds	30-38 %	0,925-0,928	750	-15 -20° C	Hemp oil
9	Sesame seed	9-12%	0,884–0,900	350	-10-15° C	Sesame oil
10	Buckwheat, corn pulp of the fetus, ankles (Hippophaerhamnoides L.)	9-12%	0,864–0,877	450	-12-15° C	Sea buckthorn oil
11	Spotted spotty seeds(Silybummarianum) насіння	25 %	0,877–0,896	500	-15-19° C	Thistle oil
12	Mustard seeds	32-44 %	0,878–0,891	850	-15-19° C	Mustard oil
13	Olives fruits	55 %	0,915–0,918	1212	+4… -2 °C	Olive oil
14	Rhizome fruits, seeds (RosacaninaL.)	10-15%	0,864–0,877	450	-12-15° C	Rhizom oil
15	Diesel	16-25%	0,79 — 0,97	-	-10….- 35°C	n-paraffins

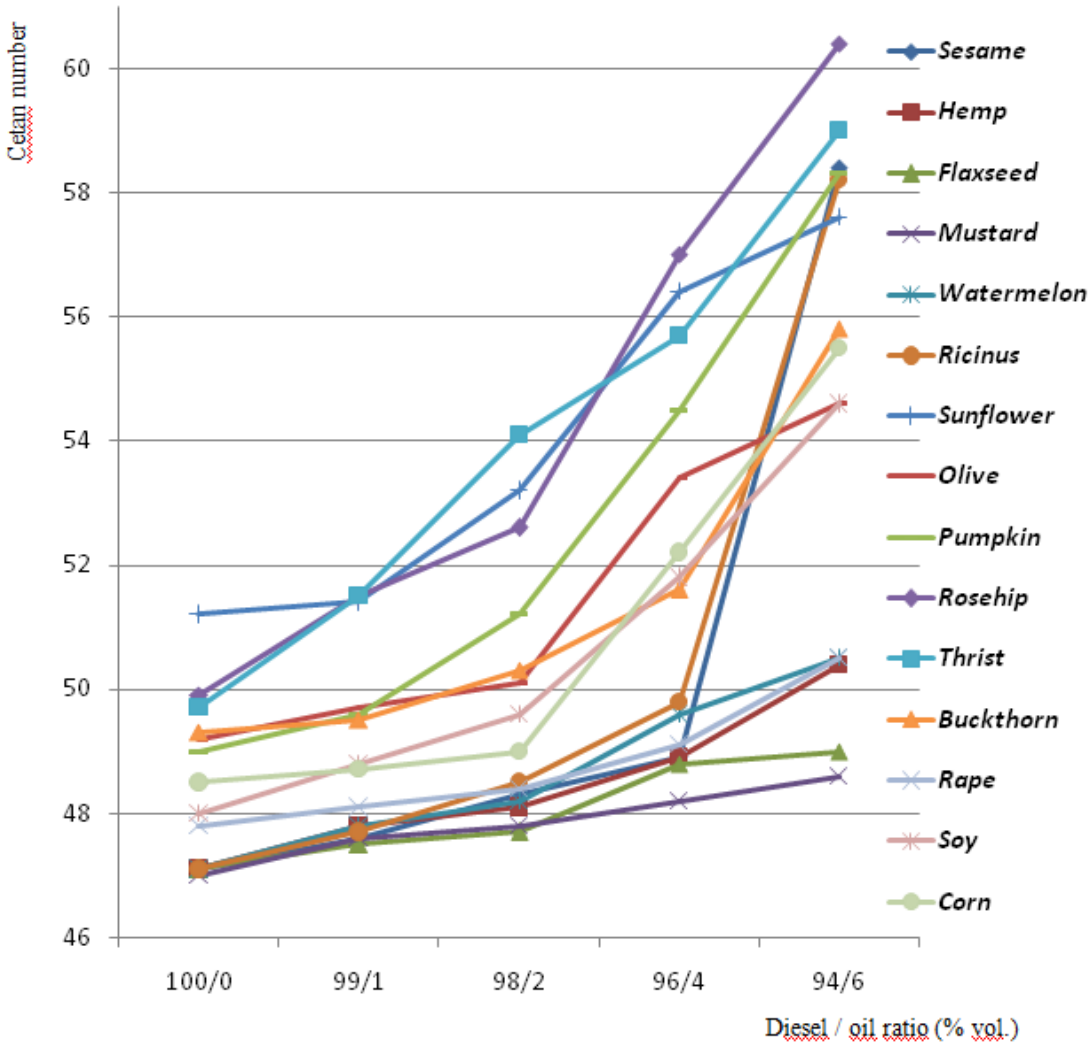

Fig.1 Effect of different types of vegetable oils on diesel fuel cetane number.

As can be seen in table 1, most of the vegetable oils, except for ricin, have a freezing temperature higher than diesel fuel, therefore we had to investigate the effect of adding small amounts of vegetable oils on the main characteristics of diesel fuel such as cetane number, freezing temperature and viscosity of diesel fuel compositions. These characteristics are presented in fig. 1, 2, 3. As can be seen in the presented in fig. 3 dependences of the viscosity of the original composition on the type of added oil in diesel fuel, no more than 1-6% of vegetable oils can be introduced without significant change in the viscosity of these mixtures (fig. 3). The freezing temperature almost does not change (fig. 2) when added in a mixture of such types of oils as flax, rapeseed, sesame, mustard and watermelon so they can be added for both summer and winter diesel fuel (Fig. 2). However, with the introduction of all other types of vegetable oils, it can be seen a significant increase in the freezing temperature to -5 ... -10 ° C. This means that these types of oils can only be added to summer diesel fuel (fig. 2).

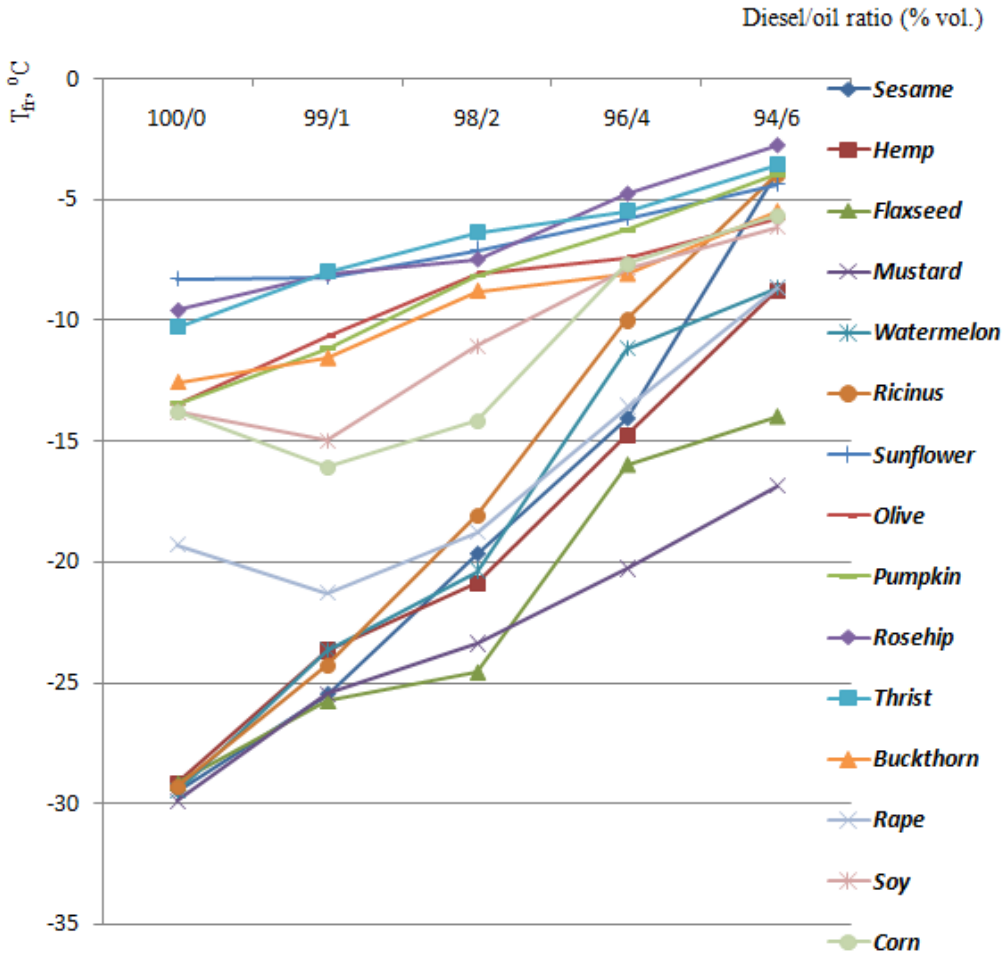

Fig.2. Effect of different types of vegetable oils on the diesel fuel freezing temperature, T_{fr}.

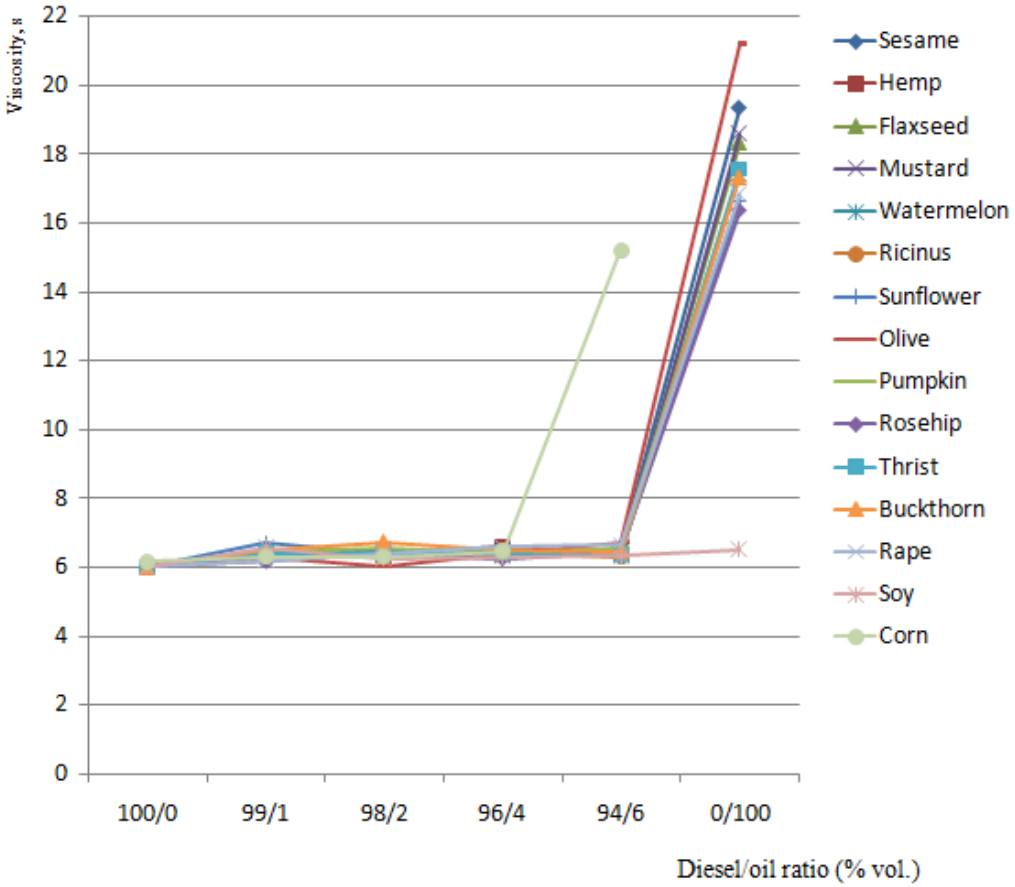

Fig. 3. Effect of various types of vegetable oils on the diesel fuel viscosity

At the same time, as can be seen in fig. 1, the addition of even small amounts of studied oils (3-6%) raises the diesel fuel cetan number from 45-50 to 55-60 units, which greatly improves the

efficiency and completeness of diesel fuel combustion and ensures reduction of harmful emissions by 10-20% compared to diesel fuel obtained from oil [4].

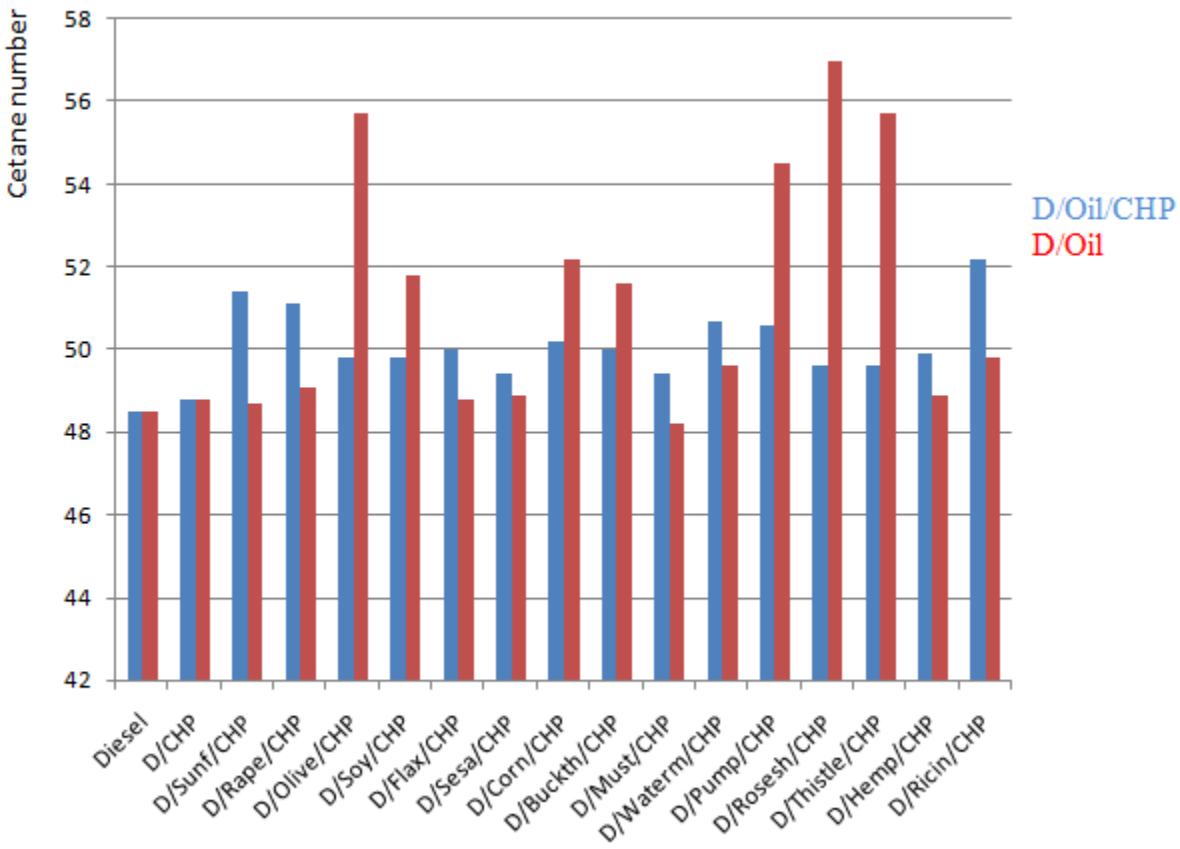

Fig. 4. Influence of different types of vegetable oils (5%) on diesel fuel cetane number with the content of the combustion initiator (0,5%) cumene hydro peroxide CHP.

In addition, we studied the influence of the known diesel fuel combustion activator - cumene hydroperoxide, on the cetane number of mixtures (fig. 4) containing the minimum amount of vegetable oils (5%). Only cumene hydroperoxide addition does not affect the increase of the diesel fuel cetane number. As can be seen in fig. 4 for such varieties of oil, as olive, soybean, corn, sea buckthorn, pumpkin, rosehip and thistle introduction of 0,1% cumene hydro peroxide gives additional growth of the diesel oil mixtures cetane number from 48 to 51-58. While for the introduction of other types of oils, even with cumene gyroperoxide, gives the same effect as without it. This means that natural oils are more effective initiators and activators of combustion and have a more significant effect on the cetane number increase than cumene hydro peroxide.

Conclusions

1. An analysis of the diesel fuel properties with the addition of special additives based on vegetable oils, which can be used as activators of motor fuels combustion, is carried out.

2. The research presented in the paper confirmed the possibility of introducing up to 6% of 7 of the 15 examined vegetable oils to regulate cetane number, viscosity and freezing temperature of diesel fuel with and without the cumene hydroperoxide addition.

3. The greater influence of certain vegetable oils on the increase of diesel fuel cetane number and combustion completeness in comparison with cumene hydro peroxide are shown.

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