Use of synthetic motor fuel in agricultural machinery

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Abstract. The use of synthetic motor fuels, in particular, synthetic diesel fuel in road transport, synthesized from various sources (coal, oil shale, natural gas, biomass) is an important direction in meeting the existing modern energy and environmental requirements in this industry. In the process of performing various research and practical work on the production and operation of synthetic motor fuels, their comparative characteristics and indicators are established in relation to standard diesel fuel. Experimental determination of the required characteristics and indicators of synthetic and petroleum diesel fuels and their subsequent analysis will allow developing rational solutions for their application. This article presents the results of scientific research conducted to determine some of the performance indicators of a diesel car running on synthetic diesel fuel synthesized from natural gas.

1 Introduction

At present, the use of various alternative environmentally friendly energy sources, including synthetic motor fuels, is the most affordable and expedient solution to the energy and environmental problems of road transport.

In the world, the technologies for producing synthetic diesel fuel from various raw materials (coal, oil shale, natural gas, biomass) have found the greatest distribution. At the moment, several high-performance GTL plants operate in the world industry: Mossel Bay (South Africa), Bintulu (Malaysia), Oryx (Qatar), Pearl (Qatar), Eskravos (Nigeria) . A plant for the production of synthetic diesel fuel from natural gas (Gas to Liquids-GTL) has been put into operation in Uzbekistan for the production of diesel fuel, aviation kerosene, naphtha and liquefied petroleum gas.

It is known that the determination of the main comparative performance characteristics and indicators of diesel vehicles running on synthetic and petroleum diesel fuels will provide the necessary scientific and practical information about the possibility of their application and operation features.

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2 Purpose and problem statement

It is known that at present in the world synthetic diesel fuel is synthesized from natural gas or from other sources on the basis of technology or advanced Fischer-Tropsch technology.

The resulting synthetic diesel fuel product during operation must provide the necessary performance properties of a car or other type of transport operating on this type of fuel.

It is known that the operational properties of the car include: traction and speed, braking, fuel efficiency, environmental friendliness, handling, steering, manoeuvrability, stability, smoothness, etc.

On the other hand, the motor fuels used can mainly affect the traction-speed, fuel-economic and environmental properties of the vehicle.

In this regard, the goal of the research is to study the performance of a diesel car running on synthetic diesel fuel.

3 Analysis of publications

Currently, modern energy and environmental problems of vehicles with an internal combustion engine are being solved using various types of environmentally friendly alternative sources, such as natural gas in compressed or liquefied form, liquefied petroleum gas, alcohols, ethers, hydrogen, biofuels, including synthetic motor fuels from various raw materials (coal, oil shale, natural gas, biomass), which are produced on the basis of the Fischer-Tropsch technology (the process of synthesis of higher hydrocarbons from a carbon source, through synthesis gases (CO and H2), using catalysed reactions [1-2] .

Moreover, in recent years, the technology of production from synthetic diesel fuel from natural gas has been dynamically developing in those countries that have sufficient natural resources, including Uzbekistan. A significant amount of work on the determination of the CN of diesel fuels has been carried out by experimental methods, where the CN is determined by comparing its combustion characteristics in a test single-cylinder engine of a classical design (standard crankcase with pump assembly, cylinder block, heat exchange cooling system, fuel system, injector assembly, electrical control system and exhaust pipe) with the characteristics of mixtures of control fuels with a known cetane number under standard operating conditions[3-4]. Moreover, the numerical values of the properties of diesel fuel obtained from oil and SDF differ significantly from each other [5-8].

Synthetic diesel fuel belongs to the class of paraffinic diesel fuels (BTL - biomass to liquid, CTL-coal to liquid, HVO - hydrotreated vegetable oil), which differ slightly in properties depending on the raw material sources and in technical characteristics in accordance with EN 15940, OzDSt 3134 :2017. The properties of diesel fuel obtained from oil are somewhat different from the properties of synthetic diesel fuel synthesized from other raw materials. For example, the CN of modern petroleum diesel fuels is no more than 55 units, while the CN of synthetic diesel fuel is more than 70 units (GOST 3 2 5 1 1 -2013 (EN 590:2009) DIESEL FUEL EURO Specifications, O'z DSt 3134:2011 Synthetic diesel fuel component. Specifications) [9].

In recent years, many performance tests of synthetic diesel fuel have been carried out, including tests by Shell, which have shown a fairly high efficiency of using this type of motor fuel. However, the results obtained were of a general nature and there were no specific comparative data (GOST 3122-67 (ST SEV 2877-81) Diesel fuels. Method for determining the cetane number, GOST 27768-88 (ST SEV 5871-87) Diesel fuel. Determination of cetane index by calculation method).

4 Research methods

In the process of research, petroleum and synthetic diesel fuels were used; quality indicators corresponded to existing regulatory documents (Table 1).

Table 1. Comparative performance of various diesel fuels

Indicators	Unit measurements	Standards		
		Uz state standard 1134-2018	state standard 32511-2013 (EN 590:2009)	EN 1 59 4 0: 2016 (GTL)
cetane number	CFR	≥50	≥51	≥70
cetane index	-	-	≥46	≥70
Carbon content	% wt.	-	86.3	85.2
Hydrogen content	% wt.	-	13.6	14.7
Net calorific value	MJ/kg	-	42.9	44.0
Density at 15 ^{0}C	kg / m ^{3}	≤840	820-845	≥765
Viscosity at 40 ^{0}C	mm ^{2}/s	3.0–6.0	2.9	2.0-4.5
Sulfur content	mg/kg	<0.01	<10	ots.
Start boiling point	^{0}C	170	170	200
End boiling point	^{0}C	368	360	310
Boiling temperature 95% volume	^{0}C	≤360	≤360	≤360
50% volume	^{0}C	≤280	≤280	≤280
Content of polyaromatic hydrocarbons				
Aromatic content	% wt.	≤8.0	<11.0	<0.1
Olefin content				
Limiting filterability	% about.	-	≤1.0	-
temperature	% about.	-	≤0.1	-
Filterability coefficient				
Conductivity	^{0}C	≤ - 5	– 37	-27
Lubricity (wear scar)	-	-	≤2	-
	pS/m	≥100	≥100	≥100
	µm	460	460	460

5 Results and discussion

5.1. Resources for obtaining synthetic motor fuels

As noted above, due to the limited fossil organic resources in recent years, in many countries, serious attention has been paid to obtaining synthetic motor fuels from various possible sources (Table 2)

Table 2. Resources for obtaining synthetic motor fuels

Name	Unit measurements	Resource potential	
		In the world	In Uzbekistan
Coal	billion ton	1074	1.9
Natural gas	trillion m ^{3}	199	2
oil shale	billion ton	411	47
Biomass (annual)	billion m ^{3} (billion ton)	(500)	6

As follows from the above data, there are sufficient resources in the world and in Uzbekistan to obtain synthetic motor fuels, as well as other types of renewable energy sources (Table 3).

Table 3. Renewable energy sources

Name of energy	Potential, billion/year		
	In the world	In Uzbekistan	
	Gross	Gross	Technical
Solar	$131*10^{6}$	$76.5*10^{3}$	$0.27*10^{3}$
Wind	$2*10^{6}$	3.33	0.64
Hydraulic	$7*10^{6}$	3.43	0.39
Biomass	$0.1*10^{6}$	13.8	2.92
Total	$140.1*10^{6}$	$97.6*10^{3}$	$4.22*10^{3}$

5.2. Landfill tests of a diesel car

In order to determine the individual performance indicators of a diesel vehicle running on petroleum and synthetic diesel fuels, field tests of an ISUZU diesel light truck were carried out. NQR -71 RL , which was equipped with test equipment - fuel flow meter, test complex " KORSUS - DATRON ", etc. (tab. 4).

Table 4. Field testing of a diesel light truck ISUZU car NQR - 71RL

Fuel	V_{max}, km / h	Acceleration time to a speed of 60 km / h , s	Fuel consumption, l /100 km					
			40	50	60	70	80	90
DT	104.17	15.91	15.42	15.06	13.84	14.04	14.42	14.62
GTL	105.5	16.86	1 6 , 3 6	15.95 _	14 , 55 _	14, 68	15 , 22 _	15 , 46 _

5.3. Discussion of the results of experimental studies

The field experimental studies carried out to determine the maximum speed of movement, the acceleration time of the car to a speed of 60 km/h and fuel consumption at speeds of 40, 50, 60, 70, 80 and 90 km/h showed that the traction and speed qualities of the car on oil and synthetic diesel fuels are practically the same, however, the consumption of synthetic diesel fuel increases by about 4-5.5%.

6 Conclusion

Comparative studies of petroleum and synthetic diesel fuels have shown that the synthetic fuel produced in Uzbekistan provides the necessary performance indicators for vehicles operating on this type of fuel.

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