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The Comperative Research of the Antistatic Property of the Amino-And Hydroxyethyl Imidazolines of Petroleum and Oil Acids

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ABSTRACT

The amino and hydroxyethyl imidazolines based on fractions of natural petroleum acids boiling in the range 140-160 °C, 160-180 °C, 180-200 °C, cotton, sunflower and corn oil acids have been investigated as additives for hydrotreated diesel fuel. It has been determined that influence of amino- and hydroxyethyl imidazolines of petroleum acids increases when the boiling point of them increase.

It has been revealed that, the influence of imidazolines of vegetable oils on the specific electrical conductivity decreases in following order: Sunflower FA AminoEIM – Corn FA AminoEIM – Cotton FA AminoEIM and Sunflower FA HydroxyEIM – Corn FA HydroxyEIM – Cotton FA HydroxyEIM.

On the other hand, results demonstrate that the imidazolines of petroleum acids have better antistatic properties than the imidazolines of vegetable oil acids. The concentration for imidazolines of petroleum acids is 75 ppm in order to meet the modern requirements (SEC≥150 pS/m), however for vegetable oil acids, this value is 100-150ppm.

Keywords: hydrotreated diesel fuel, specific electrical conductivity, antistatic additive, natural petroleum acids, vegetable oil acids, aminoethyl imidazolines, hydroxyethyl imidazolines

INTRODUCTION

As it is known, imidazolines belong to the classification of the cation type surfactants. It makes imidazolines and their derivatives to be applied in different industrial sectors in a wide range. Nowadays, imidazolines are applied as inhibitor, dispersant, emulsifying agent, antistatic compounds, bleaching activators, biologically active compounds and etc.in the petroleum refinery, weaving, dye, oil production and other industrial areas [1].

On the other hand, diesel fuel that meets the modern requirements and is produced by deep hydrotreating does not contain oxygen, nitrogen and sulfur heteroatoms, therefore their lubricity and electrostatic properties are degradated. Different additives are applied in order to maintain the exploitation time of modern diesel fuel at the desired level. These additives should dissolve well in the fuel and should not negatively influence its other quality indicators, at the same time, they should be efficient from economical point of view and produced on the basis of renewable feedstock [2,3]. That is why, the new application area of the hydroxyethyl imidazolines of natural petroleum and vegetable oils as an additive to the diesel fuel should be taken into account.

As it is obvious, the power of the engine and the usage efficiency of the fuel increase and the solid compounds decrease by the increase in the combustion efficiency in the internal combustion engine. The additive that contains following components has been used in order to obtain the aforementioned parameters: di-tert-butyl peroxide, the imidazolines of tallow oil and neodecene acids. In this composition, organic di-tert-butyl peroxide is a source of additional oxygen and free radicals for

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enhancing the combustion chain reaction of diesel fuel. Tallow oil acids is used as detergent without ash for protecting the combustion system (combustion camera and injector), absorb the moisture, and prevent the corrosion. Neodecane acid influences as an initiator and stabilizing agent for the mentioned organic peroxide and makes a durable fuel against microbes, this is very important during the usage of biodiesel fuel [4].

Another diesel fuel additive which contains imidazoline had been prepared by Russian researchers. This additive carries 0.045-0.4% of barium alkylphelonate and 0.005-0.1% of imidazoline derivative, the product of the reaction between sulfocarbon acid and diethyltriamine, the product of the reaction between alkylphenol, hexametylenetetraamine, diethyltriamine and boric acid. The imidazoline derivative of the additive has been synthesised on the basis of alicyclic carbon acids and polyethylenepolyamine [5].

The patent that was released by Duane R. and his co-workers was dedicated to the diesel fuel additives those carry imidazoline derivatives. This additives consist of the mixture of alkylphenyl etoxysilates those contain 9-12 carbon atom and hydroxy or aminoethyl imidazolines. As a result of the synergic interaction of these two components, the resistance of the metal surface to the air, water and the fuel corrosion increases and the details of the engine become durable [6].

The other patent was dedicated to the application of imidazoline derivatives based on the isostearic acid and polyethylenepolyamine for internal combustion engines in order to decrease the formation of precipitation in fuels and oil. Then, sulfoacid compositions was used in order to enhance the detergent properties of this additive

The application of 1-hydroxyethyl-1-alkyl-2 imidazolines, bis-imidazolines and their derivatives was investigated for enhancing the detergent properties of liquid hydrocarbon fuels in the similar research work [7].

N-alkylglycine imidazoline which is prepared by American researchers Rodney L. and his co-workers is added to diesel fuel in order to enhance its detergent and anticorrosion properties. As a result of the researches, it was identified that, N-alkylglycine imidazolines lower the formation of precipitation by 88% [8].

In another patent of the same authors, aminoethyl imidazolines based on N-acyl sarcosine and DETA had been investigated as a corrosion inhibitors for hydrocarbon fuels. The missing feature of this additive is that they keep water during synthesis and it negatively effects its long term usage for diesel fuel [9].

The composition additives those carry 2-imidazoline derivatives and have been prepared by Russian researchers enhance the anticorrosion and detergent abilities in fuels. This additive carries 75-90% alkyl (C_3-C_8) nitrate, 5-15% anticorrosion component (mass), hydrocarbon fraction boiling in the range of 120-270°C. Anticorrosion component is chosen from a group of 3,4,4-trimethly-2pheniloctane acid, 2-imidazoline, alkyl (C_4-C_9) thiazolidine, N-oleilsarcosine. Researches reveal that the addition of 0.01-0.8% of this additive enhances the anticorrosion and operating properties of diesel fuel. The usage of the additives for diesel fuel does not only enhance the operation properties of petroleum and gas-condensate diesel fuel, but also lets to keep them up to 2-3 years instead of 1-1.5 years [10].

According to the information from different sources, imidazolines and their derivatives are not applied to diesel fuel directly, they are applied with appropriate additives. Taking into account this fact, the application of the imidazolines, especially those are produced on the basis of natural petroleum and oil acids directly to diesel fuel should be on spotlight .

In the presented work, the comperative research of the hydroxyethyl imidazolines of natural petroleum and oil acids to diesel fuel in order to enhance its antistatic property is given.

EXPERIMENTALS

Materials and Methods

In the research, the fractions of petroleum acids from Baku oils boiling in the range of 140-160 °C (fr.I), 160-180 °C (fr.II) və 180-200 °C (fr.III) have been used. Petroleum acids have been taken from Baku Oil Refinery factory named after H.Aliyev.

The mixture of oil acids which are produced by the hydrolysis of cotton, sunflower and corn oils have been used. Hydroxyethyl imidazolines those have been synthesized on the basis of natural petroleum acid fractions and acids based on vegetable oils are produced according to the method mentioned on the work [11, 12].

Dietylendiamine and N-hydroxyetylendiamine have been obtained from the "Sigma-Aldrich" company of Germany.

The specific electrical conductivity (SEC) which characterizes the antistatic property of diesel fuels has been determined by the apparatus EL-4M according GOST 25590.

The physical and chemical properties of diesel fuel which was used during the research are given in Table 1.

As can be seen from Table 1, the diesel fuel does not meet the requirements specific electrical conductivity (SEC ≥ 150 pS/m).

Table1. *Physical and chemical properties of diesel fuel used in the research.*

Properties of Diesel Fuel	Index of Diesel Fuel	Testing Method
Cetane number	47	ISO 5160
Density at °C kg/m3	849.5	ISO 12185
Kinematic viscosity, mm^2/s at 20°C	2.23	ISO 3104
Acidity, mg KOH/100 cm^3 of fuel	0.01	ISO 7537
Fractional composition, °C		
Initial boiling point	190	ISO 3405
10%	210	ISO 3405
50%	270	ISO 3405
90%	335	ISO 3405
96%	345	ISO 3405
Ignition temperature, °C	73	ISO 2719
Hydrocarbon composition, %		
Aromatic	21.23	ASTM D-6591
Paraffin - Naphthene	78.52	ASTM D-6591
Unsaturated	0.25	ASTM D-6591
Total Sulfur Content, % mass	0.0012	ASTM D-5453
Freezing point, °C	-36	
Cloud point	-28	ISO 116
The amount of water, %	-	
Lubricity,µm (average value)	620	ISO 12156
Flash point, °C	4	ISO 6297
Specific electrical conductivity (SEC)	8	GOST 25590.

RESULTS AND DISCUSSION

For investigating the influence of amino-and hydroxyetylimidazolines on the antistatic property of diesel fuel, they have been added to diesel fuel at the interval of certain concentration (figure.1-2).

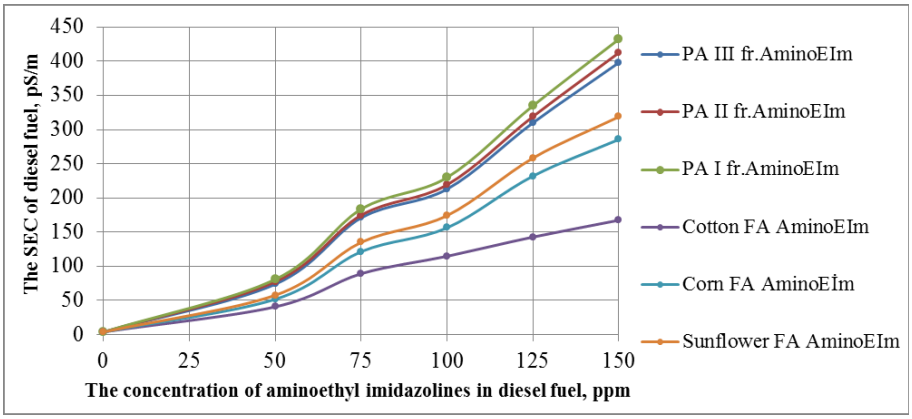

Fig1. *The effect of hydroxyethyl aminoethylimidazolines of petroleum and fatty acids on the antistatic property of diesel fuel*

As can be seen from Fig.1, when the concentration of the aminoethyl imidazolines of both petroleum and oil acids in diesel fuel increases, specific electrical conductivity (SEC) increases. Besides that, according to the results, it is revealed that, the influence of the PA I fr.AminoEIm on the SEC of diesel fuel is greater than the influence of PA III fr.AminoEIm. This shows that the antistatic property of aminoethyl imidazolines decreases with an increase in the boiling point of the petroleum acid fractions those they are based on. On the other hand, for the aminoethyl imidazolines of vegetable oils, the antistatic property decreases in the following order: Sunflower FA AminoEIM – Corn FA AminoEIM – Cotton FA Amino EIM.

As it is obvious from the results, the antistatic property of the aminoethyl imidazolines of petroleum acids is better than the antistatic property of the aminoethyl imidazolines of vegetable oil acids. Besides that, results indicate that when 75 ppm of the aminoethyl imidazolines of petroleum acids is used, the antistatic property of diesel fuel meets the modern requirements (SEC≥150pS/m), however for the aminoethyl imidazolines of vegetable oil acids, this value is 100-150ppm.

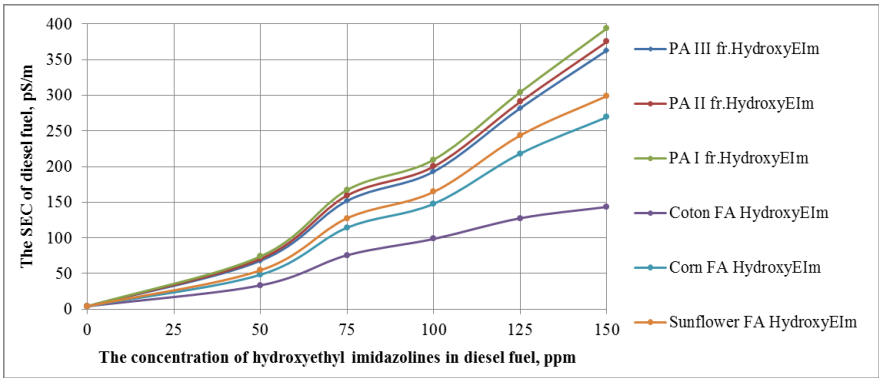

Fig2. *The effect of hydroxyethyl imidazolines of petroleum and fatty acids on the antistatic property of diesel fuel*

As it is obvious from Figure 2, similar to the aminoethyl imidazolines of petroleum and oil acids, when the concentration of hydroxyethyl imidazolines in diesel fuel increases, the SEC of fuel also increases. Besides that, according to the results, it is revealed that the efficient concentration level in diesel fuel for all three fractions of petroleum acids is 75 ppm. The SEC of diesel fuel is higher than 150 pS/m at this concentration. Similar to aminoethyl imidazolines of petroleum acids, the antistatic effect increases from the first to the third fraction for hydroxyethyl imidazolines as well. The efficient concentration of hydroxyethyl imidazolines of vegetable oil acids in diesel fuel is 100-150ppm like aminoethyl imidazolines. Besides that, similar to aminoethyl imidazolines, the influence of

hydroxyethyl imizadolines on the antistatic property of diesel fuel decreases in the following order: Sunflower FA HydroxyEIM – Corn FA HydroxyEIM – Cotton FA HydroxyEIM.

CONCLUSIONS

According to the results, it can be mentioned that, both the aminoethyl and the hydroxyethyl imidazolines of petroleum acids are efficient than the imidazolines of oil acids and they are strongly recommended as an antistatic additive to diesel fuel

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Khayala Hamlet Kasamanli, was born in 29th of December, 1978 in Ganja, Azerbaijan. She obtained her bachelor degree in Chemistry in 2000 and master degree in Organic Chemistry in 2002 at Ganja State University. Since 2002, she had worked as a lecturer and since 2011, she has been working as a senior lecturer at Ganja State University.

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