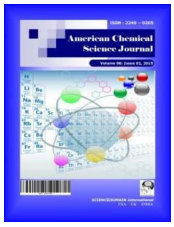

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Effect of Synthetic Zeolite on Some Physical Characteristics and Research Octane Number of Final Product Gasoline Sample Produced from Khartoum Refinery in Sudan

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Authors' contributions

This work was carried out in collaboration between authors ME and AAJ. Author ME designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ME and AAJ managed the analyses of the study. Author AAJ managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

This research explored the effect of synthetic zeolite on pH, density, vapour pressure and Research Octane Number (RON) for gasoline final product, gasoline sample was taken from Khartoum refinery. The Used sample was tested according to American Society for Testing and Materials (ASTM) before and after blended with synthetic zeolite. Previously tetra ethyl lead (TEL) and tetra methyl lead (TML) have been used to improve the fuels octane number, but they have negative effects on the environment, and have been banned internationally. The (RON) of marked gasoline sample was recorded 90.7 before blended with zeolite. In order to enhance the RON of used gasoline synthetic zeolite was added to the gasoline with concentration (10% w/v). Octane number of blends was measured by Cooperative Fuels Research (CFR) engine. Some of the physical properties for final product gasoline after addition were improved into a limits assigned by ASTM and Khartoum Refinery (KR). (RON) was increased to 91.9 after adding synthetic zeolite.

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Keywords: Gasoline; zeolite; octane number; physical properties of gasoline.

1. INTRODUCTION

Gasoline anti - knock additives, these are compounds which when added to a gasoline fuel for spark ignition engines, raise its antiknock quality, which is expressed by octane numbers. There are three broad classes of compounds from which antiknock additives are selected [1,2]:

a) Hydrocarbons of natural high octane number.
b) The aromatic amines.
c) The organometalic compounds.

The relative effectiveness of compounds of these classes is shown in Fig. 1 [3].

The hydrocarbon class of antiknock compounds should be regarded as fuel components rather than considered for their antiknock effectiveness as additives [4]. The usefulness of the amines appears to be confined to special cases, such as to supplement the tetraethyl lead in aviation gasoline of the organometallics, there are many which exhibit antiknock value [3]. The lack of one or more of the other essential qualities in additives, such as solubility, volatility, and low cost, has ruled out all but two, the lead alkyl and iron carbonyl [5-7]. The later is lower in cost but increases engine wear because of its abrasive combustion products, thus making its impractical [7]. Of the lead alkyls, tetraethyl lead, the original selection, is now the accepted standard antiknock agent for commercial use in motor and aviation gasoline [8,9].

Zeolite is porous, hydrated aluminosilicates. They may be natural minerals or synthetic materials. The general chemical composition of a zeolite is [10-13]:

$$M^{n}_{x/n}Si_{1-x}Al_xO_2 \cdot yH_2O$$

Where M = e.g. Na+, K+, Li+, Ag+, NH4 +, H+, Ca2+, Ba2+…etc.

The properties of zeolite are closely related to both structure and chemistry three main characteristic properties (adsorption, ion exchange and catalytic activity) [14,15].

The main objective of this article is use the synthesized zeolite to enhancement the RON of final product Sudanese gasoline produced from Khartoum refinery in Sudan.

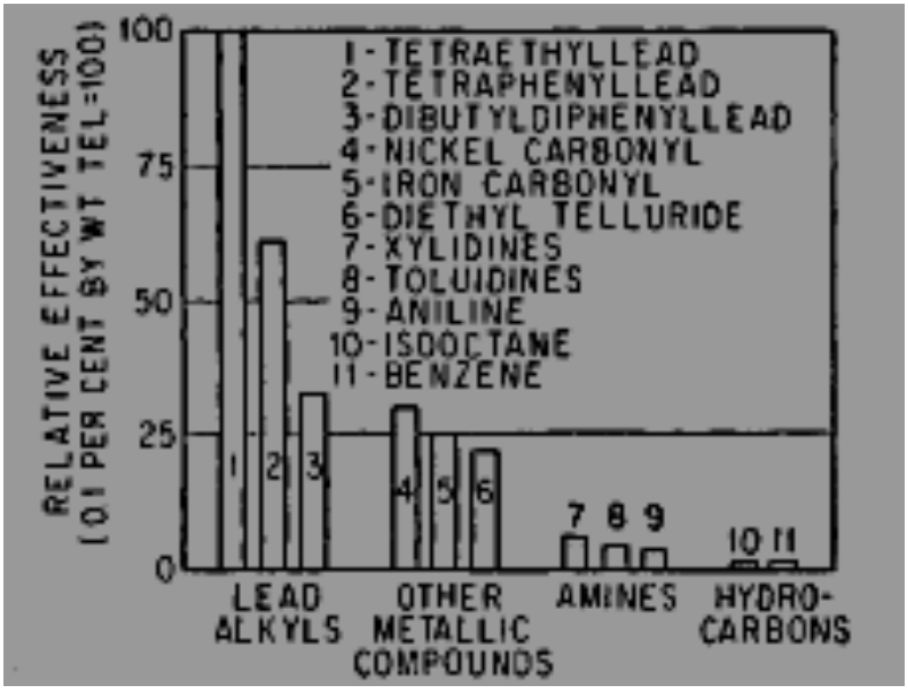

Fig. 1. Relative effectiveness of compounds on antiknock quality of gasoline

2. MATERIALS AND METHODS

2.1 Chemicals

All chemicals used were of analytical reagent grade (AR) and of highest purity degree available. They included hydrochloric acid, iso-octane, n-heptane, methyl isoketone, standard lead (II) and gasoline product produced from Khartoum refinery.

2.2 Procedures

The gasoline used was produced from Khartoum refinery, synthetic zeolite was added to improve octane number of local gasoline. Some physicochemical characteristics of Sudanese gasoline were checked by applying many tests according to American Society for Testing and Materials (ASTM). These tests included: density, PH, vapour pressure and RON.

The experimental work was conducted at Central Laboratories of Khartoum Refinery (KR) (Algily, Khartoum north) and Central Petroleum Laboratories (CPL), Elamarat, str. 61, Khartoum. Specific volume of local reformat gasoline (1000 mL) was treated by 100 g synthetic, tests of quality control for gasoline were carried out before and after addition.

2.2.1 Determination of density and vapour pressure

Density and vapour pressure of sample before and after treatment by synthesized zeolite were tested according to American Society for Testing and Materials ASTM D1298 & ASTM D323 respectively [8].

2.2.2 Determination of pH

About 50 mL of sample were taken and transferred into a clean 250 mL beaker, then the electrode of pH apparatus was washed by distilled water and deionized water finally PH of sample in a 250 mL beaker was measured automatically [4].

2.2.3 Determination of Research Octane Number (RON)

RON of final product sample before and after treatment by synthesized zeolite was determined according to ASTM D2699 [8].

2.2.4 Preparation of synthetic zeolite

About 40 g of k-fledspar was extracted from rocks with jaw and crusher, crush converted into powder then a clay was crushed with pestle and mortar, 20 g sodium carbonate (trona) was added to the above powder. The mixture was heated for 6 hours in 1100℃ by using electronic furnace, crucible was cooled in a dissector for 2 hours [14]. Raw materials for synthesis zeolite shown in Table 1.

Table 1. Raw materials for synthesis zeolite

Name	Source	Purity
Clay	River Nile	Natural
Sodium Carbonate	Alfasher	Natural
K- feldspar $KAlSi_3O_8$	Bioda desert	Natural

2.2.5 Method for addition of synthetic zeolite to final product gasoline at concentration 10 w/v

- A 1000 ml used gasoline was prepared at refrigerator temp. in a glass container with fitting cover.
- Density, pH, vapour pressure and RON was measured for gasoline before of addition the synthetic zeolite.
- Glass container was filled with 1000 ml of gasoline and 100 g of synthetic zeolite was added with stirring for 10 min by using magnetic stirrer.
- The blended gasoline was filtrated by using 18 mm filter paper.
- Density, pH, Vapour pressure and octane number of these blend were measured after blending [6,7].

3. RESULTS AND DISCUSSION

The results obtained for physical tests according to ASTM are shown in Table 2.

Table 2. Density and vapour pressure characteristics of used sample before and after treatment by synthetic zeolite

Test	Before blended	After blended
Density (Kg/m^3)	760.1	738.4
Vapour pressure (kpa)	54	60

The density and vapor pressure properties of gasoline are very important [7] because increased density led to a decrease in the octane

number and increased vapour pressure led to increase in the octane number. No limits had been assigned for the density and vapor pressure by ASTM because they depend to greatly on the temperature of the country but the refineries have assigned limits to these physical parameters is shown in Table 3.

Table 3. Limits of physical parameters gasoline assigned by Khartoum Refinery

Test	Summer	Winter
Density	>740 kg|m^3	>740 kg|m^3
Vapour pressure	40- 67 KPa	40 – 85KPa

According to the assigned results of density and vapour pressure, the results obtained in (Table 1) appear improved in permissible range. The results of density and vapour pressure are represented in Figs. 2 and 3 respectively.

Natural zeolite led to reduce the acidity of gasoline, also the pH properties of gasoline was important. Now limits assigned by ASTM and Khartoum refinery for pH. The results of pH before and after blending are shown in Table 4.

The synthetic zeolite showed potency in decreasing the acidity, the pH reducing process was very important because high acidity causes corrosion in the internal combustion engines. The results of pH are represented in Fig. 4.

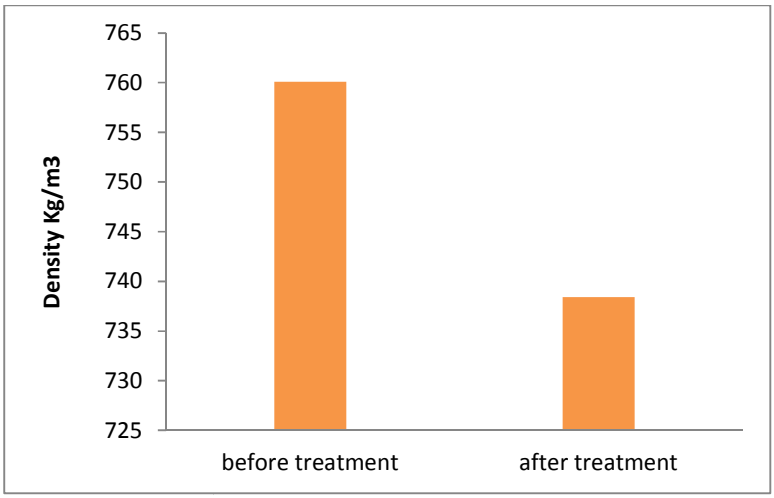

Fig. 2. Effect of synthetic zeolite on density of used gasoline sample

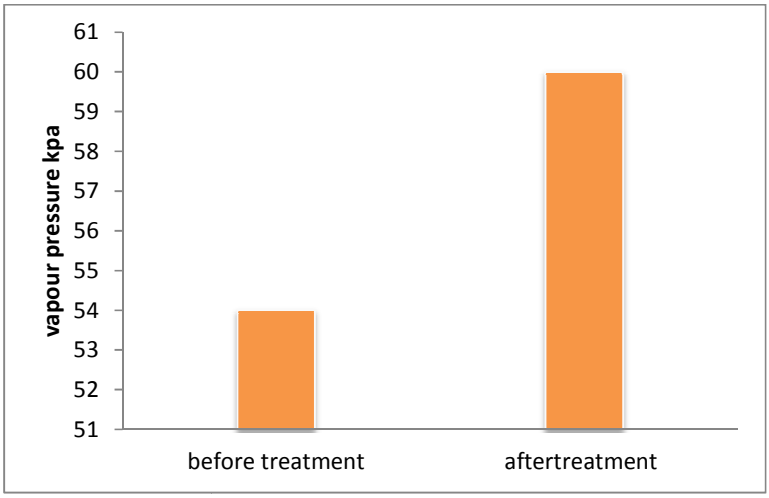

Fig. 3. Effect of synthetic zeolite on vapour pressure of used gasoline sample

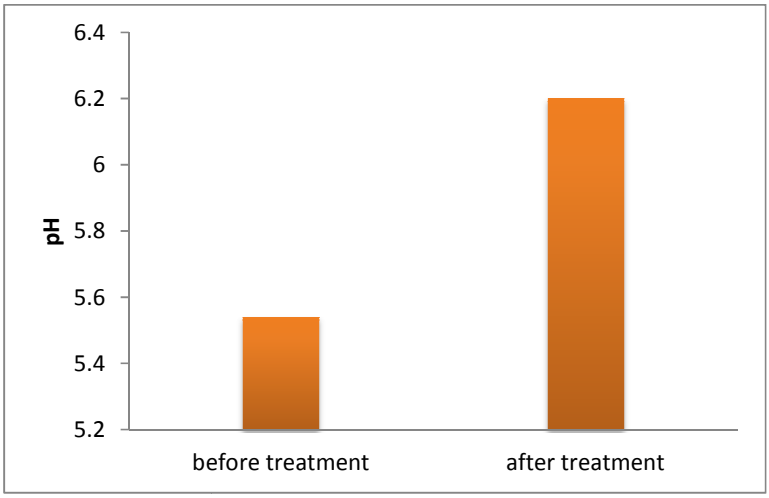

Fig 4. Effect of synthetic zeolite on pH of used gasoline sample

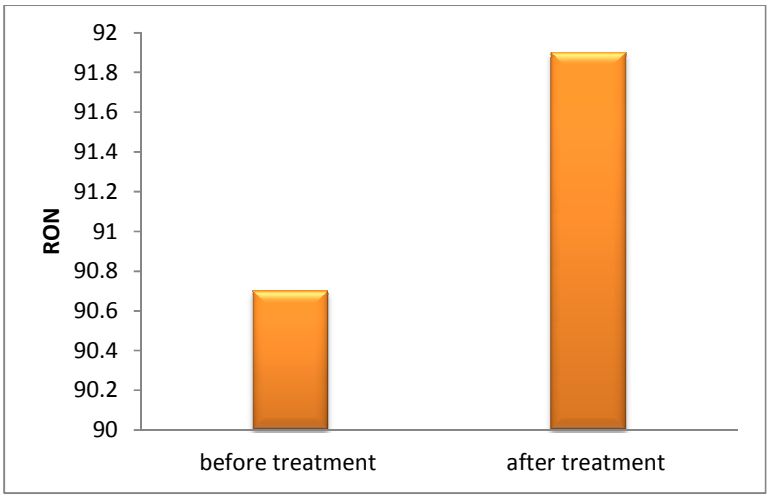

Fig. 5. Effect of synthetic zeolite on RON

Table 4. pH of used gasoline before and after treatment by synthetic zeolite

Test	Before blending	After blending
pH	5.54	6.20

The obtained results of RON were shown in Table 5.

Table 5. RON of used gasoline sample before and after treatment by synthetic zeolite

Test	Before blending	After blending
RON	90.7	91.9

The used gasoline was raised by 1.2 in RON value which is considered a clear indicator that the synthetic zeolite can raise the octane number and consequently improves the quality of gasoline. The raising of RON on addition of synthetic zeolite is attributed to the potency of the synthetic zeolite to convert the hydrocarbon chains into cyclic compounds or increasing the branched chains in gasoline [6]. Comparison between rate of octane number when synthetic zeolite is added shown in Fig. 5.

4. CONCLUSION

The octane number of used gasoline before treatment was found to be 90.7, on the other hand the RON after treatment by synthetic zeolite was found to be 91.9. Synthetic zeolite showed potency in improving RON of gasoline

sample produced from Khartoum Refinery. The density and vapour pressure properties of used gasoline after addition were improved within the range assigned by Khartoum refinery. The acidity of used gasoline was reduced to 6.20.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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