The Austrian Journal of Technical and Natural Sciences, No 1–2
ISSN 2310-5607

PREMIER Publishing
ppublishing.org

Section 2. Chemistry

DOI:10.29013/AJT-25-1.2-10-13

STUDY OF THE EFFECT OF COMPLEX ADDITIVES THAT INCREASE THE OCTANE NUMBER AND ACT AS INHIBITORS FOR AUTOMOTIVE GASOLINES ON A COPPER PLATE

***Akhmedov Orif Jumanazar o'g'li* [1], *Fayziev Jakhongir Bakhromovich* [1], *Beknazarov Hasan Soyibnazarovich* [1], *Djalilov Abdulahat Turapovich* [1]**

[1] Tashkent Research Institute of Chemistry and Technology

Cite: *Akhmedov O.J., Fayziev J.B., Beknazarov H.S., Djalilov A.T. (2025). Study of the Effect of Complex Additives That Increase the Octane Number and act as Inhibitors For Automotive Gasolines on a Copper Plate. Austrian Journal of Technical and Natural Sciences 2025, No. 1–2.* https://doi.org/10.29013/AJT-25-1.2-10-13

Abstract

In writing this article, we studied the physical and chemical properties of octane-boosting and inhibitor-functioning additives for automotive gasolines based on various local and foreign sources. Based on the reviewed literature, we synthesized a new type of complex additive that increases the octane number and acts as an inhibitor. When these additives were tested in AI-80 gasoline at concentrations of 1, 3, 5, 10, and 15 percent, they were found to increase the octane number by up to 14 units, as confirmed by the UIT-85 apparatus. To evaluate the inhibitor function in gasoline, stearylamine was added at concentrations of 0.001, 0.002, 0.005, and 0.01 percent. The results demonstrated that at a 0.01 percent concentration, the inhibitor prevented discoloration of the copper plate.

Keywords: *Gasoline, vernier caliper, copper plate, acetone, nylon rope, RON, MON, stand, test tube, water bath, corrosion, hydrochloric acid, electronic balance, oil, engine, corrosion, inhibitor, octane number, oxygenate, oxygen, methanol*

Methanol is a highly polar organic solvent that significantly alters the physicochemical properties of gasoline when added to it. During the combustion process in the engine, methanol reacts by generating free radicals, leading to the formation of oxidation products such as formaldehyde and carbon monoxide, which can cause corrosion of the engine's metal components. Due to methanol's high heat of vaporization, it can remain in liquid form and flow onto the cylinder walls without fully evaporating, washing away the lubricating oil layer on the piston. This reduces the protection against corrosion to some extent. Additionally, methanol reacts with sulfur-containing compounds and other additives present in gasoline, accelerating the corrosion of the engine's internal system. This limits the concentration of methanol that can be safely added to gasoline (Ahmedov O., Beknazarov H., Fayziyev J., 2024; Kapustin V. M., 2013; Wang Z., Liu H., Reitz R. D. 2017; Prakash A. et al., 2017).

When the volumetric content of methanol in gasoline reaches 3%, it begins to cause severe corrosion of metal components in the engine's internal fuel system, including copper, iron, aluminum, and steel (Ahmedov O. J., Beknazarov H. S., Fayziyev J. B. 2024; Gureev A. A., Azev V. S., 1996).

The addition of methanol to fuels in internal combustion engines has a corrosive effect on metals such as copper, iron, aluminum, and steel. When the methanol content reaches 3%, it significantly enhances the corrosive properties of gasoline, and as the methanol concentration increases, corrosion intensifies further. Therefore, modifying engine materials and adding corrosion inhibitors, as well as producing blended gasoline with a low methanol content, are among the key measures to prevent corrosion (Ahmedov O.J, Beknazarov H. S., Fayziyev J. B., 2025; Gustiana Awaludin Sobarsaha, Nuryoto Nuryoto, Jayanudin Jayanudina. 2021; Sharaf Faruk. 2018).

Based on the above findings, we developed an additive containing an inhibitor and studied its effect on a copper plate. To examine the impact of this additive when applied to AI-80 gasoline, we gathered the necessary equipment and reagents for the experiment (Ahmedov O. J., Beknazarov H. S., Fayziyev J. B., Djalilov A. T., 2024; Lipin P. V. et al., 2022).

A highly purified copper plate, prepared according to Standard GB/T 5096–1985 (Petroleum products – Determination of corrosiveness to copper), is taken and polished using fine sandpaper (200–600 grit). The copper plate is then washed with 99% acetone and thoroughly dried. Afterward, it is weighed using an analytical balance, and its width and thickness are measured with a vernier caliper.

The prepared copper plate is securely fastened to a stand using a nylon rope and immersed in an additive-containing gasoline solution with 0.01% mass of inhibitor, submerging it to two-thirds of the test tube's height. The test tube is then placed in a 60 °C water bath and left for 30 minutes. After the exposure, the sample is removed, and its surface is examined for signs of corrosion. Stearylamine, derived from stearic acid, is used as the inhibitor in this process. The copper plate is then thoroughly washed first with 20% hydrochloric acid and then with acetone, after which it is dried. Finally, its mass is measured using an electronic balance, and the corrosion rate of the copper layer is calculated.

Formula for Calculating Corrosion Rate **X=G/S** is used to calculate the degree of corrosion.

Here, X is the corrosion rate (g/m²); G is the mass of the plate after the experiment (g); S is the metal surface area (m²).

The inhibitor was tested at a concentration of 0.01%, and the results can be seen in the following table 1.

Table 1. *Gravimetric analysis of copper plate mass loss with and without inhibitor application*

№	Prisadka (landing)	Initial plate mass g	The mass of the plate after the reaktion is in g	The lost mass g	Corrosion rate-g/m²
1.	Prisadka without added inhibitor	22.4	22.152	0.248	88.571
2.	Inhibitor added prisadka	22.4	22.355	0.045	16.071

The corrosion mechanism in the darkening of the copper plate proceeds as follows. When water is present in methanol-containing gasoline, it leads to acidic corrosion and electrochemical corrosion of metals, causing the ionization of the acid. This enhances the acidic corrosion of active metals and activates other corrosive processes. The main reactions occurring at the cathode and anode are as follows:

Anod: $2Cu + H_2O \rightarrow Cu_2O + 2H^+ + 2e^-$

Katod: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

An oxide layer (composed of Cu2O and CuO) forms on the surface of the copper plate.

Over time, the mixture of oxides reacts with water, leading to the formation of copper hydroxides. The solution absorbs CO_2 from the air, resulting in the formation of copper carbonates ($(CuOH)_2CO_2$, $CuCO_3$). The resulting mixture of salts and oxides forms a uniform and dense oxide film, which makes the copper plate less susceptible to corrosion.

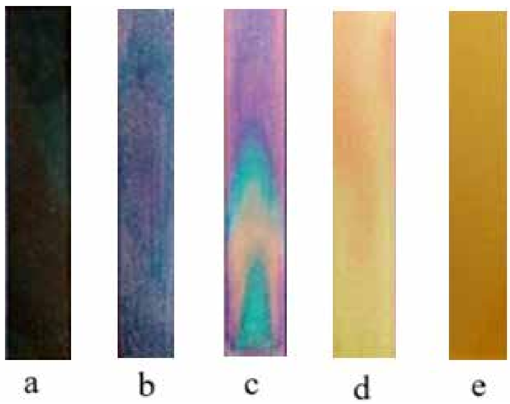
Considering the effect of temperature on copper plate corrosion, the higher the temperature, the more active the intermolecular interactions between the additive and gasoline components become, and the thermal motion of the solution molecules intensifies. This accelerates the desorption of the adsorption layer on the surface of the copper plate, exposing the metal surface and leading to an increase in the corrosion rate.

On the other hand, as the temperature increases, the solubility of gases such as O_2 and CO_2 in water decreases, which has a beneficial effect on inhibiting copper corrosion. However, based on experimental data, it was found that within the temperature range of 20–90 °C, the concentration of copper ions initially decreased, then increased, and the minimum copper ion concentration was observed at 60 °C.

Corrosion inhibitors are compounds composed of polar and non-polar groups, which act as surface-active substances that are soluble in oil. When a corrosion inhibitor is added to the base oil, it forms an oil solution similar to a colloidal solution, which is an unstable dispersion system. The polar groups containing elements such as oxygen, nitrogen, phosphorus, and sulfur adsorb onto the metal surface.

The synthesized complex additive, which functions as both an octane booster and an inhibitor, was tested on a copper plate according to GOST D 130/IP 154, and changes in the plate's color were observed. This complex additive was applied to gasoline at different concentrations (1, 3, 5, 10, and 15%) to study its effect on increasing the octane number. At the same time, its effect on the copper plate was examined in both inhibitor-added and inhibitor-free conditions. It was proven that using the inhibitor at 0.01% concentration provided optimal results.

Figure 1.



In this image, the effect of the complex octane-boosting additive without an inhibitor on AI-80 gasoline was tested. The observations are as follows:

(a) Without an inhibitor, the copper plate darkened significantly, which, according to GOST D 130/IP 154, is rated as 4b on the scale.

(b) When 0.001% inhibitor was added, the plate turned dark brown, rated as 4a on the scale.

(c) With 0.002% inhibitor, a noticeable color change was observed, rated as 3a on the scale.

(d) When 0.005% inhibitor was applied, the discoloration was significantly reduced, showing slight improvement, and was rated as 2b on the scale.

(e) With 0.01% inhibitor, the best result was achieved, with minimal color change, and it was rated as 1b on the scale according to GOST D 130/IP 154.

Among these results, the best performance was observed at 0.01% inhibitor concentration, which provided the most effective corrosion protection.

References

Ahmedov O., Beknazarov H., Fayziyev J. Oktan soni past bo'lgan to ʻ g ʻ ridan-to ʻ g ʻ ri haydab olingan benzinlarning oktan soni oshiruvchi qoʻshimchalar sintezi va iq-spektri taxlili // Talqin va tadqiqotlar. 2024. – T. 5. – 42 p.

Kapustin V. M. Chemistry and technology of oil refining / V. M. Kapustin, M. G. Rudin. – M.: Chemistry, 2013–495 p.

Wang Z., Liu H., Reitz R. D. Knocking combustion in spark-ignition engines // Progress in Energy and Combustion Science. 2017. – T. 61. – P. 78–112.

Prakash A. et al. Impact of fuel sensitivity (RON-MON) on engine efficiency // SAE International Journal of Fuels and Lubricants. – 2017. – T. 10. – № . 1. – C. 115–125.

Ahmedov O. J., Beknazarov H. S., Fayziyev J. B. Spirtlar asosida oktan sonini oshiruvchi efirlar olish va iq-spektri tahlili // Ministry of higher education, science and innovation of the republic of uzbekistan tashkent state technical university named after ISLAM KARIMOV 4–5 aprel 2024. – Toshkent. – 35 p.

Gureev A. A., Azev V. S. Automobile gasolines, properties and applications. – Moscow: Oil and Gas, 1996. – 444 p.

Ahmedov O.J, Beknazarov H. S., Fayziyev J.B Benzinning oktan sonini oshiruvchi va ingibitor vazifasini bajaruvchi qoʻshimchalar olish hamda ularning mis plastinkasiga ta'sirini oʻrganish // Termez State Pedagogical Institute International Scientific and Technical Conference – February 7–8, 2025, Termez –P. 172–174.

Gustiana Awaludin Sobarsaha, Nuryoto Nuryoto, Jayanudin Jayanudina. Article review: Comparison of octane booster additive for gasoline // Teknika: jurnal sains dan teknologi – Vol. 17. – No. 02. 2021. – P. 150–157.

Sharaf Faruk. A. M. Antiknock additives based on synergistic mixtures of oxygenates to gasoline fuels // Dissertation of candidate of technical sciences. – Kazan. 2018. – 114 p.

Ahmedov O. J., Beknazarov H. S., Fayziyev J. B., Djalilov A. T. Avtomobil benzinini oktan sonini oshiruvchi va ingibitor vazifasini bajaruvchi qoʻshimchalar olish hamda ularning fizik-kimyoviy tadqiqoti // Namangan davlat universiteti-2024-7-son. – 67 p.

Lipin P. V. et al. Joint Cracking of Vacuum Gasoil with Vegetable Oils on Zeolite-Containing Catalysts of Various Compositions // Petroleum Chemistry. 2022. – T. 62. – No. 8. – P. 886–895.

submitted 14.02.2025;
accepted for publication 28.02.2025;
published 28.03.2025

Contact: Ahmedovorif686@gmail.com