

## **PROPERTIES OF FUEL AND LUBRICANTS FOR SOLVING MILITARY- TECHNICAL PROBLEMS**

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**Abstract:** This article analyzes the physicochemical properties of fuels and lubricants used in solving military-technical problems, their stability in extreme conditions, and the influence on the reliability of equipment. Such parameters of fuels and oils used in various types of military vehicles as viscosity, combustion temperature, oxidation resistance, and temperature adaptability are studied by comparison. At the same time, the importance of high-quality fuels and lubricants in increasing energy efficiency, extending the service life, and reducing operating costs in modern troops has been scientifically substantiated. The article also sets out recommendations for innovative fueling and lubrication technologies corresponding to the operating mode of military equipment.

**Keywords.** military equipment, fuels and lubricants, viscosity, combustion temperature, oxidation stability, extreme conditions, lubrication technologies, operational characteristics, reliability, energy efficiency.

Modern high-capacity trucks, high-powered military equipment - tanks, high-performance combines and agricultural machinery, tractors, self-propelled machines with highly forcible internal combustion engines require high-quality fuel, motor, hydraulic and transmission oils, various technical fluids, plastic lubricants, and the like. The main source of obtaining these products is oil. Therefore, it is necessary to use oil and its processed products with utmost justification and economy. The founder of the science of oil is considered to be D. I. Mendeleev.

The operational properties and theory of petroleum products are the main part of the section "Methods of Obtaining Hydrocarbon Fuel and Lubricants," which is an important and relevant topic for the professional training of cadets studying tactical engineering of tank troops at the Higher Tank Command and Engineering School, since only these specialties ensure the reliable and long-term operation of the fleet of automobile and tank military vehicles, reducing the costs of operating automobiles, tanks, and other complex military-technical vehicles with a large number of petroleum products.

This article demonstrates the relationship between changes in the quality and properties of machines, engines, and assemblies and the quality and properties of fuels and lubricants, as well as operational materials, as this relationship is a necessary factor ensuring the reliable and long-term operation of the fleet of automotive and military vehicles.

In modern conditions, fuel and energy savings are very effective and are several times higher than the effect of increasing labor productivity. In this area, our independent homeland, the Republic of Uzbekistan, has found its place among the independent states. The Fergana Oil Refinery was reconstructed. In order to ensure the operation of this plant at full capacity, in addition to oil extracted from the territories of Andijan, Fergana, and Namangan regions, gas

condensates from the Bukhara-Kok Yumaloq oil refinery are transported through the Bukhara-Angren railway, the Angren-Pap mountain highway, and the Pap-Fergana railway, and consumers are fully provided with their processed products in the form of gasoline, diesel fuel, and lubricants.

Since the Mingbulak and Bukhara oil fields of our republic were put into operation and began producing at full capacity, we have gained the opportunity to sell oil products not only to our own needs but also to foreign countries.

Despite the above measures, extensive scientific research is being conducted in our country and abroad to search for other types of energy sources (atomic, solar, wind, river and sea waves, water, etc.) in order to reduce the consumption of petroleum products.

The efficient use of our country's fuel and energy resources is one of the most important issues of the national economy. To solve this problem, it is necessary to know well the characteristics and properties of energy sources used in automobiles and agricultural machines. Knowledge of the optimal processing of lubricants and the timing of their replacement is the key to improving the reliability and durability of machines and mechanisms, as well as their operation.

Fuel is a substance that is deliberately ignited to obtain heat. Not every combustible substance can be fuel. It must meet the following requirements: release as much heat as possible during combustion; be relatively easy to burn and give a high temperature; be abundant and widespread in nature; be available for extraction or suction; be inexpensive to use; retain its properties during transportation and storage. The main thing is that the fuel does not release harmful substances into the environment during combustion.

Substances with an organic origin can meet the above requirements, namely: oil, natural gases, extracted coal, combustible shales, and peat.

All types of fuels are classified by aggregate state as liquid oil (gasoline, kerosene, diesel fuel, fuel oil, alcohol, benzene); gaseous (natural and petroleum gases) and solid (mined coal, fuel shale, peat, and wood).

Tractor fleets, combines, and stationary engines and other equipment operating in motor transport and agriculture are sources of fuel, mainly using liquid and gaseous fuel.

Fuel consists of combustible and non-combustible parts. The combustible part consists of various organic compounds, namely carbon, hydrogen, oxygen, nitrogen, and sulfur.

The non-combustible part consists of mineral wastes, namely ash and moisture. The qualitative characteristic of the elemental composition of the fuel (percentage by weight) is as follows:

Carbon (C) is the main combustible part of fuel, and with its increase, the fuel's heat emission capability increases. Various fuels contain 50...97% carbon;

Hydrogen (H) is a component of fuel that ranks after carbon. It constitutes 25%, but when burned, it releases 4 times more heat than carbon;

Oxygen (O) is a component of fuel, but it does not burn and does not release heat. Therefore, it is considered the internal ballast of the fuel and constitutes 0.5...43%.

Nitrogen (N) is non-combustible, an internal fuel ballast, and constitutes 0.5...1.5%.

Sulfur (S) - burns, does not release much heat, constitutes 0.1...4% in oil. However, even when burning, it forms sulfur dioxide -  $\text{SO}_3$ , turning into a substance that corrodes the surface of gaseous and liquid metals.

Ash (A) is the non-combustible composition of fuel, the amount of which is determined after the complete combustion of the fuel. Fuel with a high ash content has low heat release and low flammability. Therefore, they are difficult to use.

Moisture (W) is considered the most unpleasant composition of fuel, since its evaporation requires a portion of heat. As a result, the combustion temperature of the fuel and the amount of heat released decrease. With increased humidity, especially in winter, the performance of engines and equipment deteriorates, and the corrosion process accelerates.

Based on the physical state of the fuel, its elemental composition is determined, and judgments about the quantity of a particular substance are made based on it. However, this method makes it difficult to objectively analyze fuel. Therefore, in practice, the elemental composition of fuel, i.e., its working, analytical (experimental), dry, combustible, and organic masses, is subjected to recalculation and analysis, i.e.:

1. The organic mass of fuel can be written using the following formula:

$$C_o + H_o + O_o + N_o = 100\%$$

2. The elemental composition of the combustible mass of fuel without ash and moisture is as follows:

$$C_{\bar{e}} + H_{\bar{e}} + O_{\bar{e}} + N_{\bar{e}} + S_{\bar{e}} = 100\%$$

3. In the dry mass of the fuel, the fuel is artificially dried at 105°C, moisture is removed from it, and the elemental composition is written as follows:

$$S_q + N_q + O_q + N_q + S_q + A_q = 100\%$$

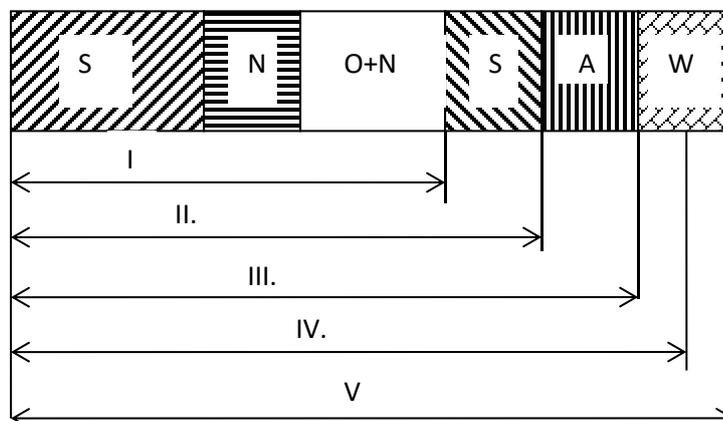
4. If, using a fuel experiment, an analytical (experimental) sample is prepared, after which it is brought to an air-dry state, it is written using the following formula:

$$C_a + H_a + O_a + N_a + S_a + A_a + W_a = 100\%$$

5. If the fuel supplied to the consumer, in addition to the combustible part, contains ash and moisture, it is called working fuel and is written by the following formula.

$$C_u + H_u + O_u + N_u + S_u + A_u + W_u = 100\%$$

The total composition of the fuel, depending on the participation of individual fuel elements, is shown in Fig. 1.



**Figure 1. Total fuel composition:**

*I-organic mass; II - combustible mass; III-dry mass; IV-experimental (analytical) mass;  
V-working mass;*

The combustible part of gaseous fuels consists of hydrogen H<sub>2</sub>, carbon (IV) oxide CO<sub>2</sub>, methane CH<sub>4</sub>, and other hydrocarbons. The main heat-producing component of gaseous fuels is methane and heavy hydrocarbons. The ballast part of gaseous fuels consists of non-combustible gases, namely nitrogen - N<sub>2</sub>, carbon (IV) oxide - CO<sub>2</sub> and sulfur (IV) oxide - SO<sub>2</sub>, oxygen - O<sub>2</sub> and water vapor H<sub>2</sub>O.

- Combustion is the process of chemical combination of a combustible substance and an oxidizing agent. In practice, combustion is the oxidation of fuel with atmospheric oxygen. As a result, a certain amount of thermal energy is released, and the temperature suddenly rises. The combustion process differs greatly from other oxidation processes in that the oxidation rate is so high that the released heat does not even have time to dissipate.

- M.V. Lomonosov was the first to substantiate that the combustion process occurs as a result of the combination of a combustible substance with air.

- Combustion is an extremely complex process, and for complete combustion to occur, the following must be performed:

- the theoretically necessary amount of air for fuel combustion;
- the actual amount of air required for complete combustion of the fuel;
- theoretical combustion temperature;
- Composition of combustible products.

The mentioned units are determined by calculation based on the elemental composition of the fuel. The amount of air theoretically required for the combustion of 1 kg of gas or liquid fuel containing C, N, C, and O is calculated based on the compatibility ratio of the elements of the combustible mass for entering the combustion reaction, i.e.

- carbon combines with oxygen according to the following formula, i.e., 1 kg of carbon requires kg of oxygen to burn.

- hydrogen combines with oxygen according to the following formulas,. Consequently, 32 kg of oxygen are required for the combustion of 4 kg of hydrogen, or - kg of oxygen is required for 1 kg of hydrogen.

- sulfur combines with oxygen according to the following formula, that is, 1 kg of sulfur requires kg of oxygen.

Therefore, the oxygen required for the complete combustion of 1 kg of fuel of the above composition  $O_x$  (kg) is determined as follows.

$$O_x = \frac{2,67 c + 8H + S - O}{100}.$$

In this case, the amount of oxygen in the fuel is consumed during combustion. In reality, when burning fuel, it is not pure oxygen that is supplied, but air, which contains only 23.2% of the mass of oxygen. Then the amount of air required for the complete combustion of 1 kg of fuel  $L_{HX}$  (kg) is found using the following equation:

$$L_{HX} = \frac{2,67 c + 8H + S - O}{23,2}.$$

If air is taken in volume units, then the equation is divided by the air density (1.293), that is:

$$L_{HX} = \frac{2,67c + 8H + S - O}{23.2 \cdot 1.293} = \frac{2.67c + 8H + S - O}{30}.$$

The theoretical amount of air required for the complete combustion of gaseous fuel ( $m^3$ ) can be determined based on a predetermined equation, i.e.,:

$$L_{HX} = \frac{0.5(CO + H_2) + (n + \frac{m}{4})C_nH_n - O_2}{21}.$$

Here, n is the number of carbon atoms, m is the number of hydrogen atoms, and 21 is the volume composition of oxygen in the air, %.

However, in practice, it is impossible to achieve complete combustion of fuel using the theoretical required amount of air. Therefore, more air than the theoretical amount is supplied to the engine and other devices, which is called the actual amount of air.

The actual amount of air is expressed through the excess air coefficient.

$$L_{XX} = \beta L_{HX}.$$

-permissible mixture; -poor mixture; -rich mixture.

This coefficient is equal to the ratio of the actual air consumed for fuel combustion ( $L_{XX}$ ) to its theoretical amount ( $L_{HX}$ ), and its value depends on the type of fuel, ignition conditions, engine design, and combustion chamber, for example:

for gas fuel - 1.05...1.20;

gasoline-0.90...1.15;

diesel fuel -1.20...1.40.

A decrease in this coefficient leads to an increase in fuel consumption, i.e., incomplete combustion of fuel. Its increase leads to a poor combustion process, since extra heat is required to heat excess air, resulting in a decrease in combustion temperature.

Thus, based on the above theoretical data, determining the prospects for improving the supply of troops in the armed forces system using local capabilities, that is, modern approaches aimed at obtaining and producing raw materials based on local capabilities, the use of modern scientific achievements in improving the supply of troops, the integration of natural and special disciplines into the educational process in higher military educational institutions, requires consideration. Because in battle, having knowledge of the factors and information ensuring the success of the combat operation, based on logical-analytical, intellectual capabilities, creative thinking, an analytical approach to knowledge about the quantity and quality of military equipment belonging to the military unit, its components, the principle of system operation, and the ability to quickly resolve malfunctions and various issues of the military sphere, such as weapons, ammunition, fuel, and material supply reserves.

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