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COMPARISON OF PHYSICAL AND CHEMICAL CHARACTERISTICS OF MOTOR OILS

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Motor oils are petroleum derivatives used in lubrication systems of internal combustion engines in order to reduce their wear by formation of the durable oil film on the surface of rubbing items [1]. Motor oils are widely used for gasoline, diesel, two-stroke engines, and mechanical gearboxes. It is impossible to do without the use of these oils, as they provide engine protection and reduce the risk of combustion deposit.

Determining the physical and chemical characteristics of motor oils is a significant task, as the engine's stability under different conditions depends on them. These characteristics not only reveal the potential of motor oils but also provide the consumers with the ability to choose the most optimal oil for their engine, considering climatic and operational factors.

Hence, the aim of the research is to determine and compare the physical and chemical characteristics of samples of different motor oils.

As the subject of the study, 8 samples of commercial motor oils of various brands and markings were chosen. Synthetic and semi-synthetic oils for cold climate conditions were used, labeled as 0W-30 (O1 and O3), 0W-40 (O2), 5W-50 (O5), and 10W-40 (O6), 5W-40 (O8) respectively. Furthermore, mineral oil MOTO 2T (O4) and transmission oil 80W-85 (O7) were included in the study. These oils differ in origin: synthetic oils are produced by synthesis, mineral oils are derived from petroleum refining, semi-synthetic oils are mineral oils enhanced with synthetic additives, and the transmission oil is thickened low-viscosity oil with high polymer additives [1].

Such characteristics of motor oils as cloud point (CP), pour point (PP), mass fraction of sulfur, density, as well as kinematic and dynamic viscosity were determined. The obtained data is presented in the Tables 1 and 2.

According to Table 1, we can see that:

- O5 sample has the lowest cloud point (CP), while O1 sample has the highest one;
- O2 and O3 samples have the lowest freezing point (PP), while O4 sample has the highest one.

Based on Table 2, it can be observed that:

- the highest mass fraction of sulfur is exhibited by O7 and O4 samples (transmission and mineral oils), while O2 sample has the lowest one;
- O7 sample has the highest density, while O1 sample has the lowest one;
- O7 sample has the highest kinematic and dynamic viscosity, while O1 sample has the lowest one.

The density values of all samples do not exceed 890–905 kg/m^3 and comply with the requirements presented in [2]. The FP values do not exceed –25 °C and also meet the requirements presented in [2].

Table 1. Low-temperature properties of motor oils

Characteristic	O1	O2	O3	O4	O5	O6	O7	O8
CP	–14	–28	–28	–13	–30	–16	–19	–18
PP	–42	–50	–50	–26	–43	–37	–31	–36

Table 2. Physicochemical characteristics

Characteristic	O1	O2	O3	O4	O5	O6	O7	O8
Mass fraction of sulfur, mg/kg	1993	1966	2030	5851	2156	2104	6723	2930
Density at 20 °C, kg/m^3	838,3	837,9	838,9	878,6	846,1	864,4	879,2	854,3
Kinematic viscosity at 20 °C, mm^2/s	118,8	184,8	174,6	234,8	273,1	281,8	396,4	235,9
Dynamic viscosity at 20 °C, Pa/s	99,6	154,9	146,5	206,3	231,0	243,6	348,5	201,6

References

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CRYSTALLOGRAPHIC INSIGHTS INTO HYDROTHERMALLY SYNTHESIZED TETRAGONAL BARIUM TITANATE NANOPARTICLES

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The escalating demand for high-performance piezoelectric perovskite materials, integrated into several technologies as sensors, actuators, ultrasonic devices, and thermal imaging, promotes researchers worldwide to optimize efficiency and explore eco-friendly alternatives to lead-based perovskites, addressing this growing demand for piezoelectrics. Therefore, barium titanate (BT, $BaTiO_3$) has emerged as a promising solution due to its dielectric properties and biocompatibility [1]. Herein, our work employs X-ray diffraction (XRD) on hydrothermally synthesized BT nanoparticles to investigate its crystal structure and piezoelectric properties. The focus is on understanding how geometric features influence the BT performance after hydrothermal synthesis under elevated temperature and pressure, contributing new insights to the existing body of knowledge in this field.

BT nanoparticles were synthesized through a hydrothermal process using barium hydroxide octahydrate and titanium dioxide, then XRD analysis to identify phase composition and crystal structure.

Fig. 1 shows that the XRD pattern was agreed well with the reference card (COD, No. 1507756, $BaTiO_3$), indicating a pure phase without impurities. The observed peak shoulder around $2\theta = 45°$ confirmed the tetragonal crystal structure. Analysis of lattice parameters (a = 3.9979, b = 3.9979, c = 4.0228 A) was done. Furthermore, crystallite size = 67.356 nm, and lattice strain = 0.00215 were determined.

In Fig. 2, the simulation model of refining crystallographic data results revealed a contrast in geometric symmetry between normal and distorted tetragonal barium titanate. It might be the impact of emergent oxygen vacancies in the crystal lattice during hydrothermal synthesis under elevated tem-