Practical Lesson 6

INVESTIGATION OF THE OPERATING PROPERTIES OF LUBRICATING MATERIALS USED IN TRANSPORT VEHICLES

The main objective of this practical work is to study and evaluate the main operating properties of lubricating materials used in transport vehicles.Students will develop skills in assessing the technical condition of lubricating oils by determining parameters such as viscosity, density, level of contamination, color and appearance, as well as changes under temperature influence.Lubricating materials are used in engines, transmissions, and other friction units of transport vehicles to perform several important functions:

- reducing friction,
- preventing wear,
- cooling mechanical components,
- protecting surfaces from corrosion and damage.

The operational performance of lubricating oils directly depends on their physicochemical properties, which may change during the operation process.

The main operating properties include:

- viscosity (dynamic and kinematic),
- density,
- color and external appearance,
- mechanical impurities (contamination level),
- temperature resistance.

Procedure for Determining Viscosity

1. The lower expanded part of the viscometer is filled with oil and placed into a thermostat so that the oil reaches the required temperature (Fig. 1). The sample is kept in the thermostat for 15 minutes.

The experiment is conducted at three temperature levels: 20 °C, 40 °C and 100 °C.

2. Using vacuum, the oil is drawn from the lower part of the instrument into the first spherical chamber.
   The time required for the oil to flow from mark (a) to mark (b) is measured using a stopwatch.

   To obtain more accurate results, the measurement is repeated three times and the average time value is calculated.

The kinematic viscosity is determined using the following formula:

$$\nu = \tau \cdot c_t$$

Here:

- τ (tau) – the average flow time of the liquid;
- C_t – the instrument constant, the value of which is indicated in the instrument passport (technical specification).

Figure 1. TV12LT Low Temperature Viscosity Bath (low-temperature thermostatic bath)

Typically, to determine the dependence of viscosity on temperature, it is calculated using formula (3) at three temperature levels: 20 °C, 40 °C and 100 °C and the obtained results are recorded in Table 1.

Oil temperature, °C	Average flow time, s (seconds)	Viscometer constant coefficient, Ct	Kinematic viscosity of the oil, mm²/s
20			
40			
100			

Table 1

Procedure for Determining Fuel Density

The density of diesel fuel ranges from 0.78 to 0.86 g/cm³ and the heat released during combustion is approximately 42.5 MJ/kg. The density of diesel fuel is determined in laboratory conditions using a hydrometer (areometer). The density measured at room temperature is converted to the standard temperature of 20 °C (reference density) using formula (1) for comparison purposes.

$$\boxed{\rho^{20} = \rho^{t} + \gamma(t-20)} \qquad (1)$$

ρ^{20} -density corrected to 20°C

ρ^{t} - density measured at temperature t°C

γ — temperature correction coefficient for density

t — actual measurement temperature in °C

The density of diesel fuel affects the combustion process. The higher the density of diesel fuel, the poorer the atomization of the fuel under the influence of the air flow (the fuel droplets become larger) and the evaporation process becomes less efficient. As a result, it becomes difficult to obtain the required combustible mixture composition, which may lead to incomplete combustion of the fuel.

TV12LT Low Temperature Viscosity Bath (low-temperature thermostatic bath)

Procedure for Determining Fuel Density

1. The fuel sample to be tested is carefully poured into a glass cylinder.
2. A clean and dry hydrometer (areometer) is slowly immersed into the liquid.
3. The temperature of the fuel whose density is being determined is measured. The reading of the hydrometer at the point where it touches the liquid surface is taken as the density at that temperature.
4. After the density is determined at room temperature using the hydrometer method, it is converted to the standard temperature of 20 °C (reference temperature) using formula (1).

Diesel fuel grade	Hydrometer reading, ρ□ (g/cm^3)	Temperature of diesel fuel, °C	Temperature correction factor, γ	Density of diesel fuel at 20 °C, ρ_{20} (g/cm^3)

Importance of Motor Oil Color

The color of motor oil is a visual indicator of its chemical composition, the presence of additives, and the changes that occur during operation.

1.1. Color of New Motor Oil

New motor oils usually have the following characteristics:

- Light yellow,
- Golden color,
- Bright and transparent appearance.

This condition indicates that the oil does not contain oxidation products or mechanical impurities.

1.2. Color of Used Motor Oil

During operation, the oil gradually changes its color to:

- Dark brown,
- Blackish,
- Black.

This process is considered normal, because the oil accumulates combustion products, metal wear particles, and carbon residues. However, excessively rapid darkening of the oil may indicate a malfunction in the engine.

2. Evaluation of Motor Oil Based on Its Appearance

The appearance of the oil is evaluated by determining its transparency, uniformity, and the presence of foreign impurities.

2.1. Transparency

- Transparent and homogeneous oil – indicates good quality and normal condition.
- Cloudy or turbid oil – indicates the presence of water, fuel, or mechanical impurities.

2.2. Foaming

If foam appears on the surface of the oil, it may indicate:

- malfunction or depletion of anti-foam additives,
- air entering the engine lubrication system.

2.3. Sediment and Layer Separation

- Sediment at the bottom – indicates the presence of dust, metal particles, and carbon residues.
- Layer separation – indicates contamination with water or fuel.