Assessment of the service properties of commodity motor oils by hydrogen indicator

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Abstract. Basic oils produced from oil or obtained by the synthesis of monomers are generally chemically neutral. To improve the service properties of base motor oils, additive packages and active ingredients are introduced into it. The presence of anti-seize, anti-wear, and dispersing-stabilizing additives in a composition of commercial oil of a certain concentration of compounds of alkali metal salts changes its chemical activity [1]. Based on this, as a measure of service properties (anti-seize, anti-wear and dispersion-stabilizing properties (DSP)) of commercial motor oils can be used hydrogen indicator - pH.

In the work, as an invariant estimate of the concentration of resource additives and service properties of commercial motor oils, the use of pH is considered. Correlation dependences of pH on BSP and viscosity of the studied motor oil are given.

1Introduction. The quality of fresh commercial motor oil (quality, performance of oil) is characterized by properties that determine its suitability for a particular internal combustion engine [1]. The set of qualities of motor oil is characterized by operational and service properties.

The performance features of fresh commercial motor oil characterize the ability of the oil to work under various conditions and operating models of the internal combustion engine [1-3].

The operational properties of fresh commercial motor oil include:
- physical and chemical properties of the base oil;
- indicators of the composition of the base oil;
- viscous properties;
- antioxidant properties;
- antifoam properties;
- anticorrosion properties.

The operational properties of fresh commercial motor oil are formed, set and strictly standardized by the developer and the manufacturer. Basically, these properties are controlled by the manufacturer on the basis of laboratory chemical research and do not change during the operation of motor oil.

Service properties of fresh commercial motor oil are properties that determine the working capacity (resource) of both the oil itself and the durability of tribomechanical systems of an internal combustion engine [1,2].

The service properties of fresh commercial motor oil include:
- dispersing - stabilizing properties;
- extreme pressure and antiwear properties;
- antifriction properties;
- washing properties.

Service properties are formed by a specific additive package, as a rule, such packages are low-resource, that is, after their exhaustion, the engine oil must be replaced. Based on the foregoing, the stability of the properties of engine oil and the long-term trouble-free operation of an internal combustion engine should be ensured by a package of additives related to service properties.

To reduce and prevent the formation of carbon deposits, special surfactants called detergents are introduced into motor oils. Among them are ash-less compounds, in particular succinimides. It should be noted that the term “detergents” is, to a certain extent, conditional, since these additives mainly prevent the formation of deposits on heated surfaces, and do not have a washing effect in the literal sense of the term.

The detergent action of additives, in itself, does not ensure the effective operation of the oil, since the products formed have low stability and gradually precipitate, increasing the contamination of engine components and parts. On this basis, the control of detergents does not require consideration.

In this regard, from the energy point of view, the processes occurring at the interface between the dispersing-stabilizing additives and the solid phase between molecules are of great importance [3,4].

Based on this, a hydrogen pH value can be used as an indicator of service properties (by anti-seize, anti-wear, and dispersion-stabilizing properties) of commercial motor oils [1,2]. Accounting for pH in this case allows us to ensure the invariance of the assessment of the concentration of resource additives.

2 Materials and methods. Synthetic and mineral commodity motor oils with service properties according to API SM, SN, SN / CF with viscosity according to SAE 5W30, 5W40, 10W40 were used as the test material.

Actual pH values for each oil sample were measured with a WTW-315i / Set analytical pH meter equipped with a special SenTix electrode for measuring pH in fatty environments with an accuracy of 0.001 pH.

Before measurement, the instrument was calibrated with a buffer solution with a pH value of 7.0.

The pH was measured at a constant controlled temperature close to the calibration temperature of the device, for which the oil samples were thermostatic until the temperature of each of them became constant and equal to the ambient temperature. The control was a sample with a minimum temperature. A thermometer was placed in a container with a control sample, according to the readings of which they monitored the achievement of a given temperature.

The sample temperature was not controlled since the pH meter is equipped with a temperature compensator.

Before the measurement, the electrodes were thoroughly rinsed with a buffer solution, removing the remnants of the previous oil sample, blotted with filter paper, lowered into the analyzed sample and after 1 - 3 minutes. (after establishing a constant value) recorded the readings of the device. The measurement was performed at least two times, repeated measurement after 1 min.

Between measurements, the electrodes were left in a buffer solution.

The pH value was taken as readings from the instrument panel. The measurement result is the arithmetic average of two results of parallel measurements.

Assessment of the activity of the DSP additive included the introduction of an oil of 3.5 ml ashless pollutant in a volume of 2.1 ml into the test sample (distilled water was used as the pollutant) and active mixing of the sample for 0.5 min. Then, by the color, height of the sediment, and the volume of precipitated water, the actual activity of the DSP was evaluated [4].

Evaluation of extreme pressure and anti-wear properties was carried out on a MAST - 1 machine according to a standard procedure [1].

3 Results and discussion. Figure 1 shows the correlation curves obtained by comparing the results of measuring the pH and DSP.
Analysis of the graphs indicates that the evaluation of the DSP of a commodity is small cannot be carried out by the hydrogen indicator, since the correlation is negligible. Therefore, the use of an ash-less pollution may be the main means of assessing DSP.

Studies have shown that the average DSP value for API SM SAE 5W40 oils is 6.3 points, API SN SAE 5W40 is 8.2 points, API SN / CF SAE 5W30 is 9.6 points. Based on this, it should be considered that the engine oil resource depends on the activity of the DSP. In addition, the DSP score allows you to compare the performance characteristics of oils in accordance with their classification by groups of operational properties.

Figure 2 shows the pair correlation between the hydrogen index and the friction moment.
On the contrary, the use of a hydrogen index in assessing extreme pressure and antiwear properties is acceptable, since a close correlation between the friction moment and the hydrogen index is found.

The analysis of the graphs in Figure 2 shows that the average value of the friction moment for API SM SAE 5W40 oils is $27 \cdot 10^{-3} N \cdot m$, for API SN SAE 5W40 it is $12.7 \cdot 10^{-3} N \cdot m$, for API SN / CF SAE 5W30 - $6.6 \cdot 10^{-3} N \cdot m$. In addition, the graphs (Figure 2) provide an indicative assessment of operational properties by the content of extreme pressure and antiwear additives in terms of pH for the choice of motor oil for trouble-free operation of an internal combustion engine.

4 Conclusions.
1. Measuring instruments and a method for studying the service properties of commercial motor oils according to the DSP and the pH value are proposed;
2. Based on experimental studies, it was found that the average DSP value for fresh marketable oils API SM SAE 5W40 is 6.3 points, API SN SAE 5W40 8.2 points, API SN / CF SAE 5W30 9.6 points;
3. A ballistic assessment of the DSP allows you to compare the performance characteristics of the oils in accordance with their classification by groups of operational properties;
4. The extreme pressure and anti-wear properties of commercial motor oils can be estimated by the pH indicator, since a close correlation between the friction moment and the hydrogen index is found.

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