THE NEW GENERATION OF OILS FOR THE HYDRAULIC SYSTEMS OF INDUSTRIAL EQUIPMENT

L. A. Radchenko and A. A. Chesnokov

The state of industrial oil production in 2001 is examined. The characteristics of modern series I-G-S(d) hydraulic oils with improved filterability and the conditions required for their production are reported.

Industrial oils for lubrication of various industrial equipment are manufactured with and without additives as a function of their service properties. Of the industrial oils manufactured in Russia in 2001, 650,000 tons, 87% were lube oils with no additives and only 13% were oils with additives that improve their antioxidant properties and ensure the required level of lubricating, anticorrosion, antifoam, demulsifying, and other properties. The volume of oils with additives is clearly insufficient, and industry continues to use oils with no additives, which decreases the reliability of operation of the equipment and reduces the time between oil changes.

Most industrial oils with additives are series IGP oils, and more than 80% of them are IGP-18, IGP-30, and IGP-38 oils used in the hydraulic systems of industrial equipment (metal-working machines, presses, automated lines, hydraulic drills, coal combines, etc.) for transmitting energy from one unit or aggregate to another and for converting this energy into usable work.

Production of these oils was organized approximately 30 years ago, during construction of AvtoVAZ, and they were intended for servicing of industrial equipment purchased abroad. All of the large refineries in Russia now manufacture these oils, and production volume was approximately 70,000 tons in 2001.

Due to extensive automation of production processes, the designs of hydraulic systems, especially control devices, have become more complicated, they are equipped with electrohydrodynamic valves, and the operating regimes have been intensified. All of this has led to stiffening of the requirements for the quality of lube oils, especially the antioxidant stability and purity.

The performance properties of series IGP oils do not satisfy the higher requirements for hydraulic oils for modern high-precision equipment with fine (pore diameter of 5-10 mm) filters for re-equipping such large industrial enterprises as AvtoVAZ, Uralmaszavody, Magnitogorsk Metallurgical Combine, etc.

The antioxidant, thermal, and colloidal stability of series IGP hydraulic oils decreases with an increase in the operating temperature. The products of oxidation of the oils and decomposition of additives are deposited on the surfaces of friction couples and especially in the by-pass openings of valves, which makes operation of control devices more difficult or leads to their failure in time. In addition, fine filters are clogged by these substances.

Filterability is one of the most important performance properties of hydraulic oils. It was found that over 80% of all breakdowns in hydraulic systems is caused by contamination of oils during production (with dust, rust, fibers, etc.) and as a result of aging during use.

Based on domestic and foreign experience in using them, fresh hydraulic oils should be characterized by purity class 7-8. Series IGP oils are in class 15-16 in the best case; according to our data, they are basically classless. For this reason, filters with 10-20 mm pore diameters must be used, especially the ultrafine filters installed in modern precision equipment.
The problems related to the filterability of series IGP oil arise in many enterprises that operate equipment with fine filters. As our studies with Pall Co. showed, after filtration of IGP oils, sediment containing additives added to the oil, in addition to particulate contaminants, remained on the filters. This happens because the additive production technology and composition in series IGP oils, developed more than 30 years ago, does not make it possible to filter these oils through pores 15 mm and less in diameter.

In addition, water invasion of series IGP oils due to high humidity, accidental entry of water or cutting fluids (CF) leads to pathological worsening of the filterability. Cases have been observed where operation of fine filters totally stopped when water entered, even in a very small quantity (less than 0.03 wt. %) due to clogging by drops of water. For this reason, series IGP oils are not recommended for use in equipment with fine filters.

The following problems must be solved to ensure dependable operation of modern hydraulic systems:

Π% oils must be created that keep hydraulic systems clean and prevent accumulation of contaminant particles formed as a result of oxidation of the oil, wear of the equipment, and decomposition of additives;

Π% purity class 7-8 commercial hydraulic oil must be supplied and must be filterable through ultrafine filters (3-5 mm).

The new generation of I-G-S(d) hydraulic oils contain a special additive that prevents the harmful effect of small amounts of water on filterability. In addition, this additive creates solubilizing, dispersing, and detergent effects that make it possible to eliminate direct contact of the water with the metal in the equipment and to keep insoluble components suspended (they do not stick to the surface of the filters and other parts of hydraulic systems).

The improved filterability (purity class 7-8) of fresh series I-G-S(d) oils is due to the use of two-stage filtration (coarse and fine). The “filterability coefficient,” which should be no greater than 1.1, was introduced in the standards documentation for the first time for controlling the purity of oils.

In developing this series of oils, special attention was focused on additives that improve the lubricating and anticorrosion properties, since problems with the hydrolytic and thermal stability of effective additives of the zinc dialkylthiodiposphate type arise in oils invaded by water. The products of oxidation and composition of these additives are deposited on the parts of the hydraulic system, causing corrosion of nonferrous metals and their alloys.

A balanced additive composition that simultaneously gives the oils higher antiwear properties than in IGP oils was selected to eliminate the negative effect of zinc dialkylthiodiprophosphate on nonferrous metals.

The antiwear properties of the oils were assessed both on a four-ball friction machine (FM) and on a bench that simulates the hydraulic system of heavy machines and flexible production modules using friction pairs made of materials for control machines: rhenium Fluoron FChK15M5- SCh 20 cast iron and nonferrous alloy TsAMS 10-5-0.3-SCh 20 cast iron.

The studies were conducted at a pressure of 0.5 MPa and sliding speed of 0.2 m/sec. The results of the tests (Table 1) showed that series I-G-S(d) oils have better tribotechnical properties than IGP-18 oil. The friction coefficient in I-G-S-32(d) oil is 1.5 times lower than in IGP-18 oil.

Table 1

<table>
<thead>
<tr>
<th>Friction pair</th>
<th>Wear $l_h$ during running in, mm</th>
<th>Intensity $l$ of wear, $10^{-11}$ mm/km</th>
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<tbody>
<tr>
<td></td>
<td>FChK15M5</td>
<td>TsAMS10-5-0.3</td>
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<tr>
<td><strong>With I-G-S-32(d) oil</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FChK15M5 – SCh-20</td>
<td>2</td>
<td>–</td>
</tr>
<tr>
<td>TsAMS 10-5-0.3 – SCh-20</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td><strong>With IGP-18 oil</strong></td>
<td></td>
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</tr>
<tr>
<td>FChK15M5 – SCh-20</td>
<td>10</td>
<td>–</td>
</tr>
<tr>
<td>TsAMS 10-5-0.3 – SCh-20</td>
<td>–</td>
<td>4</td>
</tr>
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