2. A. P. Alekseev, G. F. Bol'shakov, and G. A. Safonov, in: Chemmotology — Theory and Practice of Rational Utilization of Fuels and Lubricants in Vehicles and Equipment [in Russian], MDNTP im. F. É. Dzerzhinskii, Moscow (1988), pp. 66-70.
3. A. A. Strepikheev, V. A. Derevitskaya, and G. L. Slonimskii, Principles of Chemistry of Macromolecular Compounds, 2nd edn. [in Russian], Khimiya, Moscow (1967), p. 377.

INFLUENCE OF ESTERS ON PHYSICOCHEMICAL PROPERTIES OF

SOLVENT-TREATED LUBE OILS

T. N. Peryshkina and V. V. Grigor'ev   UDC 547.2:665.765-404:543

Blends of synthetic fluids and petroleum oils are often used for the lubrication of industrial equipment. The is done not only because of the high cost of the synthetic fluids, but also because of recommendations for the improvement of certain characteristics of synthetic fluids by the addition of petroleum oils. The work reported here was aimed at studying the properties of blends of petroleum oils and esters as the base stocks for oils used to impregnate sintered plain bearings in instruments with low-power drives.
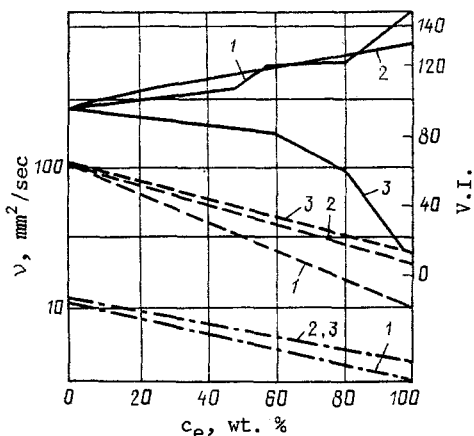

Fig. 1. Viscosity ν at 100°C (dot-and-dash curves) and at 40°C (dashed curves) and viscosity index V.I. (continuous curves) of blends of VI-70 oil with ester, as functions of ester content c_e: 1) DOS; 2) PE-2; 3) DOP.

TABLE 1

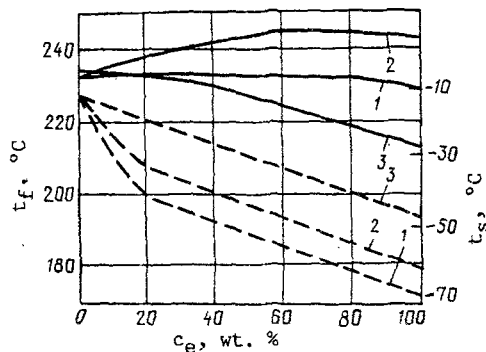| Index	VI-70 oil	Ester		
		PE-2	DOS	DOP
Viscosity, mm²/sec				
at 40°C	14,6	22,3	11,6	25,9
at 100°C	12,1	4,42	3,2	4,1
Viscosity index	95	132	149	10
Density at 20 C, kg/m³	921	987	911	982
Temperature, °C				
flash point (open cup)	234	248	230	215
solid point	—12	—60	—70	—50
Carbon residue, %	0,16	0,092	0,038	—
Refractive index n_D^{20}	1,486	1,454	1,450	1,487
Volatility (120°C, 96 h), %	12,1	9,2	22,4	—
Molecular weight	493	636	426	390

Fig. 2. Flash point t_f (continuous curves) and solid point t_s (dashed curves) of blends of VI-70 oil with ester, as functions of ester content c_e: 1) DOS; 2) PE-2; 3) DOP.
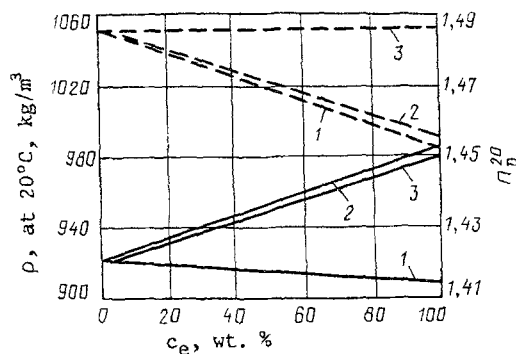

Fig. 3. Density ρ (continuous curves) and refractive index n_D^{20} (dashed curves) of blends of VI-70 oil with ester, as functions of ester content c_e: 1) DOS; 2) PE-2; 3) DOP.
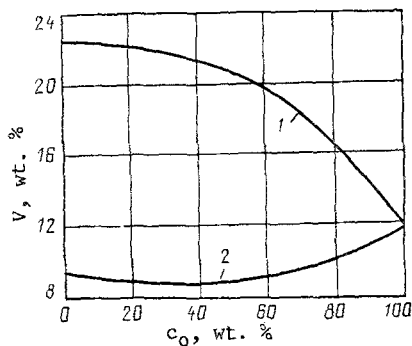

Fig. 4. Volatility V (96 h at 120°C) of blends of VI-70 oil with DOS (1) or PE-2 (2), as functions of oil content c_o.

Such oils must have the optimum level of viscosity (7-10 mm²/sec at a working temperature of approximately 100°C), good viscosity-temperature properties (viscosity index 100 minimum), a low solid point (−20°C to −40°C), low volatility, low carbon residue, and a high flash point (210°C minimum). For our investigation we selected the petroleum oil VI-70, which is produced by severe solvent treatment, and esters of polybasic acids and aliphatic alcohols that are the most widely used as lube base stocks: tetraester of pentaerythritol and C_5–C_9 synthetic fatty acids (PE-2) and diesters of 2-ethylhexyl alcohol and sebacic or o-phthalic acid − dioctyl sebacate (DOS) and dioctyl phthalate (DOP), respectively.

The physicochemical characteristics of these mineral and synthetic components are listed in Table 1. The esters PE-2 and DOS, in comparison with the straight petroleum oil, have better viscosity-temperature properties, lower solid point, and lower carbon residue. The low volatility of the PE-2 ester can be attributed to its higher molecular weight. One deficiency of these particular esters is their low viscosity at 100°C (3.2-4.42 mm^2/sec). The dioctyl phthalate is also poor in viscosity-temperature properties (viscosity index 10).

The flash point of the blends (Fig. 2) increases as more of the high-boiling component PE-2 is added to the petroleum oil, but decreases when the low-boiling DOP is added. For the VI-70, DOS, and blends of the two, the flash points are all very similar. The addition of the esters to the petroleum oil gives much lower solid points, with the effect being greater for the DOS and PE-2 (solid points lower) than when adding the DOP.

The density and refractive index of the blends are additive quantities (Fig. 3). In Fig. 4 we have plotted the volatility as a function of composition for blends of VI-70 with PE-2 or DOS. When the content of DOS — the more volatile component — is increased in the blend, the volatility is increased sharply. For the blends of VI-70 and PE-2 up to a 50:50 ratio, the volatility remains essentially constant.

Thus, on the basis of the set of physicochemical characteristics that have been determined, we can recommend as the base stocks in formulating oils for use in sintered plain bearings certain blends of VI-70 oil with the PE-2 ester, in 80:20 and 60:40 ratios (with respective 100°C viscosities of 10 and 7 mm^2/sec). These blends have been used as the basis of development of oils for household equipment, designated MBT-9 and MBT-7.