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WASTES FROM MAKING PLANT OILS AS FEEDSTOCK FOR ENGINEERING LUBRICANTS

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Wastes from producing plant oils attained 5-15% of the volumes of the pure oil. In general, they constitute mixtures of plant oils enriched in fatty substances and distilled fatty acids. These wastes are dark in color and have an unpleasant smell and as regards taste cannot be used as food products for people and animals.

An effective method of utilizing these wastes is for technical purposes, in particular making lubricants. We have examined the basic physicochemical properties of the wastes formed in producing sunflower oil. Table 1 gives the results.

These wastes are dark-brown liquids of high acid number and with a specific odor. However, their viscosities, thermal oxidation stability, and lubricating properties are much better than those of sunflower oil, which provide certain advantages for their use as bases of transmission and hydraulic oils, and also plastic lubricants particularly intended for engineering, use in agriculture, forestry, and woodworking.

Importance attaches to the ecological aspect of making and using lubricants based on wastes from plant oils, for which purpose we have examined the biological decomposition of products from purifying plant oils made by pressing and centrifugation. Laboratory studies have been done on tap water polluted by mineral oils,

Table 1

Indexes	Sunflower oil	Wastes from sunflower oil production
Viscosity at 100°C, mm^2/sec	7.7	11.5
Flash point (open cup), °C	320	340
Solid point, °C	–16	–7
Acid number, mg KOH/g	2	22
Density at 20°C, kg/m^3	925	950
Color, CNT units	3	6
Wear spot diameter (on tester), mm	0.26	0.23
Thermal oxidation stability at 250°C	20	25
Iodine number, gI_2/100 g	130	150
Saponification number, mg KOH/g	190	200

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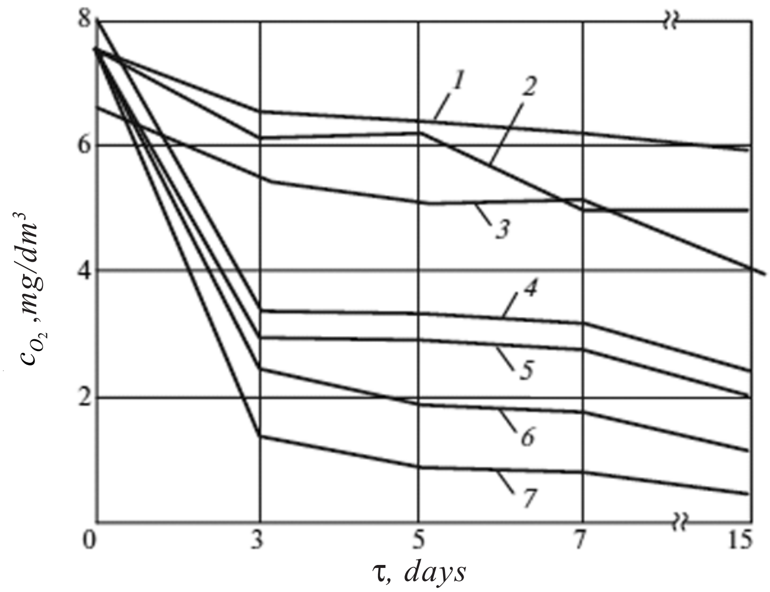

Fig. 1. Dependence on time τ of the dissolved oxygen content c_{O_2} in water contaminated by oils and products from their processing: 1) I-12; 2) M10-G_2k; 3) sunflower oil; 4) products from the processing of wastes in the production of sunflower oil; 5) polymerized rapeseed oil; 6) oxidized rapeseed oil; 7) sediment from rapeseed oil.

plant oils, and production wastes, and also by the products from the oxidation and polymerization of the latter, which have shown that plant oils as regards biological decomposition are much more active than mineral oils not only without additives (I-12) but also with them (M10-G_2k).

We have determined the biochemical oxygen demand (Fig. 1) in water polluted by those oils, which has shown that even after three days of storage, water containing small amounts of plant oils, wastes, and processing products show considerable reductions in the dissolved oxygen concentrations, which shows that there are vigorous biological decomposition processes in these media.

The data are quite well correlated with the rapid biological decomposition of plant oils when these escape into the soil or water resources. The decomposition in water of I-12 and M10-G_2k mineral oils is much slower: at 20C, the biochemical oxygen demand in these polluted waters is activated in not less than 15-30 days (water polluted with plant oils shows activation within 2-3 days).

The technologies are identical for making plant oils from various oil seeds. The wastes from the production of maize, flax, rapeseed, and other oils are comparable in physicochemical properties with the wastes from producing sunflower oil and can be used in making engineering lubricants.

Viscous products are formed by heating the wastes from the production of sunflower and rapeseed oils with access of air for several hours at 300°C. They can serve as viscous and antiwear additives, and also as bases for making plastic lubricants and analogs of transmission oils. Table 2 gives the physicochemical characteristics of products from the oxidation and polymerization at 300°C over 0-8 h for wastes formed in the production of sunflower and rapeseed oils.

The wastes from the production of sunflower and rapeseed oils on heating to 300°C with access of air within 2 h are transformed into high-viscosity products, which are compatible with mineral oils and plant oils and can raise their viscosities and improve the lubricating capacity. For example, if I-20 industrial oil is treated

Table 2

Indexes	Products from the oxidation and polymerization of wastes from production of oils					
	sunflower			rapeseed		
	0 h	2 h	8 h	0 h	2 h	8 h
Viscosity at 100°C, mm^2/sec	11,5	17	28,4	11,8	2,02	50,2
Acid number, mg KOH/g;	22	23	24	36	37,1	38,8
Solid point, °C	–7	–7	–5	–5	–4	–2
Wear spot diameter (on tester), mm	0,23	0,22	0,22	0,24	0,23	0,21

Table 3

Indexes	Oil I-20A	
	without additives	with the addition of 3% of the product from oxidation and polymerization of sunflower oil
Viscosity at 40°C, mm^2/sec	31	35
Flash point (open cup), °C	200	205
Solid point, °C	–15	–14
Acid number, mg KOH/g	0.03	0.1
Wear spot diameter (on friction tester), mm	0.32	0.26
Color, CNT units	2	3.5

Table 4

Indexes	Plastic product from the oxidation and polymerization at 300°C of wastes in the production of rapeseed oil			Solidol
	0 h	8 h	10 h	
Viscosity at 40°C, mm^2/sec	11.8	60.2	70.1	83.4
Acid number, mg KOH/g	36	40	41	2.8
Flash point (open cup), °C	–5	–2	+10	+25
Dropping point, °C	–	–	80–90	85–105
Wear spot diameter (on tester), mm	0.24	0.21	0.21	0.21

with 3% of the product from the oxidation and polymerization of sunflower oil (fraction obtained after 8 h), one gets a slight increase in viscosity, but also a substantial (about 20%) improvement in the lubricating capacity of that oil as estimated from the diameter of the wear spot with a four-ball friction tester (Table 3).

It may be that these products from processing wastes may be applicable as ecologically clean viscous and antiwear additives to mineral and synthetic oils. The products from processing with lower viscosity (from 15 to 20 mm^2/sec at 100°C) have all the necessary properties for use as an analog of transmission lubricant in light-loaded systems.

Laboratory tests were done on the product from the oxidation and polymerization of wastes in the production of sunflower oil of viscosity 15 mm^2/sec at 100°C in a low-load reduction gear, which showed that the lubricant is an alternative to transmission oils of the working groups TM-2,3 (TEP-15, TAP-15V).

Table 5

Operation number	Operation	Equipment	Raw material, product	Process parameters
1	Collecting wastes from sunflower oil production	Vessel, pump	Wastes (180 liter)	Natural conditions for time of year
2	Filling reactor with oil production wastes	Pump, open reactor of volume 200 liter	same	Temperatures between -15 and +40°C, time 10-15 min
3	Heating wastes with simultaneous stirring	Reactor with heater and stirrer, thermometer	same	Heating temperature 300°C, stirring time at constant temperature 8-12 h in relation to properties of oil
4	Cooling lubricant for pumping into container	Reactor, thermometer	Plastic lubricant (175 liter)	Cooling temperature 60-80°C, time 3-6 h
5	Pumping plastic lubricant into vessel for storage	Pump, storage vessel	same	Lubricant pumping temperature 60-80°C, time 20-30 min
6	Lubricant cooling and storage	Storage vessel	same	Cooling time 1-4 h, storage conditions natural ones

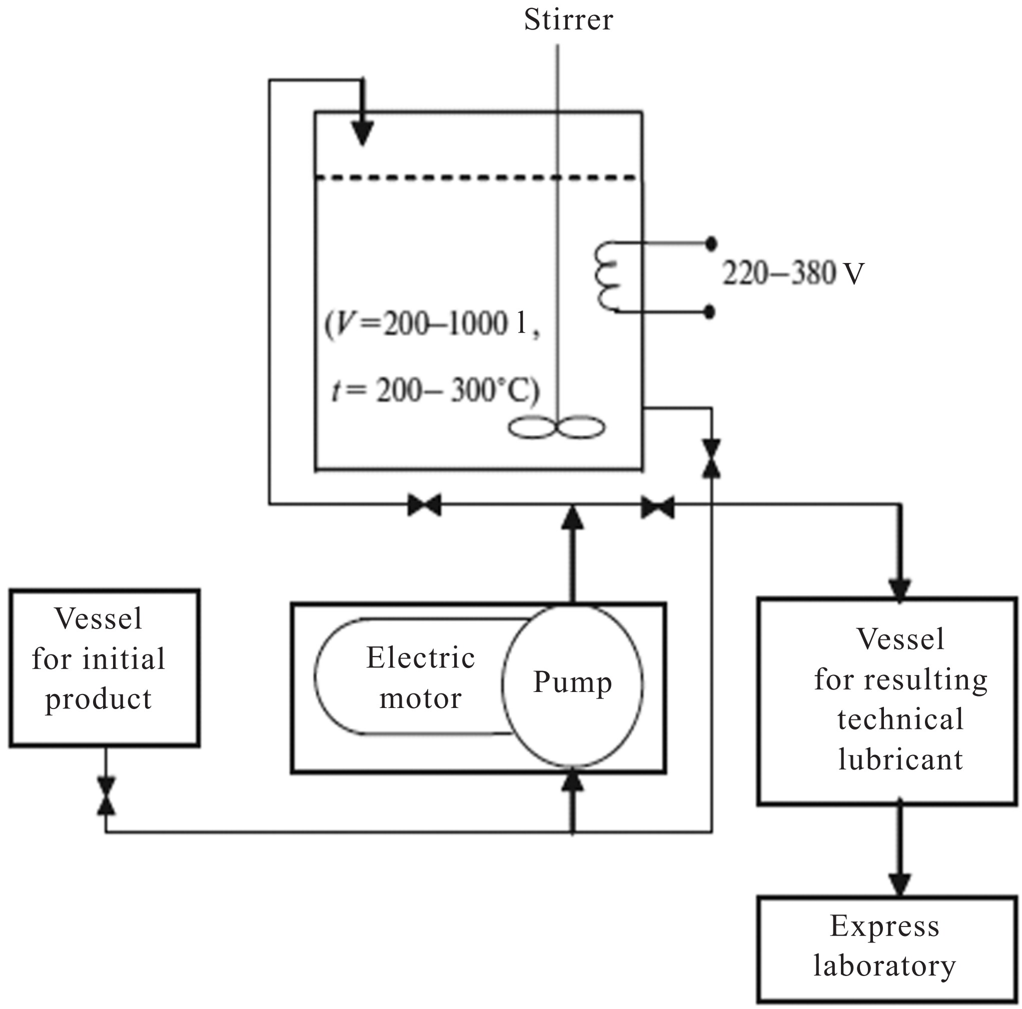

Fig. 2. Block diagram for making technical lubricants from wastes in plant oil production.

Plastic lubricants are obtained by more prolonged heating of these wastes. For example, the wastes from the production of rapeseed oil on heating for 8-10 h at 300°C are converted to a plastic product comparable in physicochemical properties with a general-purpose plastic lubricant: solidol (Table 4).

Tests on this plastic product in roller bearings showed that it is possible to replace commercial plastic lubricants intended for lubricating such units by this plastic lubricant obtained from wastes in plant-oil production. Table 5 shows the simple technology required to produce this plastic lubricant.

The basic equipment for processing the wastes consists of a reactor tank providing heating and stirring, together with a pumping plant to pump the initial products and the ones obtained. Fig. 2 shows the block diagram of making viscous additives for oils and also analogs of transmission oil and plastic lubricants.

That technology allows the producers of plant oils to extend the volumes of products by producing engineering lubricants, and also provides solutions to problems of utilizing the wastes from plant oil production.