SERVICE TESTS ON USSR MOTOR OILS IN D-9H BULLDOZERS

R. I. Sinyanskaya, V. I. Vol'nykh,
E. V. Shumkova, G. P. Belyanchikov,
and A. G. Nikitin

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At VNII NP, a summer-grade oil M-10Dk and a winter-grade oil M-4z/8D have been developed; these are similar in service properties to the Series 3 SAE-30 and SAE-10W oils produced by Teboil (Finland), which are used in the USSR in operation of bulldozers produced by Caterpillar (USA). These oils have been subjected to comparative laboratory tests and also nonengine and engine tests in accordance with the set of methods adopted for qualification rating, and also in conformance with the requirements of GOST 17479—72 for motor oil classification. At the same time, all of these oils were tested by the methods accepted for use in rating transmission and hydraulic oils. It was established (Table 1) that the USSR oils are very similar to the imported oils in engine service properties.

In order to confirm these results, service tests in D-9H bulldozers were run on experimental batches of the M-10Dk and M-4z/8D oils and prepared at VNII NP, in comparison with the SAE-30 and SAE-10W oils. The tests were run in four bulldozers operating in mines in Magadan Province [northeast Siberia] in normal earth-moving service. The Caterpillar operating instructions for the bulldozers allow the use of motor oils not only in the engine, but also in the transmission speed changer gearbox and in the final drive gears. The four oils were used as lubricants for all of these components in the service tests. After eight months of testing (from December to July), the operating time of each machine on the test oils averaged 3000 h, with 3289 h on the USSR oils (1644 h on the M-4z/8D winter oil and 1645 h on the M-10Dk summer oil), and 2903 h on the imported oils (1565 h on the SAE-10W and 1338 h on the SAE-30).

The winter-grade oils were replaced by summer-grade at the same time in all of the components, with an ambient air temperature of 0°C. The engine oil was changed at 250-h intervals, and the oil in the transmission components was changed at 1000-h intervals. During these tests, the bulldozers operated on diesel fuel with 0.2-0.5% sulfur content. The average loading of the engines with respect to fuel was the same for all bulldozers (50-51%). When the machines were operated on the USSR oils, the average fuel consumption was 36.1 kg/h, and on the imported oils it was 37.3 kg/h. The oil-burning in the engines was 0.08-0.5% of the fuel consumption, with the USSR oils giving lower values than the imported oils.

There were no malfunctions in engine or transmission operation due to the oil during the course of the tests. Also, there were no serious leaks in the oil systems or seals, as evidenced by the low oil consumption. At the end of the tests, the rubbing parts of the cylinder/piston and rod/crank groups, the crankshaft, and the turbocompressor, as well as the parts of the hydromechanical transmission, did not show any damage or any trace of corrosion. Ratings of the varnish and carbon fouling of the engine parts showed that the USSR oils kept all of the rings completely free (no stuck or sluggish rings). In the engines operating on the imported oils, the ring mobility was rated at 0.16. The fouling of the first piston grooves in the engines operated on the USSR oils was rated at 0.36 (average for two bulldozers), in comparison with a rating of 7.65 in the bulldozers operated on the imported oils. The fouling of the other piston elements was approximately the same for the two groups of oils. The overall fouling of the pistons in the engines operating on the USSR and imported oils was rated at 1.15 and 9.55, respectively.

Measurements of the engine parts and transmission components showed that the ring wear on the USSR oils was less than on the imported, with respective values of 1.04 and

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TABLE 1

Oil properties	M-10Dk	M-4z/8D	SAE-30	SAE-10W
Viscosity, mm^2/sec				
at 100°C	10.77	7.62	11.92	6.67
at −18°C	—	2600	—	2340
Viscosity index	90	115	97	121
Sulfated ash, %	1.9	1.76	1.18	1.17
Base number, mg KOH/g	9.15	8.6	7.81	7.79
Acid number, mg KOH/g	2.27	2.47	2.20	2.43
Temperature, °C				
flash point (open cup)	228	202	220	184
solid point	−18	−42	−18	−47
Content, %				
solid contaminants	0.015	0.015	0.008	0.006
water	None			
Thermal-oxidative stability				
Papok method, min	80	53	66	56
in gear test stand				
sludge after 50 h at 135°C, g	None			
increase in viscosity at 50°C, %				
after 30 h	34	47	8	27
after 40 h	47.1	62	12	58
after 50 h	63.5	82	17	96
Corrosion, g/m^2				
on lead panels	None			
in moist medium	0.25	0.81	0.56	2.26
Stability in DK-2 oxidation test				
sludge, g	None	2.5	4.38	10.7
viscosity at 100°C, mm^2/sec	22	11.5	18.93	Thickened
Antiwear and E.P. properties (4-ball)				
P_W, N	320	320	320	320
P_S, N	240	240	240	240
OPI*	42	40	42	39
Compatibility				
with other oils	Compatible			
with rubber	Slight swelling			
Physical stability in presence of moisture (with 1% water)	Very little sludge		No sludge	Very little sludge
Foaming,† ASTM D 892, cm^3				
at 24°C	Trace		0	10
At 94°C	15	35	20	60

*"Generalized wear index," similar to mean Hertz load. — Translator.
†Foam breaks after 10 minutes for all oils; i.e., foam stability is zero.

2.41 g for the weight of the ring set, 12 and 225 μm for the decrease in thickness of the first ring, and 0.88 and 2.24 mm for the increase in end-clearance of the first ring. The groove wear was the same for the imported and USSR oils. The wear of the rod bearings was lower on the USSR oils than on the imported oils (368 g vs 670 g for the set). The rod journals of the crankshaft, the cylinder liners, the turbocompressor parts, the transmission pump parts, and the speed changer gearbox parts showed the same degree of wear for the USSR oils as for the imported oils. The results of these measurements were in line with the data obtained by chemical analysis; the iron content of the USSR oils was lower than that of the imported oils by a factor of 1.5-3 (Tables 2 and 3).

The physicochemical properties of the oils after use in the engine (Table 2) indicate that the USSR oils have a number of advantages in terms of the basic service properties. The reserve of stabilizing properties after 250 h of operation had not dropped to nearly the extent observed for the imported oils. The dispersing/stabilizing capability as determined by the "oil spot filtration" method was also higher for the USSR oils. The reserve of neutralizing properties and pH after 250 h of service was approximately the same for

TABLE 2

Oil properties	M-10Dk	M-4z/8D	SAE-30	SAE-10W
Change in viscosity at 100°C, %	18,5	0,3	8,2	1,3
Acid No., mg KOH/g				
fresh oil	0,83	0,7	2,1	2,7
after 250 h	2,9	3,1	3,5	3,8
Base No., mg KOH/g				
fresh oil	8,8	8,7	7,9	9,8
after 250 h	4,3	4,07	5,1	6,1
Reserve of properties, %				
neutralizing	34,6	44,2	43,4	42,6
stabilizing	68,5	94,0	42,0	80,0
pH				
fresh oil	8,9	10,0	8,6	8,1
after 250 h	6,8	7,4	6,5	7,3
Dispersancy and stabilizing capability rating	4,0	2,5	5,5	3,0
Content (after 250 h)				
solid contaminants, %				
total	1,24	0,685	1,46	0,67
noncombustible	0,28	0,115	0,351	0,152
iron, mg/liter	69,3	47,4	81,9	103,5

TABLE 3

Oil properties	M-10Dk	M-4z/8D	SAE-30	SAE-10W
Viscosity at 100°C, mm^2/sec				
fresh oil	10,67/10,73	7,58/7,50	11,71/11,70	6,84/6,90
after 1000 h	9,94/10,25	6,56/7,01	11,62/10,36	6,74/6,90
pH				
fresh oil	8,9/8,9	10,0/10,0	8,6/8,6	8,1/8,1
after 1000 h	7,5/8,6	7,4/8,0	7,3/8,3	7,9/7,5
Base No., mg KOH/g				
fresh oil	8,86/8,86	8,66/8,66	7,8/7,8	9,8/9,8
after 1000 h	6,9/8,7	6,5/6,5	7,5/7,3	8,7/8,8
Content (after 1000 h)				
solid contaminants, %				
total	0,225/0,206	0,228/0,310	0,250/0,236	0,240/0,368
noncombustible	0,066/0,104	0,072/0,145	0,089/0,189	0,095/0,168
iron, mg/liter	107,1/232,2	74,7/236,7	76,5/268,8	107,1/262,8

Note. First value is for oils used in transmission gearbox, second value for oils used in final drive gear.

the oils being compared. The levels of these reserves indicate that the used oils do not contain any corrosive organic acids.

Data on the physicochemical properties of the oils used in the transmission components are listed in Table 3. It will be seen that the two groups of oils change to the same degree in such indices as the viscosity, base number, pH, and contents of solid contaminants and iron.

From the results of these service tests, we conclude that the USSR oils M-10Dk and M-4z/8D are in no way inferior to the imported Series 3 SAE-30 and SAE-10W oils, and that the USSR oils will give good service in the engine, transmission, and hydraulic systems of D-9H bulldozers.