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ROLF Lubricants GmbH
 Att. to Sergej Metzker
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Report – Testing of hydraulic fluid ROLF HYDRAULIC HVLP in viscosity grades ISO VG 22, 32, 46, 68 and 100 according to DIN 51524–3 for JSC Obninskorgsintez

Dear Mr. Metzker,

specialists of Evonik Operations GmbH (Evonik) and ROLF Lubricants GmbH have agreed to perform standard tests for ROLF HYDRAULIC HVLP in viscosity grades ISO VG 22, 32, 46, 68 and 100 according to DIN 51524–3. The hydraulic fluids ROLF HYDRAULIC HVLP are formulated using Evonik's Viscosity Index Modifiers (s. Table 1). The tests should demonstrate the fulfilling of DIN 51524–3 requirements.

Table 1: Formualtion details of ROLF HYDRAULIC HVLP

Components	ISO VG 22	ISO VG 32	ISO VG 46	ISO VG 68	ISO VG 100
HiTEC®					
VISCOPLEX®					
HiTEC®		-	-	-	-
MAXOIL® D mark K		-	-	-	-
Tatneft HVI-2				-	-
LUKOIL PNOS I-20A					
Gazpromneft I-40A	-	-	-		

Tests were carried out in full, required by DIN 51524–3.

According to the results of laboratory tests, it was concluded that hydraulic oils ROLF HYDRAULIC HVLP ISO VG 22, 32, 46, 68 and 100 fulfill the main requirements of DIN 51524–3. Detailed information on the tests are presented in Table 2.

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Table 2: Test results of ROLF HYDRAULIC HVLP ISO VG 22, 32, 46, 68 and 100 according to DIN 51524-3

Test	Method	min	max	ISO VG 22	ISO VG 32	ISO VG 46	ISO VG 68	ISO VG 100
KV-20 [cSt]	ASTM D445			623.7	1253	3231	5451	9286
KV0 [cSt]	ASTM D445			138.5	241.5	429.1	743.0	1214
KV40 [cSt]	ASTM D445	VG 22: 19.8 VG 32: 28.8 VG 46: 41.4 VG 68: 61.2 VG 100: 90.0	VG 22: 24.2 VG 32: 35.2 VG 46: 50.6 VG 68: 74.8 VG 100: 110	21.11	30.75	44.42	70.85	103.2
KV100 [cSt]	ASTM D445			4.952	6.349	7.95	11.74	15.67
VI [-]	ASTM D2270			170	164	152	161	162
Pourpoint [°C]	ASTM D5950		VG 22: -39 VG 32: -30 VG 46: -27 VG 68: -24 VG 100: -21	-48	-45	-42	-45	-42
Flash Point C.O.C. [°C]	ASTM D92	VG 22: 175 VG 32: 175 VG 46: 180 VG 68: 180 VG 100: 190		186	202		220	222
Particle Size (PODS)	ISO 4406		21/19/16	18/14/8	19/15/8	20/17/11	20/16/9	20/17/11
Fluid cleanliness [mg/100mL]	DIN ISO 4405		50 mg/kg	6.0	8.0	9.0	8.0	9.0
Filterability (dry) – Stage 1 [%]	ISO 13357-2	80		92.3	96.97	92.70	96.89	95.62
Filterability (dry) – Stage 2 [%]	ISO 13357-2	60		83.7	92.86	82.55	92.90	89.32
Water separation at 54 °C [minutes]	ASTM D1401		VG 22: 20 VG 32: 30 VG 46: 30 VG 68: 30	10	10	10	15	-
Water separation at 82 °C [minutes]	ASTM D1401		VG 100: 30	-	-	-	-	10
Water Content [%]	Karl Fischer		0.05	0.0161	0.0197	0.0173	0.0185	0.0194
Rust prevention	ASTM D665-A	pass		pass	pass	pass	pass	pass
Copper corrosion 3h, 100°C	DIN EN ISO 2160		2	1a	1a	1b	1a	1a
TOST, final Acid Number [mg KOH/g]	ASTM D4310		2	0.20	0.30		0.19	0.27
SRE-NBR 28/PX, Change of Shore-A-Hardness [Points]	DIN ISO 1817	0	VG 22: -8 VG 32: -7 VG 46: -7 VG 68: -6 VG 100: -6	-5	-5	-4	-5	-4
SRE-NBR 28/PX, Change of volume [%]	DIN ISO 1817	0	VG 22: 15 VG 32: 12 VG 46: 12 VG 68: 10 VG 100: 10	5.6	5.7	5.3	5.9	5.4
Air release at 50 °C [minutes]	DIN ISO 9120		VG 22: 5 VG 32: 5 VG 46: 13 VG 68: 13 VG 100: 21	2.2	3.1	2.3	7.1	11.2
Sequence I at 24 °C [ml]	ASTM D-892		150/0	30/0	10/0	0/0	10/0	10/0
Sequence II at 93.5 °C [ml]	ASTM D-892		75/0	30/0	20/0	10/0	20/0	20/0
Sequence III at 24 °C [ml]	ASTM D-892		150/0	40/0	10/0	0/0	0/0	0/0
FZG – failure load stage A/8.3/90 [fls]	CEC L-07-A-95	10		-	11	-	-	-
Mechanical test in vane pump Wear on ring [mg]	DIN EN ISO 20763		120	-	pass	pass	pass	-
Mechanical test in vane pump Wear on vane [mg]	DIN EN ISO 20763		30	-	pass	pass	pass	-
ΔKV40 after KRL 20h [%]	CEC-L-45-A-99			9.9	15.93	18.12	29.26	33.93
ΔKV100 after KRL 20h [%]	CEC-L-45-A-99			12.34	19.59	22.20	33.98	39.11
Density at 15 °C [kg/m³]	ASTM D4052			851.6	864.1	874.0	881.3	885.9
Ash content [%]	DIN 51575			0.131	0.125	0.141	0.134	0.130
TAN [mg KOH/g]	DIN 51558-1			0.6	0.6	0.6	0.6	0.6

Sincerely yours,
 Anatolij Smirnov