

REPORT: Experiments with Aero-Engine Oils in the BMW engine
Experimental series VIIla. Report No. 382.

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PURPOSE OF THE EXPERIMENTS

In continuation of the experimental series carried out so far, the following oils were tested with regard to ring sticking:

I. SS. 904 from the Leuna production, with pour point depressant and oxidation promoter.

SS 904	Ethylene polymerizate from the Leuna production
SS 904/2	SS 904 + 0.15% BPS + 0.1 % PVO
SS 904/3	SS 904 + 2% PVO-Distillate
SS 904/4	SS 904 + 0.2% BPS
SS 904/5	SS 904 + 0.2% BPS + 0.2% Paraflow
SS 904/6	SS 904 + 0.2 % BPS
SS 904/6A	SS 904/6, but different method of manufacture.

II. SS 903 with oxidation promoter

SS 903	
SS 903a/0.15	SS 903 + 0.15 % BPS
SS 903e/0.05	SS 903 + 0.05% Anilido-Ethane-Thiol
SS 903e/0.10	SS 903 + 0.10% Anilido-Ethane-Thiol

III. SS 904 with Butylphenolsulfide under various treatments

SS 904	
SS 904f	SS 904 + 0.2% BPS with Al treated
SS 904g	SS 904 + 0.2 % BPS with Sn treated
SS 904gw	SS 904 + 0.2 % BPS with Sn treated, but other methods of manufacture.
SS 904h	SS 904 + 0.2% BPS = Methyl ether Al treated Dr. Nienburg
SS 904i	SS 904 + 0.2% BPS, Pb treated
SS 904k	SS 904 + 0.2% BPS, Cu treated
SS 904L	SS 904 + 0.2% BPS, Zn treated
SS 904a	SS 904 + 0.2% BPS (g 4)
SS 904p	SS 904 + 0.2 % BPS, Sn (OH) ₂ treated
SS 904p/2	SS 904 + 0.1% BPS, " " "

IV. Commercially used oils with Butyl Phenolsulfide (treated with Sn)

Rotring	
Rotring a	Rotring + 0.2 % BPS (g 4)
Stanavo 100	
Stanavo 100 a	Stanavo 100 + 0.2 % BPS (g 4)

V. SS 904 with substances improving the lubricating capacity.

M 22	SS 904 + 2 % OT 1 OT 1 = Trimethylolpropane esterified with oleic acid.
M 23	SS 904 + 2 % G 72 G 72 = Trimethylpropane esterified with C ₉ C ₁₀ acid.
M 24	SS 904 + 2%(G 66 + G 74) (G 66 + G 74) = Pentacrytrite esterified with C ₉ C ₁₀ acid

VI. Various Oils

SS 904
SS 904 Hydrogenated
Stanavo 100
Stanavo 120

Experimental arrangements and method

The experiments were carried out in the same way as in the experimental series VIII in report No. 298g.

Experimental results:

The explanations and remarks on evaluation and distribution of the experimental results which were made under this heading in report No. 298g are also applicable to this series of experiments.

1. Experiments with SS 904 from the Leuna Production with pour point depressant and oxidation promoter (see also appendices sheet I, 6 and 7).

After experiment No. 266 results were reached with SS 904 which were superior to those reached with Stanavo 120 by about 30%, both in relation to running time and also consumption.

The running time became less favourable at constant consumption when 0.15% BPS and 0.1% PVO (experiment No. 264) were used as addition. A remarkable feature of the analytical data of SS 904 and SS 904/2 is that the thickening is diminished strongly by the addition of BPS; this happens both in the oxidation test and in the used oil.

The addition of 2% PVO distillate without BPS (SS 904/3) had a considerably more favourable effect. The running time rose to 60% above that of Stanavo 120; there was little change in the oil consumption and in the formation of residue. The oil did, however, again thicken very much because of the lack of BPS addition. See oxidation test and analysis of the used oils.

SS 904/4 (= SS 904 + 0.2% BPS), centrifuged, gave an excellent running time. The formation of residues was also less strong than it was in the previous experiments. The high consumption of oil of 675 gm/hour allows one to suspect that the wear of piston and cylinder had advanced very far, thus invalidating the results to some extent. The thickening of the oil has been strongly repressed by the addition of BPS; this is proved by the oxidation test. In the used oil also the thickening is not very strong, if one takes into account that the running time of this experiment 274 is almost double that of the previous experiment.

The experiments Nos. 278 and 279 were intended to ascertain the effect of 0.2% paraffin as an addition to SS 904 in the presence of 0.2% BPS. The running time and the oil consumption were practically the same in both cases; one can therefore assume that Paraffin has no harmful effect on the oxidation characteristics of an oil.

SS 904/6A which differs from SS 904/6 only by its method of manufacture. shows no difference in comparison with the latter as regards the running time; there was a worsening of the consumption.

II. SS 903 with oxidation promoters (See appendices, sheet 1, 2 and 3)

After experiment No. 228 SS 903 reached a running time of 30 hours with an hourly consumption of 395 gm. of oil. In this case, however, it is not possible to use Stanavo as a comparison so that one cannot form a definite judgment on this subject. If the analyses of these products are compared with those of SS 903a experiment 249, one is again struck by the favourable effect the addition of BPS has on the thickening of the oil.

Experiments No. 249, 251 and 252 elucidate the action of oxidation promoters. The best running time was obtained with an addition of 0.15% Butylphenolsulphide (SS 903a (0.15) 0.05% of anilido-ethane-thiol (SS 903e/0.05) on the other hand caused a worsening of the running time; this is still more evident with 0.10% (SS 903o/0.10). The formation of residue was practically the same in all three cases; the consumption of oil had the best value for SS 903a/0.15. The analytical data do show however that this addition of 0.1% Anilido-ethane-thiol is capable of exerting a favourable effect on the thickening of the oil.

III. SS 904 with Butylphenolsulphide under various kinds of treatment (see appendices sheets 2, 3, 8, 9, 10, 11, 12.)

Experiments No. 298 and 305 were carried out with SS 904 with an addition of 0.2 BPS(f) treated with Al. As compared with pure SS 904 (experiment No. 297) the result showed an increase of 30% in the running time. The consumption of oil increased by about 10%. The piston looked considerably better in both these cases than when pure SS 904 was used. The thickening of the oil was also lessened by this addition f.

There was a further improvement when one added 0.2% of BPS (SS 904g) treated with tin. The running times in the three experiments with this oil (experiments 304, 309, 356) are almost double those obtained in the experiments No. 297 and 354 employing pure SS 904. There was also some, if only a small improvement in the consumption of oil, the formation of residue at the piston, on the other hand remained fairly strong. This g inhibitor also has a favourable effect on the thickening of the oil; this is shown by the analytical data. SS 904 g W, the same product, but differing in the manner of manufacture of the inhibitor had values of running time and consumption slightly less good than those of SS 904.

No effect of the inhibitor (0.2% BPS methyl ether treated with Al) was found in experiment 307 with SS 904 h. The running time was only 40% more than that of Stanavo 100. The formation of residue at the piston was considerable. The free OH group in the BPS is thus important for the catalytic properties of the latter. The analytical data also show that the OH group which is blocked by combination with ether has no effect on the thickening of the oil both in the oxidation test and also in the used oil.

The effects of treatment with Pb and Cu are shown by the experiments No. 262 and 365. The running times in both cases were about 150% longer than those for Stanavo 100 and about 50% longer than those for pure SS 904. The product containing copper seems to have a somewhat more favourable behaviour than the product containing lead in relation to the formation of residues at the piston.

The zinc treated BPS caused very strong foaming of the oil in experiment No. 367, the experiment had therefore to be discontinued prematurely.

Comparison between SS 904a and SS 904p (experiment No. 401 and 403 showed that SS 904a was superior; its running time of 39 hours exceeded that of SS 904p by 13 hours. There was no appreciable difference with respect to consumption and the formation of residues. SS 904 p/2 containing only 0.1% BPS had better characteristics, it was superior to SS 904a and also to SS 904p both in respect to running time and consumption. It would seem that this p inhibitor is more active and that it exerts its full effect only when it is used in small amounts. Experiments on this inhibitor have been continued and extended. The results shall be reported on in the next report.

IV. Commercial oils with Butylphenolsulphide (treated with Sn) (See appendices sheets 3,4,12,13.)

Experiments No. 370 and 371 showed that the effect of the inhibitor on the engine characteristics was small, the running time rose from 16 to 18 hours; the state of the piston and the measurement of consumption indicated a small improvement.

The inhibitor has a better effect on Stanavo 100. No definite conclusion could be taken from the comparison of experiments No. 349b and 368 since in between these two experiments lie 9 further experiments with a total running time of 220 hours. In experiment No. 368 the piston and cylinder were very much worn, and one has to assume therefore that the increase in the running time amounting to 135% is due not only to the inhibitor but also to the advanced stage of wear. The correctness of this assumption is confirmed by the high consumption of oil in experiment No. 368.

No objections can be made to the comparison of experiment No. 379 and 381. Here the inhibitor effects an increase in the running time of about 50% and the consumption improves by 23%. The favourable result cannot be explained from the analytical data. The data amenable to comparison are nearly the same for used and unused oils.

V. SS 904 with additions improving the lubricating capacity. (See appendix Sheets 4 and 14).

SS 904, without addition, gave a running time which exceeds that of Stanavo 100 by about 60%. When the "lubrication acids" OT1(M 22) and G 88 + G 74 (M 24) were added the running time was about equal to that of Stanavo 100. Thus, the engine characteristics of the oil are made less favourable by these additions. The running time of the unadulterated SS 904 could be reached only when G 72 was used as an addition to SS 904 (M 23). The consumption of oil kept within the normal limits. The formation of residue was nearly the same in all three experiments and corresponded to the data for pure SS 904. The additions have no effect on the thickening of the SS 904.

VI. Various oils (See appendix, sheets 4,5,15,16,17).

Experiments No. 310 and 311 were designed to show the effect of hydrogenation. For SS 904 an increase in the running time was observed from 22 to 28.5 hours; the consumption however rose by about 10%. The residue formation was the same in both experiments; the same was true for the thickening of the oil during use.

The experiments with Stanavo 100 and 120 were carried out in order to have a reference point for comparisons. The detailed exposition in report No. 298g on the results and evaluation of these experiments also apply here.

Expt. No. Engine Cylinder Piston.	Type of Oil	State of Equipment.			Running time hrs.	Oil Con- sumption. g/h	No. of correspond- ing Stan- avo Exp.	Increase in running time com- pared to Stamavo %	Decrease in oil consump- tion comp- ared to Stamavo in %
		Fixed Rings.	Gudgeon Pin Bearing	Oil Drilling					
266 I S.S. 2	SS 904 From Louna Production.	1 and 2	strong residue	partially closed	29	370	263	+ 29	+ 29
264 I S.S. 2	SS 904/2 SS 904 + 0.15% BPS + 0.1% FVO	1	"	partially narrowed	22.5	400	263	+ 0	+ 23
271 I S.S. 3	SS 904/3 SS 904 + 2% FVO Distillate	1 and 2	very strong residue	strongly narrowed	24.5	420	272	+ 64	+ 13
274 I S.S. 3	SS 904/4 centrifuged SS 904 + 0.2% BPS	1 and 2	medium Residue	partially closed	50	675	272	+ 253	- 39
279 I K.K. 1	SS 904/5 SS 904 + 0.2% BPS + 0.2% Para- flow	1	Strong Residue	partially closed	29.5	525	276	+ 79	- 12
278 I K.K. 1	SS 904/6 SS 904 + 0.2 % BPS	1	"	free	30.5	490	276	+ 85	- 4
277 I K.K. 1	SS 904/6A SS 904 + 0.2% BPS	1	medium Residue	partially narrowed	30	585	276	+ 82	- 25
228 I R.R. 1	SS 903	1	Strong Residue	Closed	30	395	-	-	-
249 I R.R. 3.	SS 903a/0.15 SS 903 + 0.15% BPS	1	Very Strong	Free	28.5	480	253	+ 50	- 23

	Exp. No. Engine Cylinder Piston	Type of Oil	State of Equipment			Run- ning Time Hrs.	Oil Con- sumption g/h	No. of corres- ponding Stan- avo Experiment	Increase in running time compared to Stanavo %	Decrease in oil consumption compared to Stanavo %	
			Fixed Rings	Gudgeon Pin Bearing	Oil Drilling						
10	251 I R.R.3	SS 903e/0.05 SS 903 + 0.05% Anilido-ethane-Thiol	1	Very Strong Residue	Strongly narrow- ed.	24	510	253	+ 26	- 31	
11	252 I	SS 903e/0.10 SS 903 + 0.10% Anilido-ethane-Thiol	1	"	partially closed	22	490	253	+ 16	- 26	
12	297 I H.H.1	SS 904	1	Strong Residue	Strongly narrow- ed.	22.5	540	294	+ 80	+ 19	
13	298 I H.H.1	SS 904 f SS 904 + 0.2% BPS treated with Al	0	Moderate Residue	Slightly narrow- ed.	28.5	650	294	+ 128	+ 3	
14	305 I M.M.4	SS 904 f Repetition	1 & 2	No Residue	Free	30.5	(700)	308	+ 145	+ 4	
15	304 I M.M.4	SS 904 g SS 904 + 0.2% BPS Treated with Sn	1	Strong Residue	Free	45.5	578	308	+ 260	+ 21	
16	309 I M.M.4	SS 904 g. Repetition	1	Moderate Residue	Free	40	540	308	+ 220	+ 27	
17	356 I T.T.1	SS 904 g Repetition	1	Very strong Residue	Slightly narrow- ed.	68.5	400	353	+ 390	+ 31	
18	354 I T.T.1	SS 904	1	Strong Residue	Narrow- ed.	22.5	540	353	+ 60	+ 8	
19	359 I T.T.1	SS 904 g w SS 904 g (Special Treatment)	2	Strong Residue	Free	40	550	353	+ 185	+ 5	

	Exp.No. Engine Cylinder Piston	Type of Oil	State of Equipment			Run- ing Time Hrs.	Oil Con- sumption, g/h	No. of corres- ponding Stan- avo Experiment	Increase in running time compared to Stanavo %	Decrease in oil consumption compared to Stanavo %
			Fixed Rings	Gudgeon Pin Bearing	Oil Drilling					
20	307 I M.M.4	SS 904 h SS 904 + 0.2% BPS- Ethyl-ether Treated with Al.	1	Strong Residue	Partially closed	17.5	680	308	+ 40	+ 7
21	362 I T.T.1	SS 904 i SS 904 + 0.2 % BPS Treated with Fb	2	Medium Residue	Free	33	590	353	135	- 2
22	365 I T.T.1	SS 904 k SS 904 + 0.2% BPS Treated with Cu	1	No Residue	Free	35.5	690	353	155	-19
23	367 I T.T.1	SS 904 l SS 904 + 0.2% BPS Treated with Zn	Experiment discontinued because of foam formation							
24	401 II P.P.5	SS 904a SS 904 + 0.2% BPS (g 4)	1 & 2	No Residue	Free	39	590	393	+ 82	- 58
25	403 II P.P.5	SS 904 p SS 904 + 0.2% BPS Treated with Sn(OH)2	1	"	"	25.5	620	393	+ 18	- 68
26	417 II Q.Q.3	SS 904 p/2 SS 904 + 0.1% BPS Treated with Sn(OH)2	1	"	"	35.5	605	416	+110	- 45
27	370 I U.U.1	Rotring	1	Strong Residue	"	16	430	384	- 6	- 8
28	371 I U.U.1	Rotring a (g 4)	1	Moderate Residue	"	18	410	384	+ 6	- 3
29	349b II O.O.1	Stanavo 100	1	No Residue	Slightly Narrow- ed.	15.5	600			

	Exp. No. Engine Cylinder Piston.	Type of Oil	State of Equipment			Run- ing Time Hrs.	Oil Con- sumption g/h	No. of corro- sion Stan- avo Experiment	Increase in running time compared to Stanavo %	Decrease in oil consumption compared to Stanavo %
			Fixed Rings	Gudgeon Pin Bearing	Oil Drilling					
30	368 II O.O.1	Stanavo 100 a (g4)	2	No Residue	Free	36.5	(945)	349 b	+ 135	(-57)
31	379 II V.V.1.	Stanavo 100	1	" "	"	28.5	615			
32	381 II V.V.1.	Stanavo 100 a (g4)	1	" "	"	43	500	379	+ 51	+23
33	284 I K.K.1	M.22 SS 904 + 2% OT 1	1 & 2	Strong Residue	Partially closed	19.5	520	288	0	+5
34	285 I K.K.1	M 23 SS 904 + 2% G 72	1 & 2	" "	Closed	31	470	288	+ 59	+ 15
35	286 I K.K.1	M 24 SS 904 + 2% (G 66 + G 74)	1 & 2	" "	"	21.5	545	288	+ 10	+ 1
36	310 II M.M.4	SS 904	0	Moderate Residue	"	22	860			
37	311 II M.M.4	SS 904 hydrogenated	1 & 2	" "	"	28.5	610			
38	263 I S.S.2	Stanavo 120	1 & 2	No Residue	Free	22.5	520			
39	272 I S.S.3	Stanavo 120	1 & 2	" "	"	15	485			
40	276 I K.K.1	Stanavo 120	1	" "	"	16.5	470			

Exp. No. Engine Cylinder Piston	Type of Oil	State of Equipment.			Run- ing Time Hrs.	Oil Con- sumption g/h	No. of corres- ponding Stan- avo Experiment	Increase in running time compared to Stanavo %	Decrease in oil consumption compared to Stanavo %
		Fixed Rings	Gudgeon Pin Bearings	Oil Drilling					
41 253 I R.R.3	Stanavo 120	1&2	No Residue	partially narrowed	19.0	370	-	-	-
42 308 I M.M.4	Stanavo 100	1&2	" "	Free	12.5	730	-	-	-
43 353 I T.T.1	Stanavo 100	1&2	" "	"	14.0	580	-	-	-
44 393 II P.P.5	Stanavo 100	1&2	" "	"	21.5	370	-	-	-
45 416 II O.O.3	Stanavo 100	1	" "	"	17.0	416	-	-	-
46 384 I U.U.1	Stanavo 100	1&2	" "	"	17	400	-	-	-
47 288 I K.K.1	Stanavo 120	1&2	" "	"	19.5	550	-	-	-

Type of Oil Expt. No. Running Time	Spec. Grav. 20°C	VISCOSITIES					Thickening % C.St. 36	Acid Number	Sap. Number	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Dist.	Water Content	BRITISH OXYD. TEST					
		C.St. 88	C.St. 99	V.I.	m	Polar Height										Thickening % 38	Acid Number	Sap. Number	Asphalt		
SS 904	0.860	244	22.6	115				0.04	0.33	0.17	-	-	-	100	-	N2	49	-	0.05	0.55	-
Unused																Air	148	203	5.63	16.0	-
Expt. 268	a.	569	37.4	107											0.040						
29 hrs.	b.	585	38.4	108			140%	3.88	12.6	0.96	0.08	0.13	0.06	99.5							
	c.	529	36.2	109																	
SS 904/2	0.859	240	21.8	114				0.05	0.33	0.17	-	-	-	100	-	N2	50	-	0.05	0.33	
Unused																Air	71	42	2.85	12.3	
Expt. 264	a.	410	29.6	107											0.046						
22.5 hrs.	b.	421	30.2	108			73%	2.88	9.1	0.66	0.08	0.15	0.06	99.7							
	c.	390	29.0	108																	
SS 904/3	0.861	272	25.0	116.9				0.05	0.28	0.16	-	-	-	100	-	N2	58	-	0.05	0.28	
Unused																Air	129	120	4.9	12.2	
Expt. 271	a.	537	35.8	107											0.051						
24.5 hrs.	b.	561	33.6	105			108%	4.70	12.9	0.79	0.07	0.18	0.04	99.75							
	c.	505	35.0	108																	
SS 904/4	0.861	239	21.5	112				0.08	0.33	0.19	-	-	-	100	-	N2	50	-	0.06	0.30	
Unused																Air	65	30	1.73	8.5	
Expt. 274	a.	442	31.8	109											0.031						
52.5 hrs.	b.	468	32.6	108			98%	3.48	10.7	0.75	0.08	0.19	0.04	99.6							
	c.	366	27.0	105																	
PLATE 6. Technical Test Stand Onpau.																					

Type of Oil Expt. No. Running Time.	Spec. Grav. 20°C	VISCOSITIES				Polar Height	Thickening % C.St. 38	Acid Number	Sap. Number	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Dist. %	Water Content	British Sayd. Test.					
		C.St. 38	C.St. 99	V.I.	m											E°38	Thickening E°38	Acid Number	Sap. Number	Asphalt	
SS 904/5 Unused	0.860	227	21.4	115				0.05	0.38	0.15	-	-	-	100	-	N2	51	-	0.05	0.43	-
																Air	68	31	1.9	9.6	-
Expt. 279 33.5 hrs.	a.		478	34.0	109.5										0.027						
	b.	0.877	503	35.0	108.6		122%	3.70	10.6	0.93	0.03	0.17	0.07	99.75							
	c.		470	33.6	109																
SS 904/6 Unused	0.860	233	21.5	112.5				0.01	0.38	0.13	-	-	-	100	-	N2	51	-	0.09	0.38	
																Air	64	24	1.98	8.9	
Expt. 278 30.5 hrs.	a.		437	32.2	110										0.024						
	b.	0.876	462	33.0	109		94%	3.86	12.0	0.78	0.08	0.12	0.05	99.5	-						
	c.		365	29.2	112																
SS 904/6a Unused	0.860	233	21.6	113				0.10	0.38	0.16	-	-	-	100	-	N2	51	-	0.09	0.38	
																Air	57	13	0.08	8.0	
Expt. 277 30 hrs.	a.		380	29.7	111.5										0.024						
	b.	0.871	404	30.2	113		70%	1.64	5.7	0.63	0.09	0.20	0.03	99.5							
	c.		352	27.9	111																
S° 903 Unused	0.854	263	25.2	120.1				0.16	0.60	0.15	-	-	-	100	-	N2	51	-	0.3	1.0	
																Air	101	98	3.0	10.4	
Expt. 228 30 hrs.	a.		655	42.7	110										0.049						
	b.	0.890	667	43.4	110		154%	0.30	1.45	1.33	0.10	0.25	0.01	99.75							
	c.		612	41.4	111																

Type of oil Expt. No. Running Time	Spec. Grav. 20°C	VISCOSITIES					Thickening % C.St. 38	Acid Number	Sap. Number	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Dist. %	Water Content	British Oxyd. Test.					
		C.St. 38	C.St. 99	V.I.	m	Polar Height										E°38	Thickening E°38	Acid Number	Sap. Number	Asphalt	
SS 903a 0.15 Unused	0.855	276	25.4	113				0.25	0.75	0.21	-	-	-	100	-	N2 Air	56 72	- 29	0.18 2.8	0.70 10.6	-
Expt. 249 28 hrs.	a.	449	34.4	114											0.036						
	b.	0.868	470	35.5	113		70%	3.30	9.8	0.73	0.13	0.21	0.06	99.25							
	c.		383	28.2	107																
SS 903e/0.05 Unused	0.854	282	25.7	117				0.22	0.70	0.18	-	-	-	100	-	N2 Air	55 82	- 48	0.18 3.7	0.75 12.6	-
Expt. 251 24.5 hrs.	a.		587	40.8	112										0.043						
	b.	0.876	636	42.7	111		125%	4.48	13.20	0.93	0.07	0.20	0.02	99.75							
	c.		556	38.6	111																
SS 903e/0.10 Unused	0.855	282	25.6	117				0.19	0.70	0.18	-	-	-	100	-	N2 Air	56 76	- 37	0.18 3.0	0.68 10.3	-
Expt. 252 22 hrs.	a.		440	34.6	115										0.020						
	b.		460	35.2	115		60%	3.28	9.7	0.72	0.14	0.22	0.07	99.75							
	c.		413	33.5	116																
SS 904 Unused	0.860	244	22.0	113				0.04	0.33	0.17	-	-	-	100	-	N2 Air	49 148	- 203	0.05 5.63	0.35 16.0	-
Expt. 297 22.5 hrs.	a.		514	34.4	106										0.044						
	b.	0.880	549	36.8	108		125%	3.99	12.7	0.83	0.11	0.09	0.04	99.5							
	c.		508	35.4	109																
Technical Test Stand, Gary, Plate 2																					

Type of Oil Expt. No. Running Time		Spec. Grav. 20°C	VISCOSITIES					Polar Height	Thickening C.St. 38	Acid Number	Sap. Number	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Dist. %	Water Content	British Oxyd. Test				
			C.St. 38	C.St. 99	V.I. m													E°38	Thickening E°38	Acid No.	Sap. No.	Asphalt
SS 904 f Unused		0.860	238	22.0	114					0.20	1.23	0.25	-	-	-	100	-	51	-	0.13	1.15	
																		51	85	3.8	12.2	
Expt. 298 28.5 Hrs.			471	32.4	106												0.027					
		a.																				
		b.	0.887	475	32.7	107			98%	3.88	11.7	0.93	0.09	0.11	0.07	99.5						
		c.		435	31.3	108																
SS 904 f Unused			239	21.5	112													52	50	-	0.20	1.0
																		52	82	66	3.5	11.7
Expt. 305 30.5 hrs.																						
		a.																				
		b.																				
		c.																				
SS 904 g Unused		0.862	242	21.5	112					0.30	1.7	0.24	-	-	-	100	-	52	51	-	0.25	1.5
																		52	68	35	2.8	11.7
Expt. 304 45.5 Hrs.			435	31.6	109												0.018					
		a.																				
		b.	0.874	453	32.9	110			67%	2.76	8.8	0.83	0.07	0.15	0.05	99.75						
		c.		453	31.4	110																
SS 904 g Unused		0.862	250	22.4	113					0.31	1.66	0.17	-	-	-	100	-	52	51	-	0.26	1.53
																		52	72	43	3.0	10.4
Expt. 309 40 Hrs.			462	33.9	111												0.042					
		a.																				
		b.	0.876	466	34.1	111			87%	3.52	10.1	0.96	0.05	0.13	0.07	99.5						
		c.		422	33.2	112																

Type of Oil Expt. No. Running Time	Spec. Grav. 20°C	VISCOSITIES					Polar Feibh	Thickening % C.St. 38	Acid Number	Sap. Number.	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Dist. %	Water Content	British Oxid. Test				
		C.St. 38	C.St. 99	V.I.	m	E°38											Thickening E°38	Acid No.	Sap. No.	Asphalt.	
SS 904 g Unused	0.882	225	21.0	114				0.06	0.42	0.15	-	-	-	100	-	N2	41	-	0.04	0.34	-
																Air	78	80	2.6	10.4	-
Expt. 358 68.5 hrs.	a.		604	39.1	107											0.043					
	b.	0.882	635	40.4	107			182%	5.98	13.0	1.15	0.06	0.18	0.03	99.5						
	c.																				
SS 904 Unused	0.858	245	22.3	114				0.03	0.57	0.16	-	-	-	100	-	N2	51	-	0.03	0.60	
																Air	144	180	5.3	12.6	
Expt. 354 28.5 hrs.	a.		575	36.5	105											0.030					
	b.	0.882	615	37.9	103			150%	4.53	12.9	0.86	0.05	0.21	0.06	99	-					
	c.																				
SS 904 g W Unused	0.859	239	21.5	112				0.06	0.48	0.19	-	-	-	100	-	N2	54	-	0.06	0.63	
																Air	90	69	3.98	11.6	
Expt. 359 40 hrs.	a.		573	36.5	105											0.050					
	b.	0.882	588	36.8	104			146%	5.43	12.8	1.18	0.09	0.18	0.08	99.5						
	c.																				
SS 904 h Unused	0.862	233	21.2	113				0.25	1.7	0.21	-	-	-	100	-	N2	51	-	0.24	1.2	
																Air	102	100	4.4	13.6	
Expt. 307 17.5 hrs.	a.		455	30.9	104											0.018					
	b.	0.877	454	31.6	106			95%	3.73	11.1	0.63	0.05	0.13	0.02	99.76	-					
	c.		443	32	109																

Type of Oil Expt. No. Running Time.	Spec. Grav. 20°C	VISCOSITIES			Polar Height	Thickening C.S. 38	Acid Number.	Sap. Number.	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Test.	Water content	British Oxyd. Test.					
		C.St. 38	C.St. 99	V.I.												E°38	Thickening E°38	Acid No.	Sap. No.	Asphalt.
SS 904 i Unused	0,856	224	21,5	116			0.06	0.56	0.15	-	-	-	100	-	N2 Air	44 52	- 19	0.03 2.5	0.50 9.0	-
Expt. 362 33 hrs.	a.	382	29,8	111										0.059						
	b.	0,868	401	30.7		80%	2.23	6.6	0.66	0.08	0.10	0.04	99.76							
	c.																			
SS 904 k Unused	0,857	223	21,5	117			0.04	0.57	0.16	-	-	-	100	-	N2 Air	39 55	- 42	0.04 2.5	0.58 10.4	
Expt. 365 35.5 Hrs.	a.	397	30.9	112										0.032						
	b.	0,869	427	4.36		91%	1.73	5.7	0.77	0.03	0.19	0.06	99	-						
	c.																			
SS 904 l Unused.															N2 Air					
Expt. 367 hrs.	a.																			
	b.																			
	c.																			
SS 904 a Unused	0,859	239	21,5	112			0.03	0.65	0.18	-	-	-	100	-	N2 Air	54 91	- 70	0.13 3.7	0.53 12.5	
Expt. 401 39 hrs.	a.	348	27,5	110										0.027						
	b.	0,868	363	28.0		52%	1.41	5.1	0.56	0.09	0.13	0.07	99.75							
	c.																			

Type of Oil Expt. No. Running Time.	Spec. Grav. 20°C	VISCOSITIES						Thickening C. St. 38 C. St. 99	Acid Number	Sap. Number.	Coloring	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Dist. %	Water content	British Oxid. Test.				
		C. St. 38	C. St. 99	V.I.	m	Polar Reagent	Thickening C. St. 38 C. St. 99										Thickening C. St. 38 C. St. 99	Acid No.	Sap No.	Asphalt	
SS 904 p Unused	0.859	241	21.7	113				0.23	0.63	0.17	-	-	-	100	-	N2 Air	52 73	- 42	0.03 2.7	0.46 10.7	- -
Expt. 408 20 hours	a.	330	26.0	109												0.046					
	b.	0.866	337	26.2	108		40%	0.83	3.2	0.60	0.09	0.16	0.09	99	-						
SS 904p/2 Unused	0.860	234	21.1	112				0.17	0.78	0.21	-	-	-	100	-	N2 Air	54 107	- 102	0.05 3.9	0.50 12.5	- -
Expt. 417 35 hrs.	a.	356	27.5	109												0.021					
	b.	0.870	351	26.8	108		50%	1.81	5.6	0.80	0.04	0.21	0.06	99.75	-						
	c.																				
Retring Unused	0.882	278	21.1	96				0.01	0.14	0.20	-	-	-	100	-	N2 Air	38 51	- 33	0.01 2.30	0.16 8.2	- -
Expt. 370 16 hrs.	a.	315	22.3	95												0.042					
	b.	0.886	321	22.6	95		15%	2.46	6.2	0.59	0.06	0.17	0.03	100	-						
	c.																				
Retring a Unused	0.879	258	20.4	100.2				0.05	0.43	0.16	-	-	-	100	-	N2 Air	35 44	- 25	0.05 2.3	0.45 9.3	- -
Expt. 371	a.	299	21.9	97												0.034					
	b.	0.885	305	22.3	97		18%	1.88	5.1	0.62	0.06	0.12	0.04	99.75	-						
	c.																				

Technical Test Stand Orgau Plate 12.

Type of Oil Expt. No. Running Time.	Spec. Grav. 20°C	VISCOSITIES					Thickening at C.St. 38	Acid Number	Sap. Number	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Test	Water content	British Oxyd. Test.					
		C.St. 38	C.St. 99	V.I.	m	Poly- mer										E ₃₈	Thickening E ₃₈	Acid No.	Sap. No.	Asphalt.	
Stanavo 100 a Unused	0.882	239	19.6	101				0.02	0.36	0.76	-	-	-	100	-	N2	34	-	0.02	0.37	-
																Air	47	56	2.3	8.3	-
Expt. 381 45 hrs.															0.028						
a.		262	20.7	101																	
b.	0.885	270	20.9	100			15%	0.36	2.0	1.04	0.07	0.19	0.03	100	-						
c.																					
Stanavo 100 Unused	0.882	241	19.9	103				0.01	0.37	0.82	-	-	-	100	-	N2	34	-	1.02	0.43	-
																Air	44	29	2.0	7.5	-
Expt. 349 b															0.032						
a.		262	20.0	100																	
b.	0.886	262	20.6	100			9%	0.61	1.8	1.17	0.07	0.18	0.02	99.75	-						
c.		240	19.5	101																	
Stanavo 100a Unused	0.883	243	19.8	101				0.05	0.30	0.79	-	-	-	100	-	N2	34	-	0.05	0.30	-
																Air	62	53	3.4	10.2	-
Expt. 368 36 hrs.															0.025						
a.		274	21.1	99																	
b.	0.887	288	21.9	100			16%	0.63	2.2	1.22	0.06	0.17	0.03	99.5	-						
c.																					
Stanavo 100	0.882	243	19.8	101				0.01	0.37	0.82	-	-	-	100	-	N2	34	-	0.02	0.43	-
																Air	44	29	2.0	7.5	-
Expt. 379 28.5 hrs.															0.021						
a.		273	21.5	102																	
b.	0.887	284	22.2	103			17%	0.49	2.4	1.42	0.12	0.39	0.04	99.2							
c.																					
Technical Test Stand Orgav. Plate 13.																					

Type of Oil Expt. No. Running Time		Spec. Grav. 20°C	VISCOSITIES					Thickening % C.St. 38	Acid Number	Sap. Number	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum test, %	Water content	British Oxyd. Test.					
			C.St. 38	C.St. 99	V.I.	m. Height	E°38										Thickening E°38	Acid No.	Sap. No.	Asphalt		
M.22 Unused		0.861	227	21.3	115				0.05	4.2	0.16	-	-	-	100	-	N2	47	-	0.04	4.0	-
																	Air	114	143	4.6	12.3	-
Expt. 284 19.6 hrs.	a.		449	32.2	109											0.053						
	b.	0.886	468	33.5	109			105%	3.73	12.20	0.73	0.06	0.19	0.03	99.5							
	c.		438	32.0	109																	
M.23 Unused		0.860	223	21.0	115				0.04	4.7	0.16	-	-	-	100	-	N2	46	-	0.06	4.8	-
																	Air	111	141	4.8	11.8	-
Expt. 285 31 Hrs.	a.		600	39.7	109											0.041						
	b.	0.879	623	40.1	108			179%	5.11	14.51	0.08	0.03	0.21	0.05	99.5							
	c.		548	37.4	109																	
M.24 Unused		0.860	226	21.0	114				0.06	5.1	0.14	-	-	-	100	-	N2	48	-	0.05	5.1	-
																	Air	118	147	4.98	12.5	-
Expt. 286 21 Hrs.	a.		513	35.9	110											0.045						
	b.	0.862	525	35.3	107			132%	3.93	14.4	0.81	0.06	0.18	0.03	100	-						
	c.		513	35.4	109																	
SS 904		0.860	244	22.0	113				0.13	1.05	0.17	-	-	-	100	-	N2	51	-	0.13	1.05	-
																	Air	129	156	4.7	12.7	-
Expt. 310 22 hrs.	a.		550	35.8	106											0.036						
	b.	0.862	581	37.6	106			138%	4.46	11.6	0.81	0.04	0.13	0.04	99.5							
	c.		639	36.0	107																	

Type of Oil Expt. No. Running Time.	Spec. Grav. 20°C	VISCOSITIES					Thickening % C.St. 38	Acid Number	Sap. Number	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Dist.	Water content	British Oxyd. Test.					
		C.St. 38	C.St. 99	V.I.	n	Polar Height										E°38	Thickening E°38	Acid No.	Sap No.	Asphalt.	
SS 904 hydrogen- ated Unused.	0.860	240	21.6	113				0.05	0.71	0.16	-	-	-	100	-	N2	49	-	0.06	0.56	-
																Air	111	126	4.9	12.3	-
Expt. 311 28.5 hrs.	a.	557	37.3	108											0.045						
	b. 0.882	594	39.8	110			148%	4.95	13.2	0.93	0.06	0.08	0.06	99	-						
	c.	344	27.3	110																	
Stanavo 120 Unused	0.887	367	27	105				0.05	0.33	1.04	-	-	-	100	-	N2	50	-	0.05	0.33	
																Air	67	35	3.13	9.1	
Expt. 263 22.5 hrs.	a.	392	27.2	101											0.032						
	b. 0.890	405	27.8	101			10%	0.68	1.9	1.36	0.08	0.18	0.03	99.75							
	c.	365	25.8	101																	
Stanavo 120 Unused	0.886	360	26.3	104				0.04	0.33	0.93	-	-	-	100	-	N2	49	-	0.05	0.33	
																Air	66	35	1.75	9.1	
Expt. 272 15 hrs.	a.	382	26.7	101											0.017						
	b. 0.889	396	27.4	101			10%	1.08	2.0	1.35	0.07	0.16	0.03	100	-						
	c.	362	26.3	103																	
Stanavo 120 Unused	0.886	360	26.3	104				0.04	0.33	0.93	-	-	-	100	-	N2	49	-	0.05	0.33	
																Air	66	35	1.75	9.1	
Expt. 276 17 hrs.	a.	392	27.2	101											0.025						
	b. 0.890	402	27.9	102			12%	1.78	5.8	1.35	0.07	0.18	0.02	99.75							
	c.	362	26.2	103																	

Type of Oil Expt. No. Running Time	Spec. Grav. 20°C	VISCOSITIES										Thickening 7 C.St. 38	Acid Number.	Sap. Number.	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Dist., %	Water content	Brit. Oxidation Test.				
		C.St. 38	C.St. 99	V.I.	m.	Polar Weight	E°38	Thickening 5038	Acid No.	Sap. No.	Asphalt.														
Stanavo 120 Unused	0.887	367	27.0	105				0.05	0.33	1.04	-	-	-	100	-	N2	50	-	0.05	0.33	-				
																Air	67	35	3.13	9.1	-				
Expt. 253 19 hrs.	a.		383	26.0	101										0.023										
	b.	0.890	407	27.9	101			11%	0.70	1.8	1.43	0.09	0.24	0.05	99.75										
	c.		367	26.4	103																				
Stanavo 100 Unused																N2									
																Air									
Expt. 308 12.5 hrs.	a.																								
	b.																								
	c.																								
Stanavo 100 Unused	0.882	241	19.9	103				0.01	0.37	0.82	-	-	-	100	-	N2	34	-	0.02	0.43					
																Air	44	29	2.0	7.6					
Expt. 353 18.5 hrs.	a.		252	20.0	100										0.032										
	b.	0.886	262	20.5	100			9%	0.61	1.8	1.17	0.07	0.18	0.02	99.75										
	c.		240	19.5	101																				
Stanavo 100 Unused	0.882	241	19.9	103				0.01	0.37	0.82	-	-	-	100	-	N2	34	-	0.02	0.43	-				
																Air	44	29	2.0	7.5	-				
Expt. 393 21.5 hrs.	a.		260	21.6	101										0.016										
	b.	0.888	292	22.5	102			21%	1.01	3.8	1.35	0.07	0.24	0.03	99.75										
	c.																								

Technical Test Stand Plate 16.

Type of Oil Expt. No. Running Time	Spec. Grav. 20°C	VISCOSITIES						Thickening % C.St.38	Acid Number	Sap. Number	Coking	Asphalt	Insoluble in Benzene	Ash	Residue of Vacuum Dist.	Water content	Brit. Oxidation Test				
		C.St. 38	C.St. 99	V.I.	m	Polar Height	E°38										Thickening E°38	Acid No.	Sap.No.	Asphalt	
Stanavo 100 Unused	0.882	241	19.9	103				0.01	0.37	0.82	-	-	-	100	-	N2	34	-	0.02	0.43	-
																Air	44	29	2.0	7.5	-
Expt. 416 22 hrs.		268	21.1	101											0.019						
	a																				
	b	0.887	274	21.4	101			14%	0.44	1.6	1.28	0.04	0.26	0.04	99.75	-					
Stanavo 100 Unused	0.882	243	19.8	101				0.01	0.37	0.82	-	-	-	100	-	N2	34	-	0.02	0.43	-
																Air	44	29	2.0	7.5	-
Expt. 384 17 hrs.		258	20.7	102											0.020						
	a																				
	b	0.886	263	20.8	101			13%	0.58	1.9	1.14	0.05	0.22	0.02	99.5	-					
Stanavo 120 Unused	0.886	360	26.3	104				0.04	0.33	0.93	-	-	-	100	-	N2	49	-	0.05	0.33	-
																Air	66	36	1.75	9.1	-
Expt. 288 27 hrs.		405	27.9	101											0.048						
	a																				
	b	0.890	424	28.4	100			18%	0.76	3.05	1.39	0.04	0.27	0.03	100	-					
Unused		380	27.3	100																	
Expt. hrs.																					
	a																				
	b																				
	c																				

Technical Test Stand Plate 17.

Technical Test Stand Plate 17.