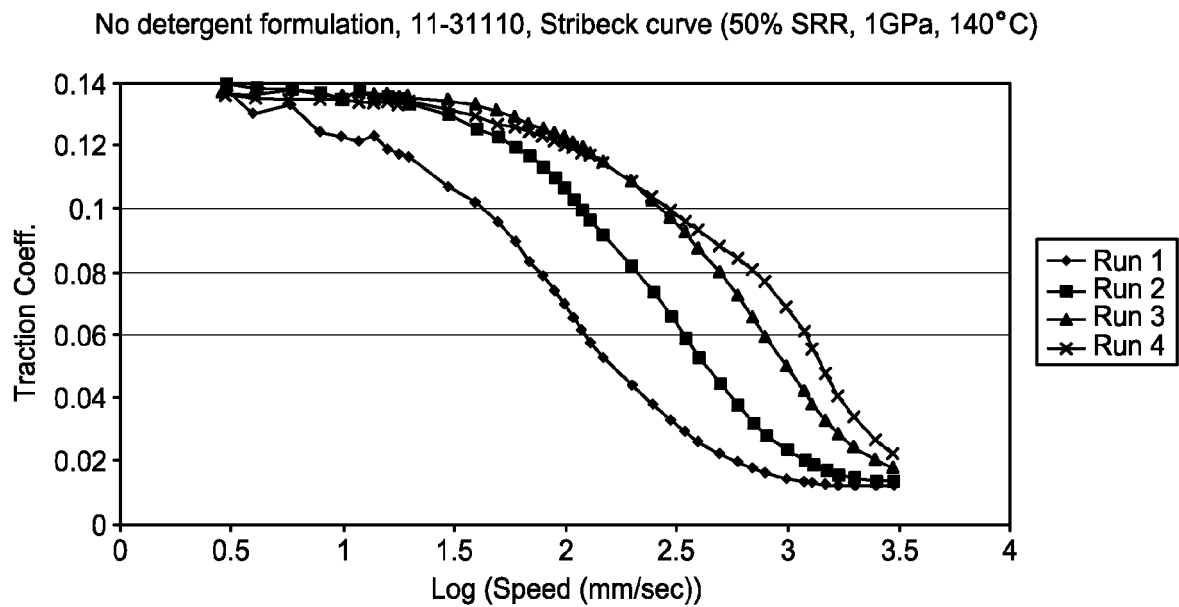


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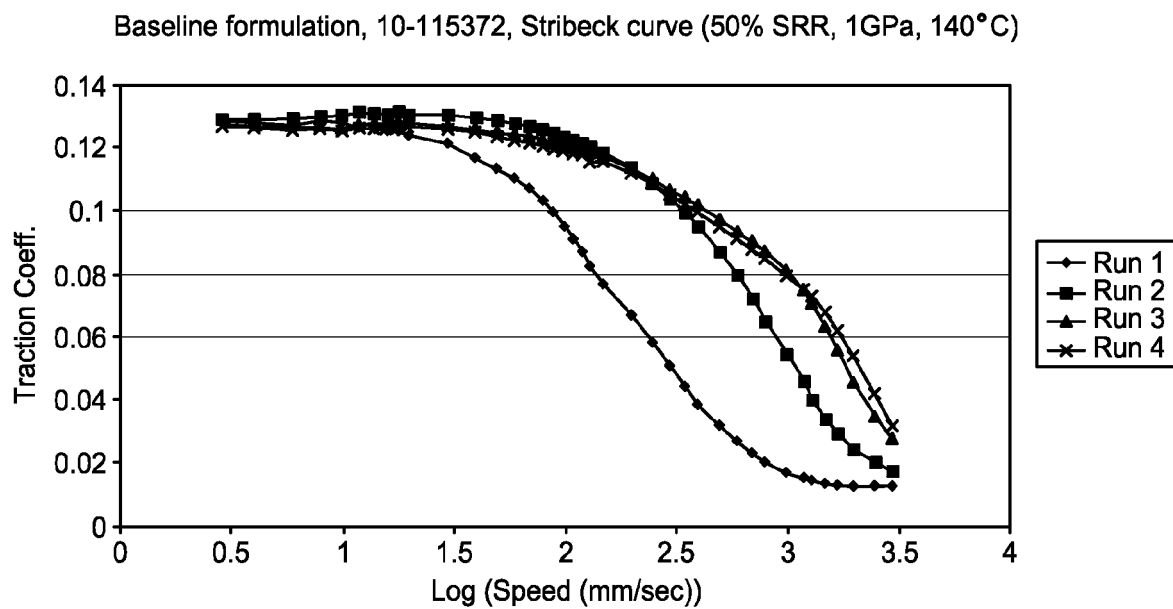
Component	Baseline	No detergent	All Mid TBN	All Low	1/2 Low/High	1.5X Low/High	50/50 Low/High	Low/High TBN mix-salicylate	Low/High TBN mix-sulfonate	Phenate only
Sample #	10-115372	11-31110	11-31111	11-62083	11-62085	11-62086	11-62087	11-31703, 11-70505	11-162199	11-119600
Base Oil	84.71	87.04	83.84	76.99	83.94	77.74	83.3	81.34	80.33	81.39
ZDDP, Pour Point, Dispersant, Inhibitor	7.96	7.96	7.96	7.96	7.96	7.96	7.96	7.96	7.96	7.96
Viscosity Modifier	5	5	5	5	5	5	5	4.5-5	5	5
64 TBN Calcium Salicylate Detergent				10.05	2.5	7.5	1.87	5		
205 TBN Calcium Salicylate Detergent	1.5		3.2							
280 TBN Calcium Salicylate Detergent					0.6	1.8	1.87	1.2		
365 TBN Calcium Sulfonate Detergent									1.71	
405 TBN Magnesium Sulfonate Detergent	0.83									
8 TBN Calcium Sulfonate Detergent									5	
114 TBN Calcium Phenate Detergent										5.65

FIG. 1

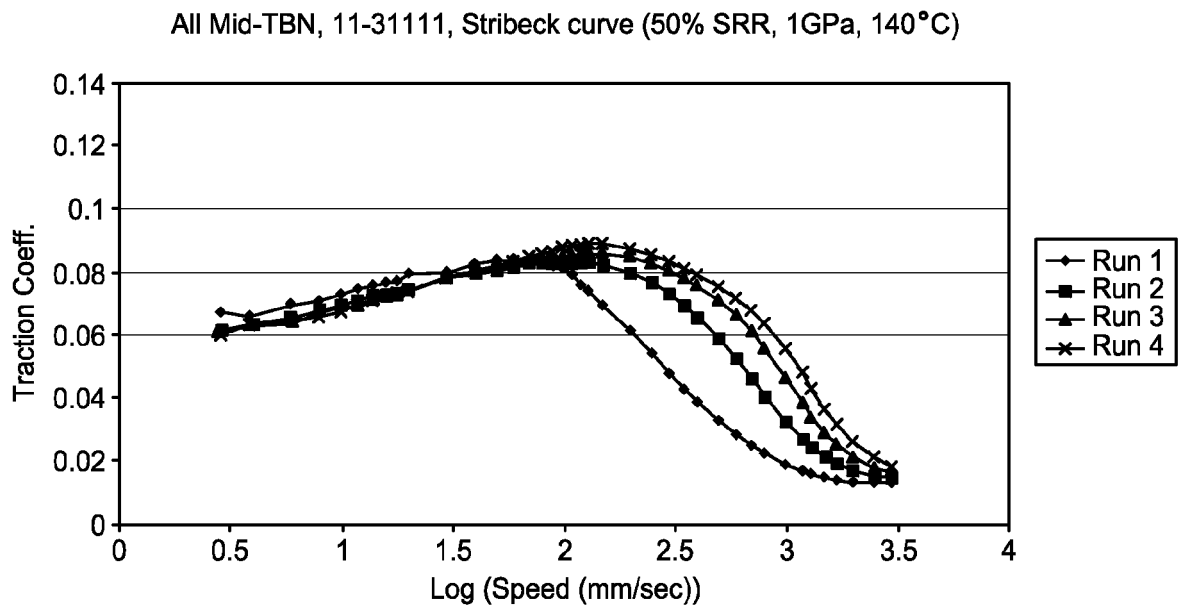
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**FIG. 2**

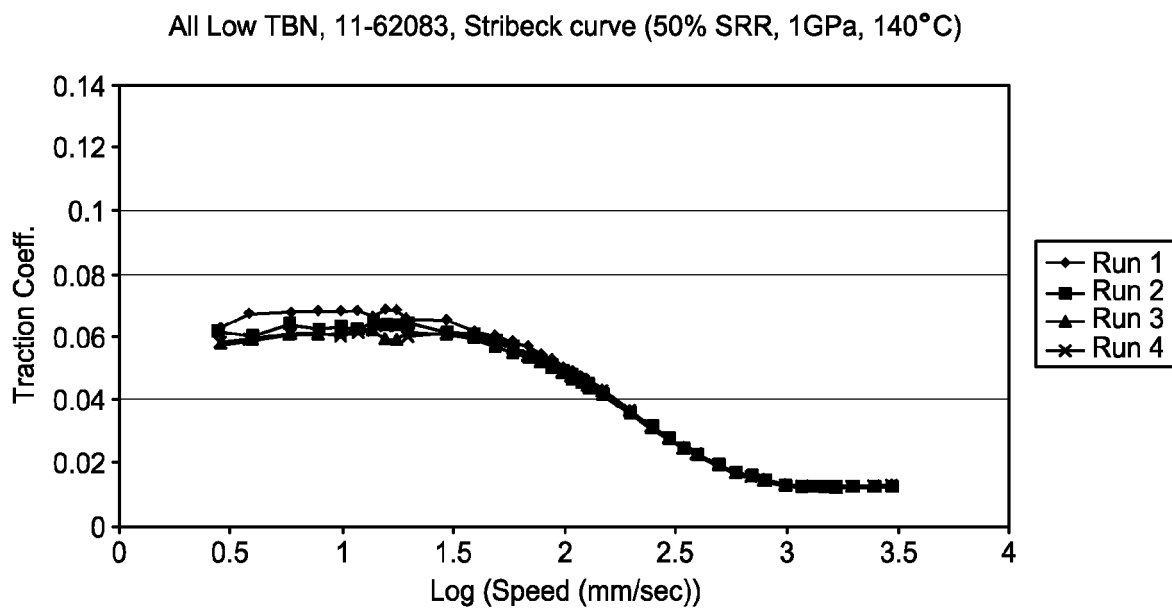
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**FIG. 3**

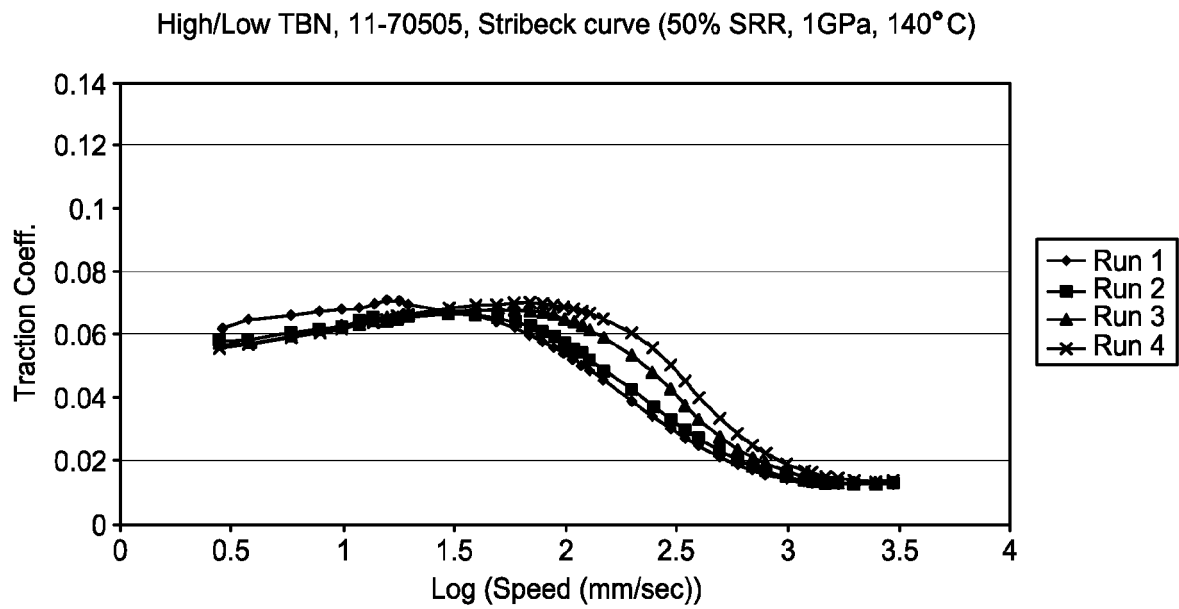
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**FIG. 4**

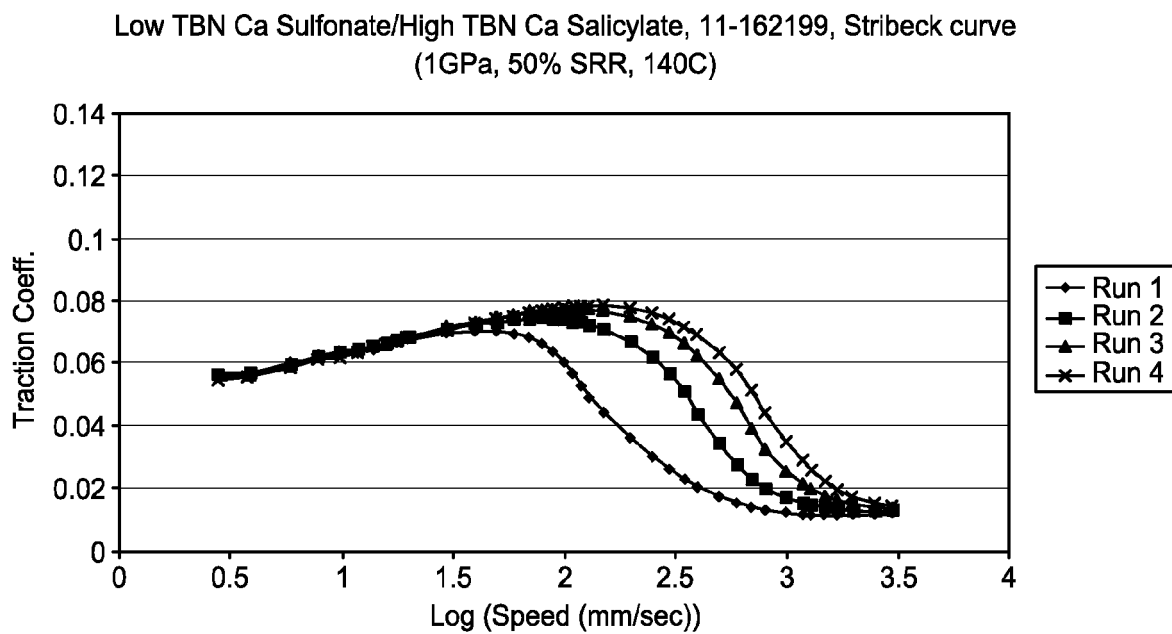
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**FIG. 5**

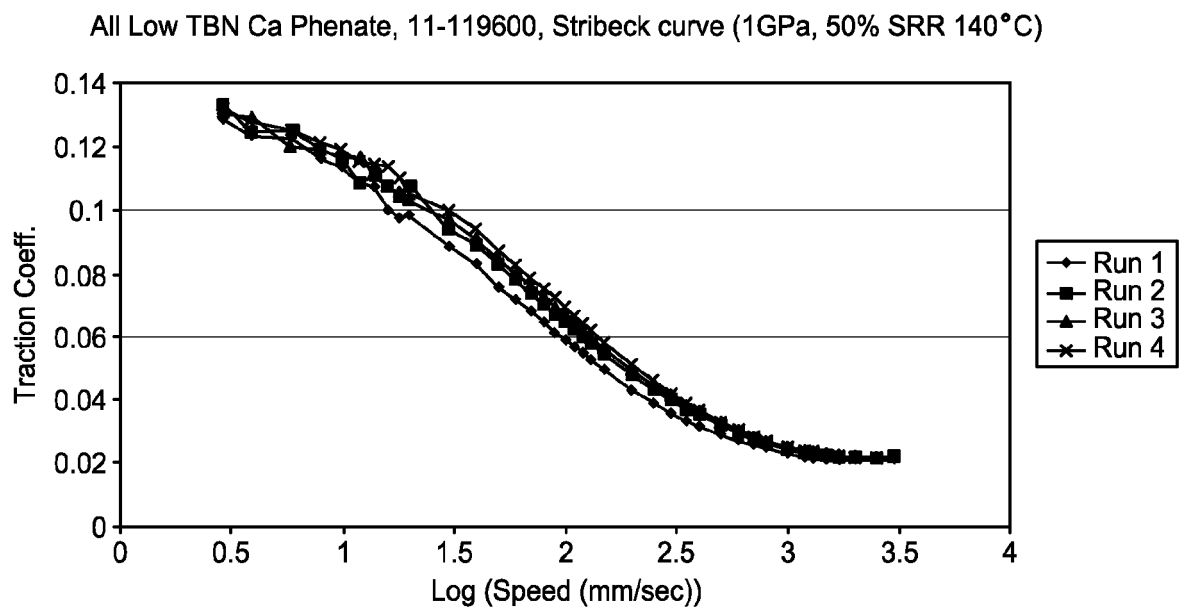
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**FIG. 6**

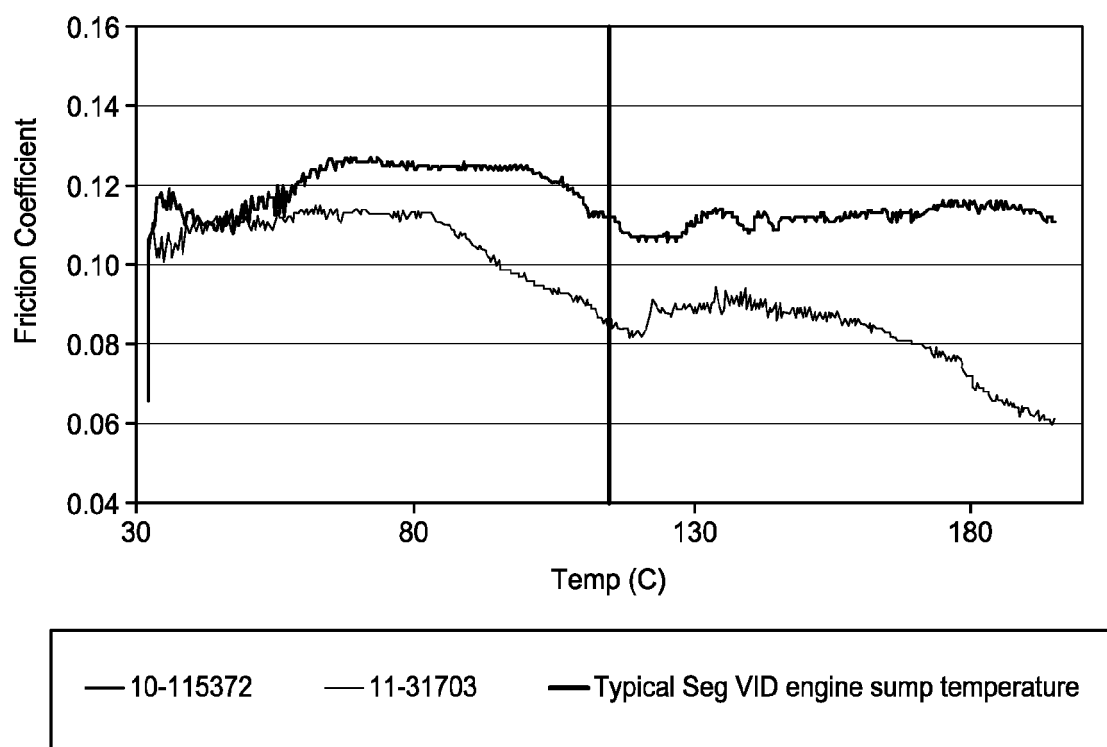
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**FIG. 7**

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**FIG. 8**

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**FIG. 9**

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	Baseline	No detergent	All Mid TBN	All Low	1/2 Low/High	1.5X Low/High	50/50 Low/High	Low/High TBN mix-salicylate	Low/High TBN mix-sulfonate	Phenate only
Sample Number	10-115372	11-31110	11-31111	11-62083	11-62085	11-62086	11-62087	11-70505	11-162199	11-119600
Figure	2	1	3	4				5	6	7
Run 1	0.241	0.210	0.172	0.133	0.191	0.132	0.183	0.138	0.177	0.199
Run 2	0.311	0.270	0.189	0.128	0.259	0.134	0.222	0.137	0.204	0.211
Run 3	0.321	0.312	0.201	0.124	0.304	0.140	0.271	0.147	0.235	0.213
Run 4	0.322	0.318	0.208	0.125	0.323	0.150	0.277	0.153	0.244	0.218
Ave	0.299	0.278	0.192	0.127	0.269	0.139	0.238	0.144	0.215	0.210
STD	0.034	0.043	0.014	0.003	0.051	0.007	0.038	0.007	0.026	0.007
Improvement vs Baseline	---	-0.021	-0.106	-0.171	-0.030	-0.160	-0.061	-0.155	-0.083	-0.089

FIG. 10

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Description	Reference	Ref w/1.3% low TBN	Ref w/2% low TBN	Ref with 4% low TBN	Ref with 8% low TBN	All low TBN
Sample #	13-78069	13-78074	13-78070	13-78071	13-78072	13-78073
Base Oil	84.74	83.74	83.19	81.64	78.54	77.04
ZDDP, Pour Point, Dispersant, Inhibitor	7.96	7.96	7.96	7.96	7.96	7.96
Viscosity Modifier	5	5	5	5	5	5
350 TBN Calcium Salicylate Detergent	2.3	2	1.85	1.4	0.5	0
64 TBN Calcium Salicylate Detergent	0	1.3	2	4	8	10
Ave	0.214	0.186	0.192	0.163	0.158	0.167

FIG. 11

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	0W-20 Baseline	0W-20 Balanced Low TBN/High TBN
Sample #	10-114804	11-70505
Seq IIIG, Viscosity Increase, %	49	88
Seq IIIG, Avg Weighted Piston Deposits, merits	4.5	6.4
Seq IIIG, Avg Cam and Lifter Wear, μm	30	48
Seq IIIGA, MRV@-35C, cP	19700	11600
Seq IIIGA, MRV@-35C, Yield Stress, Pa	<35	<35
Seq IIIGB, Phosphorous Retention, %	82.5	87.4
VW TDI 2 Piston Deposits, merits, pass against RL206-4	63*	66
Seq VID FEI 1, %	1.31**	1.65
Seq VID FEI 2, %	0.99**	1.28
Seq VID FEI Sum, %	2.3**	2.93
Seq VIII, Bearing Loss, mg	14	9
Seq VIII, Stripped Viscosity, mm ² /s	7.6	7.7
Seq IVA, Avg Cam Wear, microns	21	31
OM 646LA*, microns		
Camshaft wear		
Inlet	71	30
Outlet	90	32
Tappet wear		
Inlet	9	4
Outlet	10	8
Cylinder wear	3	2
Bearing wear		
Main bearing	0.2	0.5
Conrod bearing	0.2	0.2
Piston rings axial		
1st ring	8.6	7.4
2nd ring	0.8	0.5
3rd ring	1.2	0.8
Piston rings radial		
1st ring	6.8	5.1
2nd ring	7.9	8.5
3rd ring	6.7	5.7
Timing chain wear	0.2	0.4
Ratings		
Piston cleanliness	10	16
Ring sticking	0	0
Bore polish max, %	1.3	0
Bore polish avg, %	0.4	0
Sludge	9.2	9.2
Oil consumption, g/test	6185	4146
KV@100C increase, %	31	21
Soot content, %	5.1	4.2
* comparable formulation, different viscosity modifier		
** Avg of 2 tests		

FIG. 12

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Description	Grp I ref	Grp I with 5% low TBN detergent	Grp II ref	Grp II with 5% low TBN detergent	Grp IIIA ref	Grp IIIA with 5% low TBN detergent	Grp IIIB ref	Grp IIIB with 5% low TBN detergent	Grp IIIC ref	Grp IIIC with 5% low TBN detergent	Grp IIV ref	Grp IIV with 5% low TBN detergent	Grp V ref	Grp V with 5% low TBN detergent
Sample #	12-109826	12-109827	12-109828	12-109829	12-109832	12-109833	12-109842	12-109843	12-109834	12-109835	12-109836	12-109837	12-109838	12-109839
Group I base stock	97.50	92.50												
Group II base stock			97.50	92.50										
Group IIIA base stock					97.50	92.50								
Group IIIB base stock (F-T)							97.50	92.50						
Group IIV base stock									97.50	92.50	97.50	92.50		
Group V base stock													97.50	92.50
350 TBN Calcium Salicylate Detergent	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
64 TBN Calcium Salicylate Detergent		5.00		5.00		5.00		5.00		5.00		5.00		5.00
Ave	0.192	0.165	0.188	0.174	0.188	0.149	0.191	0.170	0.185	0.171	0.174	0.157	0.193	0.149

FIG. 13

Description	Grp II ref	Grp II with 5% low TBN detergent	Grp IIIA ref	Grp IIIA with 5% low TBN detergent	Grp IIIB ref	Grp IIIB with 5% low TBN detergent	Grp IV ref	Grp IV with 5% low TBN detergent
Sample #	13-077251	13-077252	13-077253	13-077254	13-077257	13-077258	13-077255	13-077256
Group II base stock	97.50	92.50						
Group IIIA base stock			97.50	92.50				
Group IIIB base stock (F-T)					97.50	92.50		
Group IV base stock							97.50	92.50
350 TBN Calcium Salicylate Detergent	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
64 TBN Calcium Salicylate Detergent		5.00		5.00		5.00		5.00
Ave	0.164	0.152	0.161	0.158	0.173	0.155	0.174	0.144

FIG. 14

Description							
Sample #	12-109828	12-109831	12-109830	13-077248	13-077249	13-077250	
Group II base stock	97.50	96.50	95.00	92.50			
Group IIIA base stock					92.50		
Group IV base stock						92.50	
350 TBN Calcium Sulfonate Detergent	2.50	3.50	5.00	7.50	7.50	7.50	
Ave	0.188	0.187	0.185	0.192	0.181	0.190	

FIG. 15