

DSC Oxidation Test Results

<u>Description</u>	<u>Source</u>	<u>DSC Oxidation Onset Temp. °C</u>
1, 1'-Binaphthyl– 500 psi oxygen	Purchased	297
2, 2'-Binaphthyl – 500 psi oxygen	Purchased	312
Alkyl-1,1'-Binaphthyl	Method 3	280
Alkyl Perylene	Method 3	290
Bis a-methylnaphthalene methane	Method 2	263
Bis b-methylnaphthalene methane	Method 2	279
Alkylated bis a-methylnaphthalene methane	Method 3	269
1,1'-(1,2-ethanediyl)bis-naphthalene	Purchased	306
Alkylated 1,1'-(1,2-ethanediyl)bis- naphthalene	Method 3	285
AN 5	Purchased	233
Radical Coupled AN	Method 1	268
Radical Coupled AN	Method 1	268
AN 12	Purchased	230

FIG. 1

Radical Coupled AN was compared to three commercial AN products in the following formulation

Component/Description	Units	Amount
Additives		2.780
High Viscosity PAO	WT%	47.220
Low Viscosity Polyalphaolefin, wt. %	WT%	25.000
Alkyl Naphthalene Basestock	WT%	25.000

Neat Base Stocks				
Alkyl Naphthalene Basestock	AN 5	AN 9	AN 19	Radical Coupled AN
Kinematic Viscosity, 100°C mm ² /s	4.8	8.9	18.7	120.1
Kinematic Viscosity, 40°C mm ² /s	28	72	177	4747
Viscosity Index, Calculated	76	86	119	90
Aromatic/Aliphatic Carbon Ratio	0.59	0.44	0.24	0.59
Formulated Blends				
KV @ 100°C, cSt	21.3	25.3	30.0	42.3
KV @ 40°C, cSt	145	188	234	401
Viscosity Index, Calculated	172	168	168	159
Blend Appearance	Clear & Bright	Clear & Bright	Clear & Bright	Clear & Bright
Bulk Fluid Oxidation Test 150°C of Blends				
1008 Oxidation Test Sludge Rating	Moderate	Moderate	Moderate	Heavy
TAN, 504 hrs 150°C	0.078	0.054	0.079	1.250
TAN, 672 hrs, 150°C	0.079	0.093	0.098	1.190
TAN 840 hrs, 150°C	0.115	0.150	0.272	1.638
TAN 1008 hrs, 150°C	2.951	5.370	8.568	1.793
NBR28SX, 100°C, 168 Hours, % Volume Change	13.0	9.2	5.1	6.7

FIG. 2

Alkyl-1,1'-binaphthyl was compared to three commercial AN products in the following formulation

Component/Description	Units	Amount
Additives	Wt %	2.780
Low Viscosity Polyalphaolefin, wt. %	WT%	47.220
Alkyl Naphthalene Basestock	WT%	50.000

Neat Basestocks				
Alkyl Naphthalene Basestock	AN 5	AN 9	AN 19	Alkyl-1,1-Binaphthyl
Kinematic Viscosity, 100°C mm ² /s	4.8	8.9	18.5	43.8
Kinematic Viscosity, 40°C mm ² /s	29	72	175	1076
Viscosity Index, Calculated	80	96	118	75
Aromatic/Aliphatic Carbon Ratio	0.59	0.44	0.24	>0.62
Formulated Blends				
TAN	0.650	0.639	0.651	0.497
KV @ 100°C, cSt	4.3	5.7	7.9	10.1
KV @ 40°C, cSt	21	33	49	79
Viscosity Index, Calculated	103	114	130	109
Blend Appearance	Clear & Bright	Clear & Bright	Clear & Bright	C&B
Bulk Fluid Oxidation Test 150°C of Blends				
1008 Oxidation Test Sludge Rating	Moderate	Light	Light	Trace
TAN, 336 hrs	0.18	0.03	0.25	---
TAN, 504 hrs	0.32	0.46	4.46	1.23
TAN 672 hrs	0.31	2.87	7.17	1.43
TAN, 840 hrs	1.40	7.63	9.64	1.64
TAN 1008 hrs	2.10	11.96	25.02	2.15

FIG. 3

Purchased Commercial Products	Mono-Alkyl Naphthalene	Di-Alkyl Naphthalene	Tri-Alkyl Naphthalene	Tetra-Alkyl Naphthalene	Aromatic Carbon	Aliphatic Carbon	Aromatic/Aliphatic Carbon Ratio	KV 100°C	KV 40°C	Viscosity Index
Method	GC	GC	GC	GC	per 100 g	per 100 g		cSt	cSt	
	Wt %	Wt %	Wt %	Wt %						
AN 5	90.85	8.37	0.07	0.00	2.727	4.599	0.593	4.7	29	74
AN 6	93.42	6.09	0.00	0.00	2.653	4.682	0.567	5.6	36	90
AN 9	25.38	33.88	40.73	0.00	2.232	5.101	0.438	9.2	72	103
AN 12	13.06	31.57	55.26	0.00	1.782	5.506	0.324	12.4	109	105
AN 14	4.00	37.80	58.20	0.00	1.871	5.433	0.344	13.5	114	110
AN 19	2.12	11.91	52.12	33.81	1.393	5.866	0.237	18.7	177	118
AN 20	0.00	2.74	54.57	42.69	1.283	5.970	0.215	19.8	193	118

FIG. 4

5/5

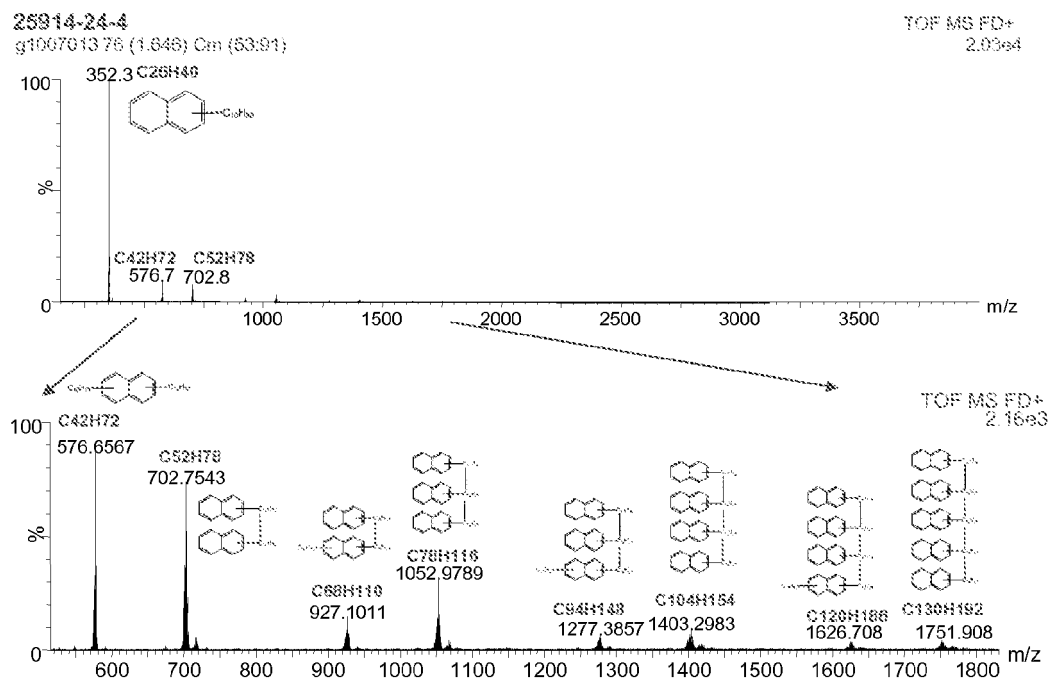


FIG. 5