

Examples	Reference 1	Reference 2	1	2	3	4	5
Performance test report Date	12/14/2010 (IIIG)	11/19/2010 (VID)	8/11/2011 (VID)	8/22/2011 (IIIG) 8/3/2011 (VID)	3/14/2011 (IIIG) 5/28/2011 (VID)	8/9/2011 (IIIG) 7/26/2011 (VID)	7/4/2011 (IIIG) 9/7/2011 (VID)
Alkoxylated alcohol	0.0	0.0	1.0	3.0	5.0	7.0	5.0
Group III	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Group IV	49.8	49.7	48.8	46.8	44.8	42.8	44.7
Group V	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Viscosity Modifier	5.0	5.5	5.0	3.0	5.0	5.0	5.0
Additive Package	10.2	9.8	10.2	10.2	10.2	10.2	10.3

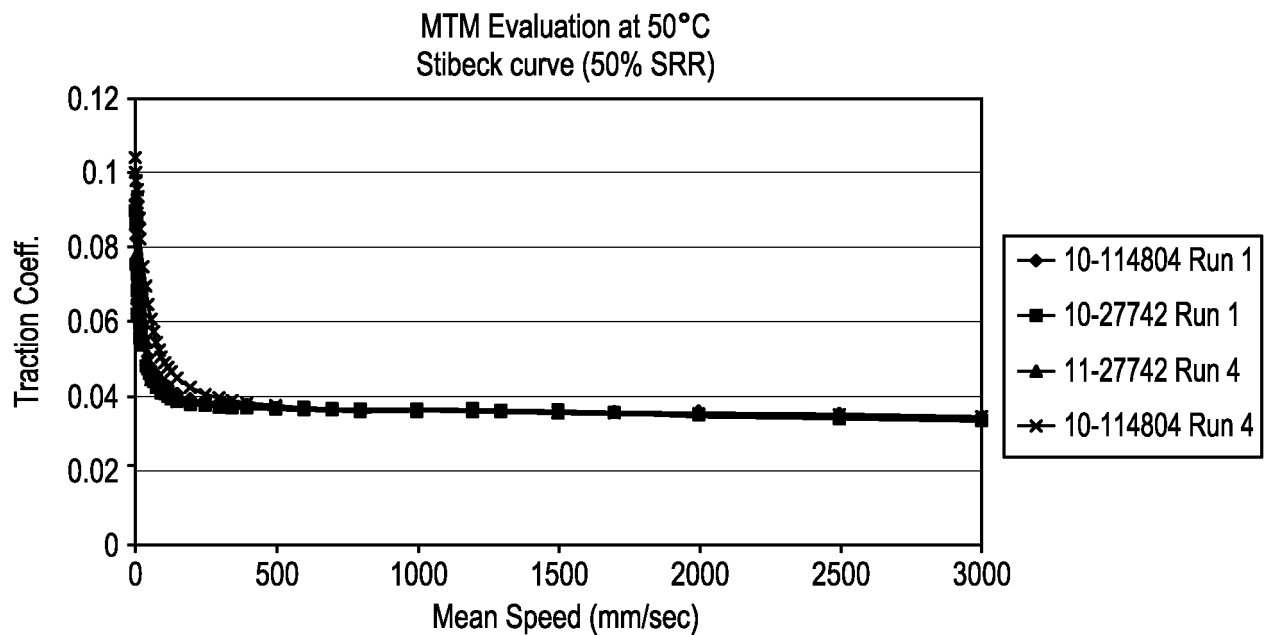
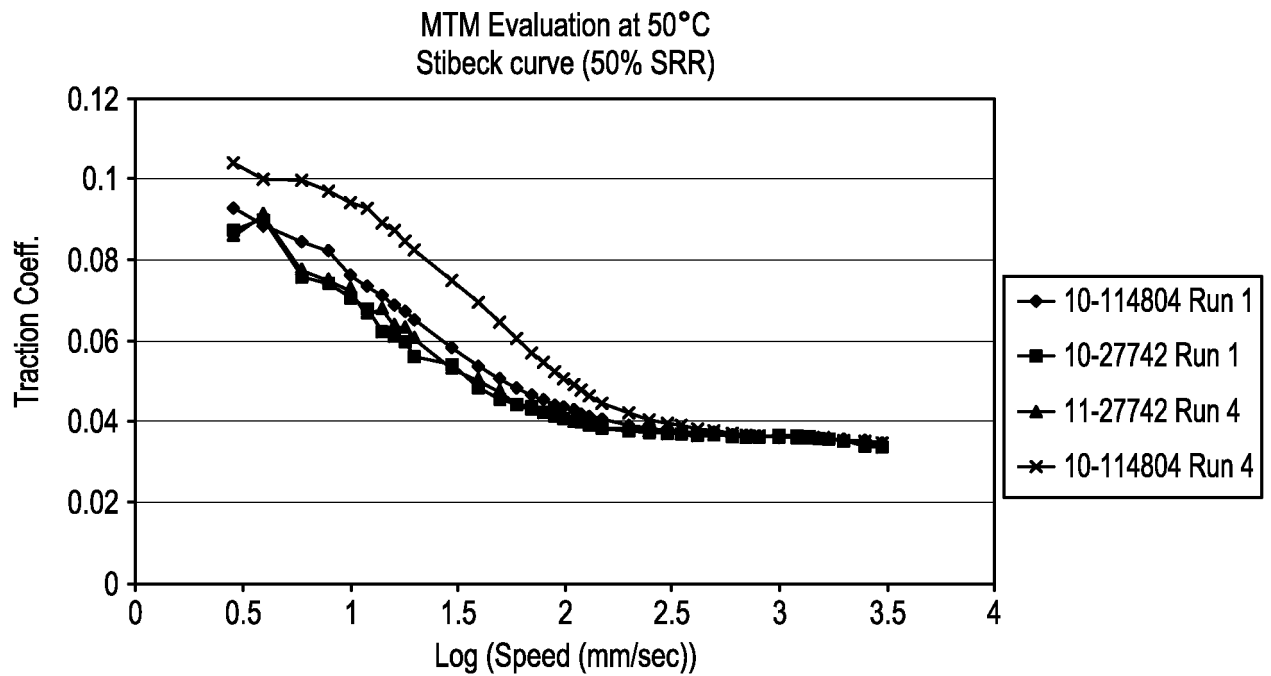
FIG. 1

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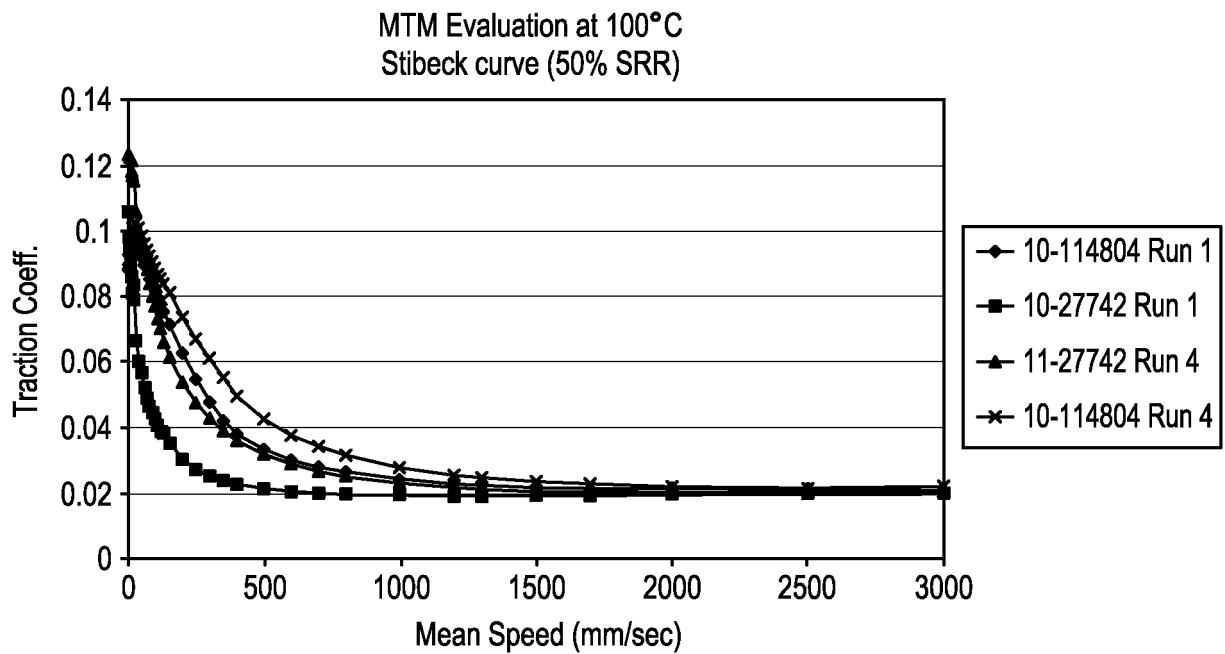
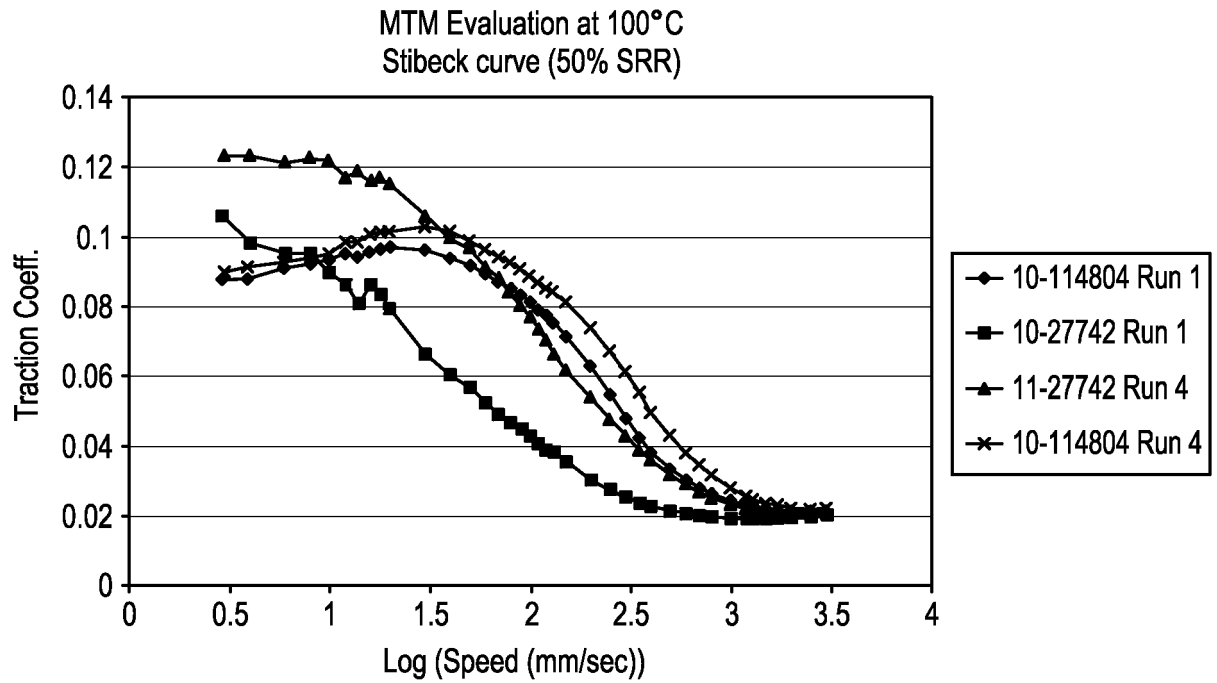
Examples	Reference 1	Reference 2	1	2	3	4	5
Bench Data:							
KV100C	8.7	8.6	8.7	8.8	8.8	9.0	8.9
HTHS at 150°C	2.6	2.7	2.6	2.7	2.7	2.8	2.7
CCS at -35°C	4140	3820	4280	5310	6440	7010	-
Viscosity Grade	0W-20	0W-20	0W-20	0W-20	5W-20	5W-20	5W-20
Engine Data:							
IIIG Kinematic viscosity increase at 40°C, %	49.3	-	-	40.2	52.1	85.8	113.9
IIIG Average weighted piston deposits, merits	4.5	-	-	5.0	5.5	6.0	5.7
IIIG Average cam and lifter wear, µm	30	-	-	28	30	45	40
IIIG Average piston varnish, merits	9.6	-	-	9.2	9.7	8.9	9.6
IIIG Oil Ring Land Deposit, merits	3.7	-	-	3.7	5.3	7.4	5.6
IIIG Undercrown, merits	1.5	-	-	2.0	1.7	2.2	1.9
IIIG Groove 1	4.1	-	-	3.1	2.7	0.8	1.3
IIIG Groove 2	2.2	-	-	1.8	3.8	3.6	4.1
IIIG Groove 3	8.5	-	-	9.5	9.3	8.5	8.6
IIIG Land 2	1.1	-	-	1.2	2.8	1.5	2.2
IIIG Phosphorus Retention, %	83	-	-	84	86	87	85
IIIG Oil Consumption, L	3.5	-	-	3.1	4.1	3.2	4.1
VID FEI 1	-	1.4	1.6	1.6	2.2	1.5	1.3
VID FEI 2	-	1.2	1.2	1.3	1.1	1.1	1.2
VID FEI SUM	-	2.6	2.8	2.8	3.4	2.6	2.5

FIG. 2

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**FIG. 3**

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**FIG. 4**

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Examples		Reference 3	6
Alkoxyated alcohol		0.0	5.0
Group II		43.0	43.0
Group IV		37.0	32.0
Group V		7.3	7.3
Viscosity Modifier		0.8	0.8
Additive Package		12.0	12.0
Engine Data:			
IIIG Kinematic viscosity increase at 40°C, %	ASTM D7320	51.0	35.0
IIIG Average weighted piston deposits, merits	ASTM D7320	5.6	7.4
IIIG Hot stuck rings	ASTM D7320	0.0	0.0
IIIG Average cam and lifter wear, μm	ASTM D7320	42	23
IIIG Oil Ring Land Deposit, merits	ASTM D7320	6.1	9.5
IIIG Undercrown, merits	ASTM D7320	1.1	0.9
IIIG Groove 1	ASTM D7320	2.4	2.6
IIIG Groove 2	ASTM D7320	3.9	6.9
IIIG Groove 3	ASTM D7320	9.6	9.9
IIIG Land 2	ASTM D7320	1.8	4.7
IIIG Phosphorus Retention, %	ASTM D7320	82	86
IIIG Oil Consumption, L	ASTM D7320	3.2	3.8

FIG. 5

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Examples		Reference 1	Reference 4	Reference 5	7	8
Group V		49.7	51.5	51.1	49.0	48.3
Group IIIA				30.0	30.0	30.0
Group IIIB		30.0	30.0			
Group V		5.0	5.0	5.0	5.0	5.0
Detergent 5		1.5	1.5	2.9	2.0	2.0
Detergent 6		0.8	0.8			
Detergent 3					4.0	4.0
Alkoxylated alcohol FM 1					0.3	1.0
Organic FM 3		0.5	0.5	0.5	0.3	0.3
Organicmetallic FM 3					0.2	0.1
Organicmetallic FM 4		0.1	0.1	0.1		
Additive Package		12.3	10.5	10.4	9.2	9.3
Engine Data:						
IIIG WPD	ASTM D7320	4.5		4.3	6.0	5.7
IIIG Viscosity Increase, %	ASTM D7320	49		139	108	99
IIIG Average cam and lifter wear, μm	ASTM D7320	30		75	49	64
IIIG Average piston varnish, merits	ASTM D7320	9.6		9.4	9.7	9.6
IIIG Oil Ring Land Deposit, merits	ASTM D7320	3.7		4.0	6.0	6.4
IIIG Undercrown, merits	ASTM D7320	1.5		1.7	2.2	1.7
IIIG Groove 2	ASTM D7320	2.2		2.2	3.5	3.5
IIIG Land 2	ASTM D7320	1.1		1.4	3.3	2.6
Oil Consumption, L	ASTM D7320	3.5		3.6	3.9	3.9
Phosphorus Retention, %	ASTM D7320	83		88	90	91
VID FEI I	ASTM D7589	1.5	1.6		2.1	
VID FEI II	ASTM D7589	1.2	1.3		1.6	
VID FEI SUM	ASTM D7589	2.6	2.9		3.7	
Bench Data:						
KV100C	ASTM D445	8.7	7.4	7.4	7.0	7.0
HTHS	ASTM D4683	2.6	2.4	2.3	2.3	2.3
MTM Friction Average	WI307SF-9		0.22	0.16	0.17	0.14

FIG. 6

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Examples		9	10
Alkoxyated alcohol		2.0	2.0
Group III		30.0	30.0
Group IV		46.1	49.5
Group V		5.0	5.0
Viscosity Modifier		5.0	5.0
Additive Package		8.5	11.9
Bench Data:			
Sulfated Ash, wt %	ASTM D874	1.8	0.3
TBN, mgKOH/g	ASTM D2896	15	4
KV100, cSt	ASTM D445	8.9	8.6
HTHS at 150°C, cP	ASTM D4683	2.8	2.5
CCS at -35°C, cP	ASTM D5273	5170	4660

FIG. 7

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Examples	11	12	13	14	15	16	17	18	19	20	21	22
Formulation Components												
Molybdenum & Sulfur-containing compounds	0.2	0.2	0.2	0.2	0	0.5	0	0.5	0.2	0.2	0.2	0.2
Mg and/or Ca sulfonates	2	2	1	2	2	2	1	2	0	0	2	0.3
Mg and/or Ca salicylates	2	2	2	1	2	2	2	1	2	0.3	0	0
Borated and/or non-borated succinimides	5	5	5	5	5	5	5	5	5	5	5	5
Dialkyl and/or diarylamines	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Phenolic derivatives	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Oleic acid derivatives	0.5	0.5	0	0	0.5	0.5	0	0	0.5	0.5	0	0
Olefin-based polymers (block, star, and/or mixed)	2	2	2	2	2	2	2	2	2	2	2	2
Polymethacrylates	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Fumarate vinyl acetate-based polymers	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Zinc dialkyl dithiophosphate (1°, 2°, and/or mixed)	0.3	0.3	0.8	0.8	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Silicone compounds	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Alkoxylated alcohols	1	1	2	2	1	1	2	2	1	1	2	2
Group II base stock		30		30		30		30		33.7		32.7
Group III base stock	30		30		30.2		30.2		32		31	
Group IV base stock	50	50	50	50	50	49.7	50	49.7	50	50	50	50
Group V base stock	5	5	5	5	5	5	5	5	5	5	5	5

FIG. 8

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Examples	23	24	25	26	27	28	29	30	31	32	33	34
Formulation Components												
Molybdenum & Sulfur-containing compounds	0.2	0.2	0.2	0.2	0	0.5	0	0.5	0.2	0.2	0.2	0.2
Mg and/or Ca sulfonates	2	2	1	2	2	2	1	2	0	0	2	0.3
Mg and/or Ca salicylates	2	2	2	1	2	2	2	1	2	0.3	0	0
Borated and/or non-borated succinimides	5	5	5	5	5	5	5	5	5	5	5	5
Dialkyl and/or diarylamines	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Phenolic derivatives	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Oleic acid derivatives	0.5	0.5	0	0	0.5	0.5	0	0	0.5	0.5	0	0
Olefin-based polymers (block, star, and/or mixed)	0	0	0	0	0	0	0	0	0	0	0	0
Polymethacrylates	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Fumarate vinyl acetate-based polymers	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Zinc dialkyl dithiophosphate (1, 2, and/or mixed)	0.3	0.3	0.8	0.8	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Silicone compounds	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Alkoxyated alcohols	1	1	2	2	1	1	2	2	1	1	2	2
Group II base stock		32		32		32		32		35.7		34.7
Group III base stock	32		32		32.2		32.2		34		33	
Group IV base stock	50	50	50	50	50	49.7	50	49.7	50	50	50	50
Group V base stock	5	5	5	5	5	5	5	5	5	5	5	5

FIG. 9

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Examples	35	36	37	38	39	40	41	42	43	44	45	46
Formulation Components												
Molybdenum & Sulfur-containing compounds	0.2	0.2	0.2	0.2	0	0.5	0	0.5	0.2	0.2	0.2	0.2
Mg and/or Ca sulfonates	2	2	1	2	2	2	1	2	0	0	2	0.3
Mg and/or Ca salicylates	2	2	2	1	2	2	2	1	2	0.3	0	0
Borated and/or non-borated succinimides	5	5	5	5	5	5	5	5	5	5	5	5
Dialkyl and/or diarylamines	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Phenolic derivatives	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Oleic acid derivatives	0.5	0.5	0	0	0.5	0.5	0	0	0.5	0.5	0	0
Olefin-based polymers (block, star, and/or mixed)	5	5	5	5	5	5	5	5	5	5	5	5
Polymethacrylates	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Fumarate vinyl acetate-based polymers	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Zinc dialkyl dithiophosphate (1°, 2°, and/or mixed)	0.3	0.3	0.8	0.8	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Silicone compounds	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Alkoxylated alcohols	1	1	2	2	1	1	2	2	1	1	2	2
Group II base stock		30		30		30		30		33.7		32.7
Group III base stock	30		30		30.2		30.2		32		31	
Group IV base stock	47	47	47	47	47	46.7	47	46.7	47	47	47	47
Group V base stock	5	5	5	5	5	5	5	5	5	5	5	5

FIG. 10

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Examples	47	48	49	50	51	52	53	54	55	56	57	58
Formulation Components												
Molybdenum & Sulfur-containing compounds	0.2	0.2	0.2	0.2	0	0.5	0	0.5	0.2	0.2	0.2	0.2
Mg and/or Ca sulfonates	2	2	1	2	2	2	1	2	0	0	2	0.3
Mg and/or Ca salicylates	2	2	2	1	2	2	2	1	2	0.3	0	0
Borated and/or non-borated succinimides	5	5	5	5	5	5	5	5	5	5	5	5
Dialkyl and/or diarylamines	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Phenolic derivatives	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Oleic acid derivatives	0.5	0.5	0	0	0.5	0.5	0	0	0.5	0.5	0	0
Olefin-based polymers (block, star, and/or mixed)	7	7	7	7	7	7	7	7	7	7	7	7
Polymerethacrylates	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Fumarate vinyl acetate-based polymers	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Zinc dialkyl dihydrophosphate (1°, 2°, and/or mixed)	0.3	0.3	0.8	0.8	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Silicone compounds	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Alkoxylated alcohols	1	1	2	2	1	1	2	2	1	1	2	2
Group II base stock		32		32		32		32		35.7		34.7
Group III base stock	32		32		32.2		32.3		34		33	
Group IV base stock	43	43	43	43	43	42.7	43	42.7	43	43	43	43
Group V base stock	5	5	5	5	5	5	5	5	5	5	5	5

FIG. 11