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Thermax® Update

REDUCE NATURAL RUBBER COMPOUND COST USING THERMAX® N990 MEDIUM THERMAL CARBON BLACK

Generally, filler type and loading decisions are based on the need to achieve specific hardness and stress strain properties within the rheological constraints of processing. Sometimes increasing filler loading is overlooked as a potential cost saving strategy because, without a corresponding change in filler type, out of specification properties and poor processing can result.

Thermax® N990 allows for higher carbon black loading, effectively decreasing the amount of expensive natural rubber in the finished compound. Depending upon ingredient costs, this can result in a significant saving. Thermax® N990 delivers these benefits without sacrificing compound performance or processing.

The following research, conducted on behalf of Cancarb Limited by the Indian Rubber Manufacturers Research Association, Thane, India, shows the effect of replacing part of the FEF black N550 with Thermax® N990 in NR compounds of three different shore A hardness (50, 60 and 70).

Compound Formulations

Compound Ingredients	50 shore A		60 shore A		70 shore A	
	A1	**A2**	B1	**B2**	C1	**C2**
NR (RSS I X)	100	**100**	100	**100**	100	**100**
FEF - N550	25	**-**	50	**40**	70	**50**
Thermax® – N990	-	**50**	-	**25**	-	**50**
Naphthenic Oil	3	**3**	5	**5**	5	**5**
ZnO	5	**5**	5	**5**	5	**5**
Stearic Acid	1.5	**1.5**	1.5	**1.5**	1.5	**1.5**
Sulphur	2	**2**	2	**2**	2	**2**
CBS	1	**1**	1	**1**	1	**1**
TMTD	0.1	**0.1**	0.1	**0.1**	0.1	**0.1**
A.O. 4020	1	**1**	1	**1**	1	**1**
Total	138.6	**163.6**	165.6	**180.6**	185.6	**215.6**

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Test Compound Properties

Properties	A1	A2	B1	B2	C1	C2
Compound Viscosity ML (1+4)@100°c (MU)	23.0	25.0	48.0	55.0	58.0	66.0
Mooney Scorch Time T_5 @ 125°C (minutes)	19.0	15.0	9.6	9.9	8.0	9.0
Rheometric Properties @ 150°C						
M_L (lbf.inch)	4.81	4.93	10.36	10.60	12.42	14.36
M_H (lbf.inch)	59.40	65.74	71.43	73.58	78.13	81.93
t_S2 (minutes)	6.69	5.31	3.80	3.83	2.93	2.98
t_{90} (minutes)	9.47	7.96	6.06	5.97	6.42	5.96
Vulcanizate Properties						
Hardness - On Button (Shore A)	49	52	60	61	68	71
100% Modulus (kg/cm^2)	14	20	27	31	43	50
300% Modulus (kg/cm^2)	47	79	129	146	177	176
Tensile Strength (kg/cm^2)	272	253	245	230	222	205
Elongation at Break (%)	620	580	490	475	395	390
Tear Strength (kg/cm)	33	38	49	57	71	51
Compression Set (%) at 70°C/22hrs - ASTM D395 Method B	21	22	22	23	30	29
Change in Properties After Aging @ 70°C/168 hours						
Hardness Change (points)	3	5	3	4	6	6
100% Modulus, % Change	29	25	26	32	19	30
300% Modulus, % Change	40	39	27	24	N/A	N/A
Tensile Strength, % Change	-0.5	-10	-2.5	-11	-10	-5
Elongation at Break, % Change	-8	-13	-13	-23	-26.5	-31

RPA Study – STRAIN SWEEP

Temperature = 50°C, Frequency = 60cpm

Strain Degree	A1	A2	B1	B2	C1	C2
	G' (kPa)	G' (kPa)	G' (kPa)	G' (kPa)	G' (kPa)	G' (kPa)
0.02	228.42	323.60	1230.80	1084.90	2501.00	4651.50
0.05	215.89	299.72	1148.90	1007.60	2355.40	3929.00
0.1	191.70	303.79	1064.00	946.20	2140.30	3398.30
0.2	184.27	300.20	1016.20	890.63	1876.50	2850.70
0.5	184.84	288.52	850.30	761.62	1477.80	2163.80
1	185.01	278.05	706.36	639.28	1149.80	1632.50
3	157.62	208.08	422.49	384.94	599.07	780.07
5	129.00	155.16	283.20	260.00	387.57	477.72
10	77.93	82.25	137.67	125.88	197.81	230.83
20	34.06	35.99	60.57	57.41	98.87	113.79
30	19.91	21.05	34.12	34.08	59.48	74.17

G' = Storage Modulus

RPA Study – TEMPERATURE SWEEP

Strain = 0.5 degrees, Frequency = 60cpm

Temperature °C	A1	A2	B1	B2	C1	C2
	G' (kPa)	G' (kPa)	G' (kPa)	G' (kPa)	G' (kPa)	G' (kPa)
40	507.07	563.81	764.67	786.12	1073.50	1070.40
50	520.38	574.55	774.41	793.80	1086.70	1080.40
60	528.80	584.42	765.47	791.58	1065.90	1063.70
70	535.08	589.70	750.73	773.41	1038.40	1030.70
80	537.76	588.88	734.72	761.10	1017.30	999.54
90	547.42	599.80	741.06	771.52	1023.00	1005.40
100	562.48	617.13	755.78	788.95	1033.00	1022.10

G' = Storage Modulus

Dynamic Testing

5 to 25 Hz @ 5 Hz intervals, 0.1% dynamic strain and 0.5% static strain at RT, using a Metravib RDS Viscoanalyzer VA 4000

Storage - Young's Modulus E' (Pa)						
Frequency	**A1**	**A2**	**B1**	**B2**	**C1**	**C2**
5	$1.95X10^{6}$	$2.49X10^{6}$	$7.89X10^{6}$	$7.28X10^{6}$	$1.27X10^{7}$	$1.88X10^{7}$
10	$1.97X10^{6}$	$2.54X10^{6}$	$8.73X10^{6}$	$7.68X10^{6}$	$1.32X10^{7}$	$1.98X10^{7}$
15	$1.98X10^{6}$	$2.54X10^{6}$	$8.24X10^{6}$	$7.61X10^{6}$	$1.34X10^{7}$	$2.02X10^{7}$
20	$2.01X10^{6}$	$2.57X10^{6}$	$8.36X10^{6}$	$7.68X10^{6}$	$1.36X10^{7}$	$2.14X10^{7}$
25	$2.06X10^{6}$	$2.62X10^{6}$	$9.21X10^{6}$	$7.88X10^{6}$	$1.37X10^{7}$	$2.00X10^{7}$
Loss Young's Modulus E" (Pa)						
Frequency	**A1**	**A2**	**B1**	**B2**	**C1**	**C2**
5	$4.43X10^{4}$	$6.97X10^{4}$	$5.88X10^{5}$	$5.40X10^{5}$	$1.07X10^{6}$	$1.86X10^{6}$
10	$5.29\ X10^{4}$	$8.12\ X10^{4}$	$6.50X10^{5}$	$6.29X10^{5}$	$1.11X10^{6}$	$1.86X10^{6}$
15	$6.11\ X10^{4}$	$9.57\ X10^{4}$	$6.58X10^{5}$	$6.21X10^{5}$	$1.15X10^{6}$	$1.90X10^{6}$
20	$6.29\ X10^{4}$	$1.00\ X10^{4}$	$6.82X10^{5}$	$6.47X10^{5}$	$1.19X10^{6}$	$2.12X10^{6}$
25	$3.06\ X10^{4}$	$6.87\ X10^{4}$	$6.60X10^{5}$	$6.13X10^{5}$	$1.21X10^{6}$	$2.24X10^{6}$
Tan Delta						
Frequency	**A1**	**A2**	**B1**	**B2**	**C1**	**C2**
5	$2.27X10^{-2}$	$2.79X10^{-2}$	$7.45X10^{-2}$	$7.41X10^{-2}$	$8.40X10^{-2}$	$9.90X10^{-2}$
10	$2.69X10^{-2}$	$3.20X10^{-2}$	$7.45X10^{-2}$	$8.18X10^{-2}$	$8.41X10^{-2}$	$9.39X10^{-2}$
15	$3.08X10^{-2}$	$3.76X10^{-2}$	$7.99X10^{-2}$	$8.16X10^{-2}$	$8.58X10^{-2}$	$9.41X10^{-2}$
20	$3.13X10^{-2}$	$3.90X10^{-2}$	$8.15X10^{-2}$	$8.43X10^{-2}$	$8.75X10^{-2}$	$9.95X10^{-2}$
25	$1.49X10^{-2}$	$2.62X10^{-2}$	$7.16X10^{-2}$	$7.79X10^{-2}$	$8.84X10^{-2}$	$11.20X10^{-2}$

For more information on the benefits of Thermax® in natural rubber and synthetic rubber compounds, please visit our website at www.cancarb.com