TECHNICAL Bulletin

Subject: Chloroprene Rubber

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THERMAX® MEDIUM THERMAL CARBON BLACK N990 IN CHLOROPRENE RUBBER

Thermax® medium thermal carbon black N990 is manufactured by the thermal decomposition of natural gas. The thermal process provides a unique carbon black characterized by a large particle size and low structure. Thermax® is widely used in applications that require excellent dynamic properties and chemical resistance. The large particle size (low surface area) and low structure allow for low compression set, high rebound and low hysteresis, thereby maintaining the inherent elastomeric properties of the rubber compound. As a non-reinforcing black, thermal black is often blended with furnace carbon blacks and/or mineral fillers to achieve cost reduction and specific physical properties in the rubber compound. The typical properties of Thermax® are listed in Table 1.

Table 1: Typical Properties of Thermax® Floform N990

	Thermax® N990
Nitrogen Surface Area, m^2/g	9.8
DBP Absorption, cc/100 g	38
pH	9.5
Ash Content (%)	0.1
Sieve Residue, 325 mesh, ppm	5
Sieve Residue, Magnetics 325 mesh, ppm	0
Fines Content (%)	4.0
Pour Density g/l	640
Pellet Hardness, grams	20
Heat Loss (%)	0.0

The effects of carbon blacks and mineral fillers on the processing and vulcanizate properties of polychloroprene are generally similar to their effects on other elastomers. Like natural rubber and other polymers with pronounced crystallization tendencies, polychloroprene gum vulcanizates have high tensile strength. The need for reinforcement, therefore, is less than for such elastomers as SBR, butyl rubber and nitrile rubber. Practical vulcanizates are obtained for the majority of uses by filling with the soft, relatively non-reinforcing thermal type carbon black. Thermal blacks afford extra economy because they can be added in greater amounts than reinforcing fillers for a given hardness.[1] Table 2 provides a comparison of Thermax® N990 with other carbon blacks at equal hardness.

[1]Graff, R.S., "Neoprene and Hypalon", in Maurice Morton, ed., Rubber Technology, 3rd edition, 1995, p. 348

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Table 2: Thermax® N990 Compared to Other Carbon Blacks at Equal Hardness

Compound	1	2	3	4	5
Neoprene W	100	100	100	100	100
Vanfre AP-2 Processing Aid	2	2	2	2	2
Stearic Acid	0.5	0.5	0.5	0.5	0.5
Maglite D, Calcined MgO	4	4	4	4	4
Agerite Stalite S Antioxidant	2	2	2	2	2
Plastogen	5	5	5	5	5
Zinc Oxide	5	5	5	5	5
Vanax NP Accelerator	1	1	1	1	1
Thermax® Floform N990	50				
SRF N770		25			
GPF N660			25		
FEF N550				25	
HAF N330					25
Total	169.5	144.5	144.5	144.5	144.5
Press Cures @ 153°C, 20 minutes					
200% Modulus, MPa	2.28	2.00	3.17	3.52	3.10
Tensile Strength, MPa	14.41	16.07	16.69	17.17	18.83
Elongation (%)	700	610	550	550	530
Hardness	52	47	51	53	52
Compression Set* (%)	29	33	32	31	30
Mooney Scorch @ 121°C, t5, min	9	11	12	12	8

*ASTM Method B, 22 hours @ 100°C

Thermax® N990 can be used at a wide range of loadings in polychloroprene rubber. The following data demonstrates the effect of various loadings in Neoprene W, using the formulation given above. The data was selected from The Vanderbilt Rubber Handbook, thirteenth edition, p. 469.

Table 3: Effects of Various Loadings of Thermax® N990 in Neoprene W®

Thermax® N990, phr	25	50	75	100	125
300 % Modulus, MPa	1.4	2.3	3.4	5.9	8.2
Tensile Strength, MPa	14.6	14.4	12.7	12.4	11.9
Elongation (%)	780	700	530	430	330
Hardness, Shore A	45	52	57	62	71
Tear Resistance, kN/m	51.9	55.4	51.0	43.0	37.8
Compression Set (%)	27	29	31	30	30
Mooney, 121°C, t5/ML	11/30	9/39	9/44	8/55	6/67

50 phr of Thermax® N990 in Neoprene W®

The following data demonstrates the physical properties provided to a Neoprene W® compound with a loading of 50 phr of Thermax® N990. The data is based on the same formulation as shown in Table 2, as provided in The Vanderbilt Handbook, p. 469. Compound mixing/analysis were performed at the BFGoodrich Laboratory in Akron, Ohio.

Mixing Procedure

The compound was mixed in a two-step process. The first pass was mixed in a BR size Banbury. The second pass was mixed on a lab mill where zinc oxide and Vanax CPA were added.

Samples were prepared and cured using standard laboratory procedures. Sheets were cured 20 minutes @ 150°C. Pellets were cured 25 minutes @ 150°C.

Properties	50 phr Thermax® N990
Mooney Scorch t5 (min)	18.75
Oscillating Disk Rheometer @ 150°C	
Tmin (N/m)	0.62
Tmax (N/m)	2.83
ts1 (min)	4.61
tc50 (min)	10.63
tc90 (min)	22.71
Cure Rate Index	5.53
Tear Strength, Die B, (kgf/cm)	65.8
Tensile Properties - Original	
Stress @ 300% (MPa)	7.21
Stress @ Break (MPa)	18.32
Elongation @ Break (%)	594
Hardness, Shore A	56
Tensile Properties, oven aged 48 hours @ 100°C	
Stress @ 300% (MPa)	8.77
Stress @ Break (MPa)	17.29
Elongation @ Break (%)	540
Hardness, Shore A	60
Tensile Properties, water aged 7 days @ RT	
Stress @ 300% (MPa)	7.6
Stress @ Break (MPa)	18.69
Elongation @ Break (%)	582
Hardness, Shore A	57
Tensile Properties, salt water aged 7 days @ RT	
Stress @ 300% (MPa)	7.37
Stress @ Break (MPa)	18.23
Strain @ Break (%)	577
Hardness, Shore A	57
Compression Set, Method B	
22 hours @ 100°C (%)	39.4

Compounding Baypren Polychloroprene Rubber for Equal Hardness - 50					
	MT-N990	**SRF-N774**	**FEF-N550**	**HAF-N330**	**ISAF-N220**
Shore A Hardness	50	50	50	50	50
Carbon Black, pbw	25	14	12	10	11
Density g/cm^3	1.280	1.320	1.325	1.340	1.315
Vulcanizate Properties, Press Cure @ 150°C, 30 minutes, 4 mm thick ring per DIN 53 504					
Tensile Strength, MPa	13	16	18	19	18.5
Elongation @ Break (%)	710	650	620	665	635
300% Modulus, MPa	3	4.2	4.3	3.2	3.5
500% Modulus, MPa	8.5	10.6	11.8	10.3	11.3
Rebound Resilience (%)	53	55	55	53	52
Tear Resistance, N	8	10	9	8	8
Set @ Break after 1 min. (%)	9	8	6	6	6
DIN Abrasion Loss, mm^3	130	118	95	82	96
Compression Set, ASTM Method B					
22 hours @ 70°C	15	16	16	15	14
70 hours @ 100°C	36	34	38	37	37

Formulation

Baypren 210	100
Magnesium Oxide	4 Maglite D
Stearic Acid	1
Vulkanox PAN – antioxidant	2 (Vulkanox OCD)
Paraffin Wax	0.6
Carbon Black	50
Active Zinc Oxide	5
Vulkacit NPV/C	0.6 (Rhenogran ETU – 80)

Plasticizers were not used in this study in order to highlight the effect of the carbon black.

Source: Bayer Technical Information tib, Rubber Business Group, KA-FK-0170e, 1997

Compounding Baypren Polychloroprene Rubber for Equal Hardness - 80					
	MT-N990	**SRF-N774**	**FEF-N550**	**HAF-N330**	**ISAF-N220**
Shore A Hardness	80	80	80	80	80
Carbon Black, pbw	135	68	56	52	50
Density g/cm^3	1.560	1.440	1.425	1.430	1.420
Vulcanizate Properties, Press Cure @ 150°C, 30 minutes, 4 mm thick ring per DIN 53 504					
Tensile Strength, MPa	14	18.5	20	20	22
Elongation @ Break (%)	230	210	200	215	230
300% Modulus, MPa	-	-	-	-	-
500% Modulus, MPa	-	-	-	-	-
Rebound Resilience (%)	32	37	36	33	31
Tear Resistance, N	14	18	15	14	18
Set @ Break after 1 min. (%)	3	4	3	4	5
DIN Abrasion Loss, mm^3	183	87	66	67	72
Compression Set, ASTM Method B					
22 hours @ 70°C	16	17	14	15	16
70 hours @ 100°C	37	36	39	37	35

Formulation

Baypren 210	100
Magnesium Oxide	4 Maglite D
Stearic Acid	1
Vulkanox PAN – antioxidant	2 (Vulkanox OCD)
Paraffin Wax	0.6
Carbon Black	50
Active Zinc Oxide	5
Vulkacit NPV/C	0.6 (Rhenogran ETU – 80)

Plasticizers were not used in this study in order to highlight the effect of the carbon black.

Source: Bayer Technical Information tib, Rubber Business Group, KA-FK-0170e, 1997