

TECHNICAL Bulletin

Subject: BIMS Inner Liner
Compounds

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MEDIUM THERMAL BLACK N990 IN EXXON BIMS INNER LINER COMPOUNDS

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® can be blended with GPF carbon black for application in halobutyl (BIIR, CIIR) tire inner liners. Performance benefits from N990 carbon black include:

- High loadability in halobutyl inner liners, compared to using only GPF grades
- Reduction of permeability in inner liners at high carbon black loading
- Reduction of compound cost due to high black loading
- Possibility for reduction of liner gauge providing cost savings

In this report, Cancarb's N990 thermal black is evaluated in tire inner liner compounds using Exxon's new brominated isobutylene paramethyl styrene (BIMS) polymer. The BIMS polymers have the same air diffusion resistance as butyl polymers but are much more heat stable. Because they have no unsaturation in the backbone, they are impervious to attack by oxygen or ozone. These properties make BIMS polymers ideal for use where inner liners see extreme environments of heat and flexing or where extended life is desired.¹

The BIMS inner liner test formulations are provided in Table 1. The N990 carbon black loading was calculated to provide hardness equivalent to the control compound.

Table 1: Test Formulations

Control	#1	#2	#3	#4
Exxpro 89-4	100	100	100	100
N660	60	45	30	15
Cancarb N990	-	30	60	90
Napht. Oil	8	8	8	8
SP1068 Tackifier	2	2	2	2
Escorez 1102 Resin	2	2	2	2
Struktol 40 MS	7	7	7	7
Stearic acid	2	2	2	2
Zinc oxide	3	3	3	3
MBTS	1.5	1.5	1.5	1.5
Sulphur	0.5	0.5	0.5	0.5

¹Jones, Glenn E., Inner Liners for Truck Tires: A Review, Presented at ACS Rubber Division, April 2000 Meeting, Dallas, Paper #56

Key Findings:

- The compound with 90 phr N990 had a 23% improvement in fatigue life cycle over the control compound
- Equivalent crack growth for all compounds up to 500,000 cycles. At one million cycles, the control compounds crack growth was twice as long as that for the compounds with 60 phr and 90 phr of N990
- Similar tan delta values across the full temperature range of -100°C to 50°C in the Goodrich Flexometer test
- Substantial improvement in adhesion to the carcass compound for the test compounds with 60 phr and 90 phr of thermal black
- Improvement in impermeability ranged from 7% to 23.5% as compared to the control compound
- Reduction in tensile strength as the N660 loading decreased and the N990 loading increased, although hardness remained equal

Detailed compound test results are provided below in Table 2.

Table 2: Compound Data

Compound #	#1	#2	#3	#4
Exxpro 89-4	100	100	100	100
N660	60	45	30	15
Thermax® N990	-	30	60	90
ODR, ASTM 2084-95, 320°F, 1° Arc				
Tmin, in-lb	6.3	6.6	6.6	6.8
Tmax, in-lb	13	13.5	13.4	13.9
ts1, minutes	5.9	6	6.7	6.9
ts2, minutes	7.5	7.5	8.4	8.1
tc50%, minutes	9	9.1	9.9	9.8
tc90%, minutes	13.3	13.3	14.6	13.9
tc95%, minutes	15.7	15	16.3	15.7
Mooney Scorch, ASTM D 1656 - 96, 125°C, ML				
Minimum Torque	50.59	50.64	48.91	48.74
Ts1, minutes	13.58	13.42	14.08	14.33
Ts5, minutes	25.5	25.58	27.08	27.67
Ts10, minutes	31.33	31.58	34.08	34.75
Ts35, minutes	38.33	38	41.42	41.92
Ts35 - s5, minutes	12.83	12.42	14.34	14.25
Originals, Cured 17' @ 160°C, ASTM D 412 - 99				
100% Modulus, MPa	1.08	1.19	1.23	1.23
300% Modulus, MPa	3.14	3.6	3.61	3.54
Tensile Strength, MPa	9.09	7.91	6.96	5.7
Elongation at break (%)	937	891	842	735
Hardness, Shore A	48.8	47.3	47.8	48.4
Cured 17' @ 160°C, Aged 7 days @ 150°C				
100% Modulus, MPa	3.1	3.12	3.29	3.29
300% Modulus, MPa	8.77	8.52	6.89	7.08
Tensile Strength, MPa	10.77	9.32	7.96	7.11
Elongation at break (%)	487	438	408	392
Fatigue to Failure, 23°C, Originals, Extension Cycles x 100, ASTM D 4482 - 99				
Average of 6	7342	4356	6072	9019

	#1	#2	#3	#4
Crack Growth, Pierced Samples, 23°C, ASTM D 813-95				
1 = no growth 2 = 2x original crack				
300,000 cycles	1	1	1	1
500,000 cycles	1	1	1	1
800,000 cycles	1.5	2	1	1
1,000,000 cycles	2	2	1	1
BFGoodrich Flexometer Tan Delta, 1Hz				
-100°C	0.04617	0.04709	0.04868	0.04306
-50°C	0.59637	0.61134	0.60539	0.60074
0°C	0.39256	0.3844	0.42234	0.4225
23°C	0.15768	0.14084	0.15685	0.15618
50°C	0.11329	0.10393	0.11421	0.11117
Adhesion, Compound to Carcass Ply, Instron 4465, RT				
Mean Peel Strength, lbs/in	107	117	129	127
Average peel strength = Average load of entire pull/test thickness				
Exxon Air Permeability				
Ft.3 - 0.001"/Ft ² -day-psi x 1000	1.53	1.37	1.17	1.42
% Difference vs. Compound #1	0	-10%	-23.50%	-7.10%