cancarb

TECHNICAL BULLETIN

Natural Rubber Engine Mounts I

Thermax® N990 medium thermal carbon black, manufactured by Cancarb Limited, is characterized by its large particle size and low structure. Thermax® is widely used in applications such as engine mounts, which require excellent dynamic properties. The large particle size (low surface area) and low structure allow for high rebound and low hysteresis, thereby maintaining the inherent elastomeric properties of the rubber compound.

In this report, Thermax® is compared in an engine mount compound to a low surface area/low structure black (Sterling 1120) that is being marketed as a replacement for N990. The physical properties of the two carbon blacks are as follows:

Parameter	Thermax® N990	Sterling 1120
NSA m^2/g	9.7	25
DBP cc/100 g	38	35
pH	10	8.7
Ash Content %	0.1	0.49
325 Mesh Sieve Residue	8	425
Fines %	4	8.4
Pellet Crush 10 mesh	20	55

**Typical Properties*

Comparison of the two carbon blacks was made in an engine mount compound based on natural rubber and formulated for the low hardness and modulus typical of such a compound. An EV curing system was used to prevent reversion and provide good heat resistance.

1702 Brier Park Crescent N.W., Medicine Hat, AB, Canada, T1C 1T9 Phone 1.403.527.1121 Fax 1.403.529.6093 customer_service@cancarb.com www.cancarb.com

cancarb

Formulation/Properties

Compound No.:	1	2	3	4
SMR 5	100.0	100.0	100.0	100.0
Kadox 920 (Zinc Oxide)	3.0	3.0	3.0	3.0
Stearic Acid	1.0	1.0	1.0	1.0
Vulkanox HS/LG (Bayer Antioxidant)	1.0	1.0	1.0	1.0
N762 Carbon Black	15.0	15.0	15.0	15.0
Thermax® N990	45.0	70.0	-	-
Sterling 1120	-	-	45.0	70.0
Sundex 790 (Aromatic oil)	15.0	15.0	15.0	15.0
Vulkacit Thiuram (Bayer Accelerator)	0.5	0.5	0.5	0.5
Vulkacit CZ/EG/C (Bayer Accelerator)	3.0	3.0	3.0	3.0
Sulphur	0.5	0.5	0.5	0.5
TOTAL	184	209	184	209
Specific Gravity	1.16	1.22	1.16	1.22
Compound Properties				
Compound Viscosity	19.2	29.6	22.8	30.8
(ML 1+4′ @ 100°C)				
Mooney scorch time				
t5 min @ 121°C	30.0	-	27.0	-
t35 min @ 121°C	30.0	-	29.0	-
Monsanto Rheometer @ 160°C. 1° arc,				
50 range, 1.7 Hz.				
MH	26.81	29.71	25.74	29.64
ML	3.41	3.87	3.12	4.24
Delta Torque	23.40	25.84	22.62	25.41
ts1	3.60	3.26	3.38	2.60
ts2	3.86	3.49	3.63	2.81
t50	4.55	4.13	4.23	3.38
t90	5.72	5.29	5.35	4.59

**Typical Properties*

1702 Brier Park Crescent N.W., Medicine Hat, AB, Canada, T1C 1T9 Phone 1.403.527.1121 Fax 1.403.529.6093 customer_service@cancarb.com www.cancarb.com

cancarb

Compound No.:	1	2	3	4
N762 Carbon Black	15.0	15.0	15.0	15.0
Thermax® N990	45.0	70.0	-	-
Sterling 1120	-	-	45.0	70.0
Vulcanizate Properties				
Cure time @ 160°C	11	10	11	10
Hardness, Shore A2	43	49	46	53
Modulus @ 50% elongation (MPa)	0.78	0.9	0.74	0.9
Modulus @ 100% elongation (MPa)	1.3	1.6	1.2	1.5
Modulus @ 200% elongation (MPa)	3.3	4.2	2.7	3.7
Modulus @ 300% elongation (MPa)	6.3	8.2	5.3	7.3
Modulus @ 400% elongation (MPa)	10.9	13.3	9.4	12.0
Modulus @ 500% elongation (MPa)	17.2	-	15.5	-
Tensile strength (MPa)	20.6	17.8	22.6	19.0
Ultimate elongation (%)	535	480	580	530
Tear strength, die C (kNm)	42	-	45.7	-
Zwick rebound (%) - cured t90 + 20 min				
@ 0°C	55.9	-	52.9	-
@ 23°C	65.5	-	62.1	-
@ 100°C	72.2	-	69.7	-
Compression set (%)	42	41	44	48
(70h @ 100°C) - cured t90 +10 min.				
DeMattia Flex Crack Growth				
Kc to 300% crack growth	78	21	93	16
Kc to 600% crack growth	225	53	250	39
Aged Vulcanizate Properties - change				
Hardness (pts)	0	-	-1	-
Modulus @ 50% elong (%)	-9	-	-3	-
Modulus @ 100% elong (%)	-8	-	8	-
Modulus @ 300% elong (%)	6	-	17	-
Tensile strength (%)	-26	-	-17	-
Ultimate elongation (%)	-13	-	-6	-

1702 Brier Park Crescent N.W., Medicine Hat, AB, Canada, T1C 1T9 Phone 1.403.527.1121 Fax 1.403.529.6093 customer_service@cancarb.com www.cancarb.com

Compound No.:	1	2	3	4
N762 Carbon Black	15.0	15.0	15.0	15.0
Thermax® N990	45.0	70.0	-	-
Sterling 1120	-	-	45.0	70.0
Dynamic Properties				
Dynamic Testing - MER 1100 @ 20Hz				
tan delta				
@ 0°C	0.057	0.151	0.149	0.189
@ 25°C	0.084	0.027	0.103	0.118
@ 100°C	0.046	0.064	0.068	0.112
E*				
@ 0°C	2.872	5.008	4.450	7.674
@ 25°C	3.114	3.973	3.770	5.031
@ 100°C	2.934	3.803	3.095	4.388
E′				
@ 0°C	2.867	4.962	4.401	7.541
@ 25°C	3.103	3.972	3.750	4.996
@ 100°C	2.931	3.795	3.088	4.361
E″				
@ 0°C	0.163	0.748	0.656	1.425
@ 25°C	0.261	0.107	0.386	0.590
@ 100°C	0.135	0.243	0.210	0.488
Dynamic/ Static Stiffness Ratio @ RT				
Dynamic Stiffness (kg/mm)	2.395	3.056	2.900	3.870
Static Stiffness (kg/mm)	5.305	4.991	4.566	4.654
Dynamic/Static Stiffness Ratio	0.451	0.612	0.635	0.832

1702 Brier Park Crescent N.W., Medicine Hat, AB, Canada, T1C 1T9 Phone 1.403.527.1121 Fax 1.403.529.6093 customer_service@cancarb.com www.cancarb.com

cancarb

Compound Properties

Very little difference was shown in the compound properties between the two different carbon blacks. Thermax® provided better processing safety but the 1120 was more than adequate. Compound viscosities and curing characteristics were all similar.

Vulcanizate Properties

The Thermax® compounds (#1 and #2) had higher moduli but lower tensile strength and hardness than the 1120 compounds (#3 and #4). Differences in tear strength, crack growth resistance were only slight, both carbon blacks giving good results for natural rubber based compounds.

Dynamic Properties

For engine mounts it is desirable to have the lowest possible values for dynamic stiffness, tan delta and transmissibility. The test results indicate that Thermax® N990 is consistently and significantly superior and provides the best dynamic properties, in all respects. Thermax® has the least tendency to affect the inherent elastomeric properties of rubber compounds and hence its widespread use in applications such as: anti-vibration parts, engine and muffler mounts, rail and bridge pads. In additional compounds not reported above, **Thermax® maintained its superiority in dynamic properties, recording the lowest figures for tan delta, dynamic moduli, transmissibility and dynamic/static stiffness ratio at all filler loadings.**

Conclusion

At equivalent loadings, the two carbon blacks, Thermax® N990 and Sterling 1120, afforded similar property levels in most cases with Thermax® providing lower hardness. Sterling 1120 performed to a marginally better degree in the cut growth test. **Thermax®, however, provided consistently superior dynamic properties, a most important consideration for the engine mount application.**

Cancarb recommends the above compound #1 as a **starting formulation** for natural rubber engine mounts. This compound has the lowest stiffness as shown by E′ and E″ and dynamic/static stiffness ratio. It also has superior cut growth properties.

1702 Brier Park Crescent N.W., Medicine Hat, AB, Canada, T1C 1T9 Phone 1.403.527.1121 Fax 1.403.529.6093 customer_service@cancarb.com www.cancarb.com