

TECHNICAL BULLETIN

N990 Medium Thermal Carbon Black in Chlorosulphonated Polyethylene 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 dispersion and superior heat, oil and chemical resistance. The large particle size (low surface area) and low structure allow for low compression set, high rebound and low viscosity, 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.

Thermax[®] can be used in all polymers and is commonly used in elastomers such as NR, NBR, EPDM, HNBR, ACM, FKM and ECO. High loadings of Thermax[®] are possible, while maintaining low viscosity and physical properties such as low compression set, thereby allowing manufacturers to reduce compound cost.

The following study, conducted on behalf of Cancarb Limited by the Indian Rubber Manufacturers Research Association, Thane, India, shows the effect of replacing FEF black N550 with Thermax[®] N990 in the following CSM compounds of three different shore A hardnesses (60, 70 and 80).

Compound Ingredients (phr)	60 shore A		70 shore A		80 shore A	
	60A	60B	70A	70B	80A	80B
CSPETS530	100	100	100	100	100	100
MgO	10	10	10	10	10	10
FEF Black N550	20	-	40	20	60	20
Thermax[®] N990	-	40	-	40	-	80
Aromatic Oil	10	10	10	10	10	10
Paraffin Wax	3	3	3	3	3	3
NBC (Antioxidant)	1	1	1	1	1	1
Ultralube 220	2	2	2	2	2	2
DPTT	1.5	1.5	1.5	1.5	1.5	1.5
MBTS	1	1	1	1	1	1
TOTAL (phr)	148.5	168.5	168.5	188.5	188.5	228.5

* CSPETS530- Chlorosulphonated Polyethylene - Grade used is TS530 having chlorine content 35%, Sulphur content 1.0% and Mooney viscosity (ML1+4)@100°C is 56

** MgO - Konoshima Chemical Co. Ltd. - Starmag 150

For the 60 and 70 shore A hardness compounds, the compound viscosity was completely maintained. The 80 shore A compound viscosity was slightly reduced, which is beneficial in processing a high hardness compound. The Mooney scorch time for all three compounds was maintained even though the total carbon black loading was increased by 20, 20 and 40 phr respectively.

There is minimum affect to both the rheometric and the vulcanizate properties despite the increase in filler loading for each test compound. Compression set was either maintained or slightly improved for the compounds based on Thermax® N990.

CSM Test Compound Properties

Compound	60A	60B	70A	70B	80A	80B	Test Method
FEF Black N550 (phr)	20	-	40	20	60	20	
Thermax® N990 (phr)	-	40	-	40	-	80	
Viscosity ML(1+4) @ 100°C	50	50	65	65	91	86	IS-11720 (Pt.3)
Mooney Scorch time t5 @ 125° C (min)	12	12	9	9	7	7	IS-3660 (Pt.7)

Rheometric properties @ 160° C

M _H (Ibf.inch)	70.76	74.09	86.36	91.03	101.55	97.62	ASTM D2084
M _L (Ibf.inch)	7.12	6.96	9.91	9.27	13.36	11.37	ASTM D2084
T _{s2} (min)	2.30	2.43	1.88	1.91	1.74	1.79	ASTM D2084
t90 (min)	16.43	23.36	13.61	16.97	14.18	14.98	ASTM D2084

Vulcanizate Properties

Hardness (shore A)	57	58	69	70	79	78	IS-3400 (Pt.23)
100% modulus (kg/cm ²)	19	17	50	46	85	78	IS-3400 (Pt.1)
300% modulus (kg/cm ²)	104	89	185	176	-NA-	-NA-	IS-3400 (Pt.1)
Tensile Strength (kg/cm ²)	218	202	212	191	202	176	IS-3400 (Pt.1)
Elongation at break (%)	530	580	380	360	230	230	IS-3400 (Pt.1)

Compression Set

70°C @ 25% defln. for 22hrs. (%)	30	30	31	28	32	32	IS-3400 (Pt.10)
----------------------------------	----	----	----	----	----	----	-----------------

In general, the differences in physical properties after ageing between the control and test compounds were relatively minor with all Thermax® compounds providing relatively similar results comparative to the control compounds. These results are remarkable given the increase in total carbon black loading for the test compounds versus the controls.

Compound	60A	60B	70A	70B	80A	80B	Test Method
Change in Physical Properties After Ageing @ 121°C for 70 hrs.							
FEF Black N550 (phr)	20	-	40	20	60	20	
Thermax® N990 (phr)	-	40	-	40	-	80	
Hardness change (points)	+3	+2	+3	+1	+2	+2	IS-3400 (Pt.23&4)
100% modulus change (%)	+74	+53	+30	+35	+40	+37	IS-3400 (Pt.1& 4)
300% modulus change (%)	+24	+39	+10	+8	-NA-	-NA-	IS-3400 (Pt.1& 4)
Tensile Strength, change (%)	+1	+1	-2	+1	+6	+5	IS-3400 (Pt.1& 4)
Elongation at break, change (%)	-9	-10	-18	-8	-9	-4	IS-3400 (Pt.1& 4)

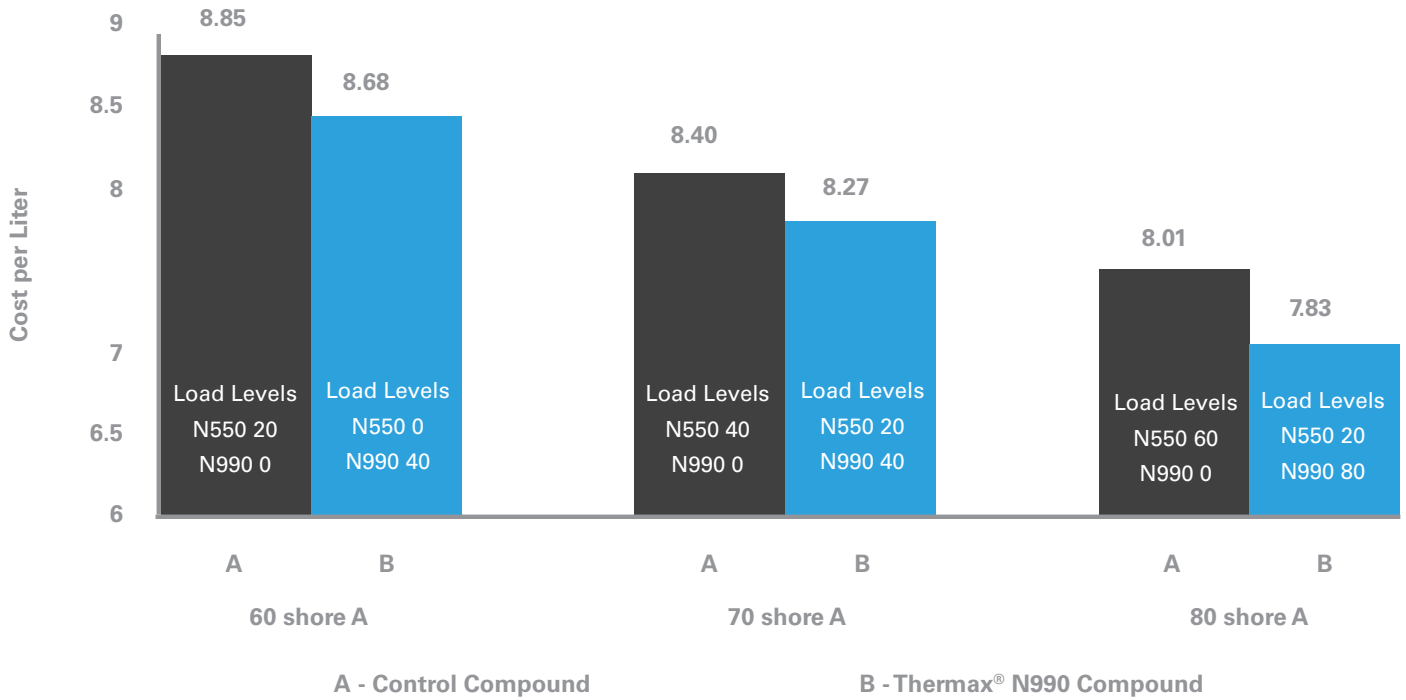
Change in Physical Properties After Oil Ageing @ 121°C for 70 hrs. (ASTM oil No.1)							
Volume Swell (%)	-3.0	-2.0	-3.5	-2.5	-3.5	-2.5	ASTM D471
Hardness change (points)	Nil	Nil	Nil	Nil	+1	+2	IS-3400 (Pt.23&6)
100% modulus (change %)	+32	+29	+38	+52	+58	+41	IS-3400 (Pt.1& 6)
300% modulus (change %)	+34	+53	-NA-	-NA-	-NA-	-NA-	IS-3400 (Pt.1& 6)
Tensile Strength (change %)	+2	-4	+5	+13	+8	+13	IS-3400 (Pt.1& 6)
Elongation at break (change %)	-13	-22	-21	-22	-26	-13	IS-3400 (Pt.1& 6)

Change in Physical Properties After Oil Ageing @ 121°C for 70 hrs. (ASTM oil No.2)							
Volume swell (%)	+26.5	+25.0	+23.5	+22.0	+18.0	+18.5	ASTM D471
Hardness change (points)	-12	-12	-13	-13	-12	-12	IS-3400 (Pt.23&6)
100% modulus (change %)	Nil	-18	-20	-9	+5	-10	IS-3400 (Pt.1& 6)
300% modulus (change %)	+9	+17	-NA-	-NA-	-NA-	-NA-	IS-3400 (Pt.1& 6)
Tensile Strength (change %)	-18	-8	-7	+1	+1	+7	IS-3400 (Pt.1& 6)
Elongation at break (change %)	-19	-17	-21	-17	-22	-9	IS-3400 (Pt.1& 6)
Tear Strength (kg/cm)	56.0	55.0	63.5	61.0	65.5	52.0	IS-3400 (Pt.17)
Dielectric Strength (kV/mm)	8	11	4	5	1	3	IS-2584-cl.7.1

The Thermax® Advantage

As shown in the above tables, Thermax® N990 can be loaded in CSM compounds at higher levels than that of FEF Black N550 without significant negative impact to the compound properties. This becomes a significant advantage to the CSM compounder when the total compound cost is analyzed (see Appendix A).

Volumetric Cost Savings in U.S. Dollars



The unique characteristics of large particle size and low structure allow for higher total filler in each of the test compounds using Thermax® N990; without adversely affecting the desired compound characteristics. This high filler loading leads to compound cost savings of up to 2.2% as illustrated in the above chart.

Thermax® N990 also improves processability of the compound by reducing viscosity while maintaining the desired hardness, allowing for excellent mixing, scorch protection, and improved extrusion and moulding.



60 shore A - Control Compound (60A)

Ingredient	phr	Price/kg (USD)	Sp. Gravity	Volume (L)	Price/L (USD) (USD)	Total Volume Cost (USD)
CSSETS530	100.0	\$10.35	1.18	84.75	\$12.21	\$1034.80
MgO	10.0	\$2.63	0.60	16.67	\$1.58	\$26.34
FEF Black N550	20.0	\$1.69	1.80	11.11	\$3.04	\$33.77
Thermax® N990	0.0	\$2.69	1.80	0.00	\$4.84	\$0.00
Aromatic Oil	10.0	\$1.15	0.99	10.10	\$1.14	\$11.51
Paraffin Wax	3.0	\$1.97	0.90	3.33	\$1.77	\$5.89
NBC (Antioxidant)	1.0	\$15.67	1.18	0.85	\$18.49	\$15.72
Ultralube 220	2.0	\$5.37	0.95	2.11	\$5.10	\$10.76
DPTT	1.5	\$8.50	1.50	1.00	\$12.75	\$12.75
MBTS	1.0	\$4.61	1.50	0.67	\$6.92	\$4.64
TOTAL	148.5			130.59		\$1156.18

Compound Specific Gravity 1.137 Compound Cost/liter (USD) \$8.85

60 shore A - Thermax® Compound (60B)

Ingredient	phr	Price/kg (USD)	Sp. Gravity	Volume (L)	Price/L (USD) (USD)	Total Volume Cost (USD)
CSSETS530	100.0	\$10.35	1.18	84.75	\$12.21	\$1,034.80
MgO	10.0	\$2.63	0.60	16.67	\$1.58	\$26.34
FEF Black N550	0.0	\$1.69	1.80	0.00	\$3.04	\$0.00
Thermax® N990	40.0	\$2.69	1.80	22.22	\$4.84	\$107.54
Aromatic Oil	10.0	\$1.15	0.99	10.10	\$1.14	\$11.51
Paraffin Wax	3.0	\$1.97	0.90	3.33	\$1.77	\$5.89
NBC (Antioxidant)	1.0	\$15.67	1.18	0.85	\$18.49	\$15.72
Ultralube 220	2.0	\$5.37	0.95	2.11	\$5.10	\$10.76
DPTT	1.5	\$8.50	1.50	1.00	\$12.75	\$12.75
MBTS	1.0	\$4.61	1.50	0.67	\$6.92	\$4.64
TOTAL	168.5			141.70		\$1,229.95

Compound Specific Gravity 1.189 Compound Cost/liter (USD) \$8.68

A cost savings of USD 0.17/L is realized due to the higher total carbon black loading in the test compound versus that of the control. N990 allows for higher loading than that of the furnace black grades.



70 shore A - Control Compound (70A)

Ingredient	phr	Price/kg (USD)	Sp. Gravity	Volume (L)	Price/L (USD) (USD)	Total Volume Cost (USD)
CSPETS530	100.0	\$10.35	1.18	84.75	\$12.21	\$1,034.80
MgO	10.0	\$2.63	0.60	16.67	\$1.58	\$26.40
FEF Black N550	40.0	\$1.69	1.80	22.22	\$3.04	\$67.55
Thermax® N990	0.0	\$2.69	1.80	0.00	\$4.84	\$0.00
Aromatic Oil	10.0	\$1.15	0.99	10.10	\$1.14	\$11.51
Paraffin Wax	3.0	\$1.97	0.90	3.33	\$1.77	\$5.89
NBC (Antioxidant)	1.0	\$15.67	1.18	0.85	\$18.49	\$15.72
Ultralube 220	2.0	\$5.37	0.95	2.11	\$5.10	\$10.76
DPTT	1.5	\$8.50	1.50	1.00	\$12.75	\$12.75
MBTS	1.0	\$4.61	1.50	0.67	\$6.92	\$4.64
TOTAL	168.5			141.70		\$1,189.96

Compound Specific Gravity 1.189 Compound Cost/liter (USD) \$8.40

70 shore A - Thermax® Compound (70B)

Ingredient	phr	Price/kg (USD)	Sp. Gravity	Volume (L)	Price/L (USD) (USD)	Total Volume Cost (USD)
CSPETS530	100.0	\$10.35	1.18	84.75	\$12.21	\$1,034.80
MgO	10.0	\$2.63	0.60	16.67	\$1.58	\$26.34
FEF Black N550	20.0	\$1.69	1.80	11.11	\$3.04	\$33.77
Thermax® N990	40.0	\$2.69	1.80	22.22	\$4.84	\$107.54
Aromatic Oil	10.0	\$1.15	0.99	10.10	\$1.14	\$11.51
Paraffin Wax	3.0	\$1.97	0.90	3.33	\$1.77	\$5.89
NBC (Antioxidant)	1.0	\$15.67	1.18	0.85	\$18.49	\$15.72
Ultralube 220	2.0	\$5.37	0.95	2.11	\$5.10	\$10.76
DPTT	1.5	\$8.50	1.50	1.00	\$12.75	\$12.75
MBTS	1.0	\$4.61	1.50	0.67	\$6.92	\$4.64
TOTAL	188.5			152.81		\$1,263.72

Compound Specific Gravity 1.234 Compound Cost/liter (USD) \$8.27

Cost savings realized using Thermax® N990 at 40 phr in combination N550 at 20 phr is 0.13 USD/L due to the higher total carbon black loading of Thermax® in the test compound versus the control.



80 shore A - Control Compound (80A)

Ingredient	phr	Price/kg (USD)	Sp. Gravity	Volume (L)	Price/L (USD) (USD)	Total Volume Cost (USD)
CSPETS530	100.0	\$10.35	1.18	84.75	\$12.21	\$1,034.80
MgO	10.0	\$2.63	0.60	16.67	\$1.58	\$26.34
FEF Black N550	60.0	\$1.69	1.80	33.33	\$3.04	\$101.32
Thermax® N990	0.0	\$2.69	1.80	0.00	\$4.84	\$0.00
Aromatic Oil	10.0	\$1.15	0.99	10.10	\$1.14	\$11.51
Paraffin Wax	3.0	\$1.97	0.90	3.33	\$1.77	\$5.89
NBC (Antioxidant)	1.0	\$15.67	1.18	0.85	\$18.49	\$15.72
Ultralube 220	2.0	\$5.37	0.95	2.11	\$5.10	\$10.76
DPTT	1.5	\$8.50	1.50	1.00	\$12.75	\$12.75
MBTS	1.0	\$4.61	1.50	0.67	\$6.92	\$4.64
TOTAL	188.5			152.81		\$1,223.73

Compound Specific Gravity	1.234	Compound Cost/liter (USD)	\$8.01
---------------------------	-------	---------------------------	--------

80 shore A - Thermax® Compound (80B)

Ingredient	phr	Price/kg (USD)	Sp. Gravity	Volume (L)	Price/L (USD) (USD)	Total Volume Cost (USD)
CSPETS530	100.0	\$10.35	1.18	84.75	\$12.21	\$1,034.80
MgO	10.0	\$2.63	0.60	16.67	\$1.58	\$26.34
FEF Black N550	20.0	\$1.69	1.80	11.11	\$3.04	\$33.77
Thermax® N990	80.0	\$2.69	1.80	44.44	\$4.84	\$215.09
Aromatic Oil	10.0	\$1.15	0.99	10.10	\$1.14	\$11.51
Paraffin Wax	3.0	\$1.97	0.90	3.33	\$1.77	\$5.89
NBC (Antioxidant)	1.0	\$15.67	1.18	0.85	\$18.49	\$15.72
Ultralube 220	2.0	\$5.37	0.95	2.11	\$5.10	\$10.76
DPTT	1.5	\$8.50	1.50	1.00	\$12.75	\$12.75
MBTS	1.0	\$4.61	1.50	0.67	\$6.92	\$4.64
Total	228.5			175.03		\$1,371.27

Compound Specific Gravity	1.305	Compound Cost/liter (USD)	\$7.83
---------------------------	-------	---------------------------	--------

Cost savings realized using Thermax® N990 at 80 phr in combination N550 at 20 phr is USD 0.18/L due to the higher total carbon black loading of Thermax® in the test compound versus the control.

*The information provided herein is furnished in good faith and without cost. Cancarb believes it to be correct but does not assume any legal responsibility for its use or the reliance upon it by others.