

TECHNICAL Bulletin

Subject: N990 Medium Thermal
Carbon Black in
NBR/PVC Rubber

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THERMAX® MEDIUM THERMAL CARBON BLACK N990 IN NITRILE/POLYVINYL CHLORIDE (NBR/PVC) RUBBER COMPOUNDS

Thermax® medium thermal carbon black N990 (MT black) is a unique carbon black characterized by large particle size (low surface area) and low structure. Manufactured by the thermal decomposition of natural gas, Thermax® is widely used in applications that require excellent heat, oil and chemical resistance, as well as superior dynamic properties. The large particle size and low structure provide compounds with low compression set, high rebound and low hysteresis as the inherent elastic properties of the polymer are maintained. Thermax® can be used with all polymers and is commonly used in compounds of elastomers such as FKM, CR, NR, IIR, NBR, EPDM, HNBR, ACM and ECO.

Thermal black is non-reinforcing and is often blended with furnace carbon blacks and/or mineral fillers to achieve cost reduction and specific physical properties in a rubber compound. When used in an NBR/PVC compound, improved compression set properties can be realized, greatly benefiting applications that require good sealing properties.

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

Compound Recipes

| Formulation (phr) | Hardness 60 SH | | Hardness 70 SH | | Hardness 80 SH | |
|-------------------|----------------|-----|----------------|-----|----------------|-----|
| | A1 | A2 | B1 | B2 | C1 | C2 |
| *NBR/PVC (70:30) | 100 | 100 | 100 | 100 | 100 | 100 |
| MC Sulphur | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Stearic acid | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Zinc Oxide | 5 | 5 | 5 | 5 | 5 | 5 |
| FEF N550 | 40 | -- | 60 | 30 | 80 | 40 |
| Thermax N990 | -- | 90 | -- | 70 | -- | 90 |
| DOP | 25 | 25 | 25 | 25 | 25 | 25 |
| TDQ | 1 | 1 | 1 | 1 | 1 | 1 |
| CBS | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| TMT | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |

*NBR/PVC(70:30) is Chemigum NVC 573 from ELIOKEM

Test Compound Properties

| Compound | A1 | A2 | B1 | B2 | C1 | C2 |
|---|-------|-------|-------|-------|-------|-------|
| Viscosity M _L (1+4) @ 100°C | 27 | 28 | 44 | 44 | 61 | 61 |
| Mooney Scorch time t ₅ @ 125°C (min) | 4.1 | 3.3 | 3.6 | 3.4 | 3.3 | 3.1 |
| Rheometric Properties @160°C | | | | | | |
| M _L (lbf.inch) | 3.84 | 4.48 | 6.15 | 5.94 | 7.99 | 6.87 |
| M _H (lbf.inch) | 44.94 | 47.54 | 58.29 | 58.98 | 63.16 | 67.35 |
| t _{s2} (min) | 1.54 | 1.27 | 1.39 | 1.28 | 1.26 | 1.19 |
| t ₉₀ (min) | 24.51 | 21.03 | 23.54 | 28.62 | 30.13 | 32.75 |
| Vulcanizate Properties Curing at 160°C for t ₉₀ minutes according to Rheometer | | | | | | |
| Hardness (Shore A) | 62 | 63 | 72 | 73 | 81 | 82 |
| 100% modulus (Kg/cm ²) | 36 | 33 | 48 | 52 | 68 | 70 |
| 200% modulus (Kg/cm ²) | 70 | 66 | 112 | 116 | 142 | 144 |
| 300% modulus (Kg/cm ²) | 117 | 99 | -- | -- | -- | -- |
| Tensile Strength (Kg/cm ²) | 191 | 140 | 170 | 154 | 164 | 167 |
| Elongation @ Break (%) | 520 | 530 | 320 | 280 | 250 | 250 |
| Tear Strength (Kg/cm) | 42 | 44 | 45 | 46 | 38 | 39 |
| Compression Set % (ASTM Method B, 70 hrs / 70°C / 25% deflection) | 59 | 62 | 52 | 48 | 50 | 47 |

For each of the respective hardnesses, compound viscosity is maintained even at the higher loadings of Thermax[®] N990. Also, at comparatively higher loadings, Thermax does not adversely affect Mooney scorch or curing behaviour.

Improvement in compression set resistance is noticeable for the compounds using Thermax[®] N990, except for the 60 Shore A hardness compound. This improvement is very beneficial for applications that require good sealing properties such as; seals, gaskets and hoses (for better clamp-fitting), which are the main applications of NBR/PVC.

| Compound | A1 | A2 | B1 | B2 | C1 | C2 |
|---|------|------|------|------|------|------|
| Change in physical properties after air ageing @ 100° C for 70 hours | | | | | | |
| Hardness change (points) | + 7 | + 8 | + 7 | + 9 | + 5 | + 5 |
| 100% modulus change (%) | + 6 | + 15 | + 25 | + 31 | + 28 | + 47 |
| 200% modulus change (%) | + 33 | + 34 | + 34 | + 35 | -- | -- |
| 300% modulus change (%) | + 29 | + 30 | -- | -- | -- | -- |
| Tensile Strength change (%) | -4 | -4 | + 4 | + 2 | NIL | + 4 |
| EB change (%) | -27 | -28 | -22 | -23 | -28 | -28 |
| Change in Properties after ageing in IRM 903 @ 100°C for 70 hours | | | | | | |
| Volume swell (%) | -12 | -11 | -10 | -8 | -9 | -8 |
| Hardness change, points | + 13 | + 13 | + 12 | + 12 | + 10 | + 10 |
| 100% modulus change (%) | + 56 | + 55 | + 68 | + 62 | + 81 | + 69 |
| 200% modulus change (%) | + 80 | + 76 | - | -- | -- | -- |
| 300% modulus change (%) | + 54 | + 41 | -- | -- | -- | -- |
| Tensile Strength change (%) | -1 | NIL | + 6 | + 5 | + 4 | NIL |
| EB change (%) | -35 | -34 | -31 | -31 | -36 | -36 |
| Change in Properties after ageing in Fuel B @ 23°C for 48 hours | | | | | | |
| Volume swell (%) | + 4 | + 4 | + 11 | + 11 | + 9 | + 8 |
| Hardness change (points) | -5 | -4 | -6 | -5 | -11 | -10 |
| 100% modulus change (%) | -25 | -20 | -27 | -26 | -24 | -22 |
| 200% modulus change (%) | -15 | -15 | -19 | -18 | -15 | -16 |
| 300% modulus change (%) | -18 | -18 | -- | -- | -- | -- |
| Tensile Strength change (%) | -35 | -27 | -31 | -26 | -25 | -25 |
| EB change (%) | -23 | -19 | -22 | -18 | -16 | -12 |

Stress-strain properties after aging in air, oil and fuel B, are maintained with the one exception of the original tensile strength of the 60 Shore A compound which is slightly lower when Thermax[®] N990 is used without blending with FEF N550 black. Compound hardness remains virtually unchanged.

The Thermax[®] Advantage

NBR/PVC is a very popular elastomer for sealing applications that require good oil & fuel resistance combined with excellent weathering resistance, such as seals, gaskets and hose. Thermax[®] N990, thermal carbon black is an excellent filler choice for these compounds. Thermax[®] N990 allows for a higher proportion of carbon black to be loaded into the compound without degrading the natural performance and characteristics of the compound.

Thermax[®], due to the unique characteristics of low structure combined with a large particle size, adds an extra degree of security by promoting lower heat development during processing which reduces the risk of scorch. This reduced risk is especially important in high hardness compounds of more than 80 Shore A.

Thermax N990 thermal carbon black from Cancarb Limited, can reduce production cost by allowing the desirable properties of the polymer to be fully realized while reducing the risk of scrap due to scorch.