

TECHNICAL BULLETIN

CR Compound for Spiral Wire Reinforced Hydraulic Hose Inner Tube

Thermax[®] N990 medium thermal carbon black is a specialty carbon characterized by large particle size (low surface area) and low structure. Manufactured by the thermal decomposition of natural gas, Thermax[®] N990 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 allows for high loading and provides compounds with low compression set, high rebound and low hysteresis, as the natural elastic properties of the polymer are maintained. Thermax[®] N990 can be used in all polymers and is commonly used in elastomers such as FKM, CR, NR, IIR, NBR, EPDM, HNBR, ACM and ECO.

Thermal carbon black is considered semi-reinforcing and often blended with furnace carbon blacks and/or mineral fillers to achieve cost reduction and specific physical properties in rubber compounds. Polychloroprene rubber is strain crystallizing and similar to natural rubber in chemical structure and tensile strength. This similarity to natural rubber extends to the processing and vulcanization properties of polychloroprene as far as the effect of carbon black is concerned.

Compound Formulations

Ingredients*	C1 (phr)	C2 (phr)
Skyprene [®] B30	65	65
Skyprene [®] G-42	35	35
Vestenamer [®] 8012	11.5	11.5
MgO	4	4
Stearic Acid	0.5	0.5
Antioxidant ODPA	2	2
Furnace Carbon Black N550	15	40

Thermax[®] N990 can be loaded in polychloroprene compounds in greater amounts than reinforcing fillers for a given hardness, while still retaining good physical properties. This high loading ability can translate directly to improved impermeability (important for hose applications) and cost savings for the compound.

The following study conducted on behalf of Cancarb Limited by the Indian Rubber Manufacturers' Research Association (IRMRA) of Thane, India, demonstrates the benefits of Thermax[®] N990 in two polychloroprene rubber formulations intended for use as tube compound in spiral wire reinforced hydraulic hose.

Two hose tube compounds were developed for this study:

- Compound #1 (C1) - With a low level (15 phr) of furnace black N550 and a high loading (150 phr) of Thermax[®] N990 medium thermal carbon black.
- Compound #2 (C2) – Represents a more commonly used formula in the hydraulic hose industry, with relatively higher loading of N550 (40 phr) and less Thermax[®] N990 (100 phr).

Ingredients	C1 (phr)	C2 (phr)
Thermax[®] N990	150	100
Paraffin Wax	1	1
Elaztobond [®] A250	3	3
Aurobond [®] MD IV	3	3
ZnO	5	5
Sulphur	1	1
TMTD	1	1

*For further detail on the ingredient selection, please see the section entitled *Ingredient Detail* at the end of this bulletin.

*For a complete list of Cancarb's trademarks and the countries where they are registered go to www.cancarb.com/trademarks.html

Compound Results

Properties	General Industry Requirements*	C1	C2
M _L (1+4) @ 100°C	100-120 MU	117	147
Rheo at 177°C /T _c 90 (minutes)	-	28.1	25.9
Rheo @ 177 t _s 2 (minutes)	1.0 min.	0.99	0.95
100% Modulus	9-11 MPa	10.7	11.8
Tensile Strength	13 MPa min.	13	13.9
Elongation at Break	125-200%	125	125
Hardness Shore A2 (points)	Min. 85 (Pref. 88-90)	91	90

% Change in Physical Properties - After Air Ageing @ 100°C/72hrs.

Tensile Strength	-	-6.5	-3
Elongation at Break	-	-24	-32
Hardness (points)	-	3	2

% Change in Physical Properties - After Ageing in ASTM Oil no. 3 @ 100°C/72hrs.

Tensile Strength	-	-32	-34.5
Elongation at Break	-	-13.5	-11
Hardness (points)	-	-22	-21
Volume Change (%)	-	61	60
Compression Set % (100°C/24hrs.)			
ASTM D395-Method B	40% Max.	34	30
Adhesion Strength			
ASTM D1871 Brass coated steel wire	-	549 N (56kg)	559 N (57kg)

*SAE International Specification – SAE J517 Feb 2013, for hydraulic hose, the target specification for this study, does not specify the physical/mechanical properties of the tube compound, those reported in this Bulletin are generally followed by the Industry

The lower viscosity of compound C1 (117) against that of C2 (147) is important as easier processing and lower heat build-up during extrusion is expected. This improved scorch safety provided by high loading of Thermax® N990 is an important factor for polychloroprene which is very sensitive to scorch.

100% modulus and shore hardness for both compounds are more or less the same and these levels of Modulus (9-11 MPa) and hardness (around 90 Shore A2) are considered essential for withstanding the high service pressure of hydraulic hose. Other properties such as air ageing, oil ageing, compression set, and adhesion strength are similar for both the compounds

The Thermax® Advantage

Polychloroprene polymer often suffers from availability problems and increasing cost. It is a challenge for the industry to maintain compound cost while preserving desired properties. Thermax® N990 medium thermal carbon black is an excellent solution to this problem.

By exploring higher loadings of Thermax® N990 as demonstrated in test compound C1, a higher volume of finished compound can be achieved without consuming more of the expensive polymer. Cost savings will depend upon the specific recipe in use and the local raw material costs. The higher loading ability offered by Thermax® N990 also reduces both the liquid and gas permeability of the polychloroprene tube which can lead to longer hose life.

Thermax® N990 is the ideal filler for achieving both cost reduction and specific properties required in polychloroprene tube compound for spiral wire reinforced hydraulic hose. It enhances the stiffness and collapse resistance of the green tube due to the higher loading capability and helps in bearing the load exerted by the steel spiral reinforcement wire.

Ingredient Detail

Skyprene® G-42 - A fast crystallizing rate grade of polychloroprene rubber from Tosoh Corporation of Japan, which helps in stiffening of the polychloroprene tube when it cools down to room temperature which helps in bearing the load exerted by the steel wire which is used as a reinforcement ply.

Vestenamer® 8012 - A product from Evonik Industries of Germany, which helps in giving high vulcanized hardness to tubes and for easier extrusion (due to its thermoplastic effect).

Both Skyprene® G-42 and Vestenamer® 8012 help in getting very high compound Mooney Viscosity of around 120 units at 100°C, which is essential for extrusion of tube with good collapse resistance and high vulcanized hardness.

Elaztobond® A250 - A modified phenol-formaldehyde resin manufactured by SI Group Inc. of the USA, which helps in good adhesion with the brass coating of the steel spiral wire.

Aurobond® MD IV - A Hexa Methoxy Methyl Melamine (HMMM) manufactured by Auropol Group of India, which functions as an adhesion promoter for Elaztobond A250.