cancarb

TECHNICAL BULLETIN

N990 Medium Thermal Carbon Black in Nitrile Rubber

Thermax® medium thermal carbon black N990 (MT black) is manufactured by the thermal decomposition of natural gas. This thermal process produces a unique carbon black characterized by large particle size (low surface area) and low structure. 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 in all polymers and is commonly used in 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. High loadings of Thermax® are possible, while maintaining low compression set and high resiliency, thereby allowing manufacturers to reduce compound cost. NBR compounds filled with Thermax® are used for applications such as, seals, gaskets, o-rings, tubing, hose, belts, and roll coverings.

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

Formulation (phr)	Hardness 60 SH		Hardness 70 SH		Hardness 80 SH		Hardness 70 SH (High ACN)
Compound	**A1**	**A2**	**B1**	**B2**	**C1**	**C2**	**D**
*NBR (JSR230SL)	100	100	100	100	100	100	--
**NBR(JSR N 220S)	--	--	--	--	--	--	100
MC sulpur	1.5	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	1.5
Zinc Oxide	5	5	5	5	5	5	5
N 550	45	30	65	40	90	60	60
N990	--	35	--	55	--	65	--
DOP	10	10	10	10	20	20	10
TDQ	1	1	1	1	1	1	1
CBS	2	2	2	2	2	2	2
TMTD	0.2	0.2	0.2	0.2	0.2	0.2	0.2

*NBR (JSR 230SL) of Japan Synthetic Rubber with ACN content 35 % & ML1+4 @ 100°C-42
**NBR (JSR N220S) of Japan Synthetic Rubber with ACN content 41 % & ML1+4 @ 100°C-56

cancarb

NBR Test Compound Properties

Compound	A1	A2	B1	B2	C1	C2	D
Viscosity M_L (1+4) @ 100° C	31	34	38	41	49	53	58
Mooney Scorch Time t5 @ 125° C(min)	8.09	8.02	6.28	5.35	4.38	4.32	6.11
Rheometric properties @ 160° C							
M_L (lbf.inch)	4.4	4.88	5.31	5.61	7.14	6.08	6.08
M_H(lbf.inch)	62.96	73.7	70.39	86	78.5	81.04	79.93
tS2(min)	2.5	2.37	2.12	1.86	1.69	1.76	1.99
t90(min)	12.2	19.93	11.4	15.62	4.74	5.86	16.76

For the each of the hardnesses, compound viscosity increased slightly, accompanied by a minor drop in Mooney scorch time, while total carbon black loading was increased by 20, 30 and 35 phr respectively.

Compound	A1	A2	B1	B2	C1	C2	D
Vulcanizate properties- Curing at 160° C for t90 minutes according to Rheometer							
Hardness, Shore A	62	61	70	71	80	79	71
100% modulus (Kg/cm^2)	33	27	46	41	77	55	49
200% modulus (Kg/cm^2)	75	68	121	115	168	157	129
300% modulus (Kg/cm^2)	140	132	186	174	212	_	205
Tensile Strength (Kg/cm^2)	191	232	227	182	220	187	233
EB%	480	540	400	380	310	260	390
Tear Strength (Kg/cm)	43	43	49	45	45	45	57
Compression Set % ASTM Method B,							
22 hrs/ 100° C / 25% deflection	33	24	38	27	29	32	33
% Change in physical properties after air ageing @ 100° C for 70 hours.							
Hardness change,(points)	+13	+15	+13	+13	+6	+7	+11
100 % modulus, change %	+21	+22	+46	+49	+25	+76	+33
200 % modulus, change %	+38	+37	+45	+46	+25	_	+39
300 % modulus, change %	+34	+34	_	_	_	_	+25
Tensile Strength, change %	+8	+6	+8	+9	+4	+4	+5
EB, change %	-25	-24	-30	-31	-26	-27	-25
% Change in physical properties after ageing @ 100° C for 70 hours in ASTM oil No.3							
Volume swell (70 hrs / 100°C)%	+4.37	+3.34	+0.91	+2.93	-1	-2.54	-1.68
Hardness change, points	-2	-2	0	0	0	0	0
100 % modulus, change %	-6	-7	-2	0	+14	+48	-2
200 % modulus, change %	+10	+11	+13	+14	+15	_	+7
300 % modulus, change %	+14	+15	+16	14	_	_	+10
Tensile Strength, change %	-7	-6	+9	+14	-5	-4	-6
EB, change %	-21	-22	-15	-16	-23	-19	-20

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

% Change in physical properties after ageing @ 40° C for 70 hours in Fuel B							
Volume swell(70 hrs / 40°C)%	+22.90	+23.37	+19.10	+19.55	+13.95	+11.10	+14.96
Hardness change, points	-8	-10	-14	-14	-12	-11	-15
100 % modulus, change %	-21	-20	-15	-14	-21	-16	-24
200 % modulus, change %	-5	-1	-5	-4	-4	-6	-18
300 % modulus, change %	-12	-13	_	_	_	_	-14
Tensile Strength, change %	-38	-38	-23	-18	-14	-13	-24
EB, change %	-31	-33	-30	-31	-19	-15	-25

In general, the differences in tensile properties and tear strength between the control and test compounds were relatively minor with all Thermax® compounds providing acceptable results. As well, there were no significant differences in air, ASTM Oil No.3 and Fuel B aging results.

Significant improvement in compression set was observed for the compounds based on Thermax® N990, except for the 80 hardness compound where high total carbon black loading could have resulted in poor polymer – filler bonding and thus somewhat higher compression set.

High Acrylonitrile (ACN) NBR vs. Medium Acrylonitrile NBR

The above observation of superior compression set was also seen when the medium ACN NBR (Compound B2) with Thermax® N990 was compared with the similar hardness high ACN NBR compound (Compound D). These two compounds exhibited similar oil and fuel ageing properties except for volume swell which was marginally on the higher for the Thermax® compound. In addition to the compression set benefit, the Thermax® compound offers a reduction in cost due to the lower price of medium ACN NBR.

The Thermax® Advantage

Improvement in compression set by part replacement of furnace black with Thermax® N990 is a significant benefit to producers of O-rings, seals, gaskets and hoses (for better clamp-fitting), which are the main applications of NBR. Additionally, a Thermax® N990 medium ACN compound (e.g. Compound B2) may be considered as a lower cost alternative to a high ACN NBR compound based on furnace black alone.

Finally, Thermax® N990, due to its unique characteristics of lower structure and large particle size, gives lower heat development during processing (e.g. extrusion), especially for higher hardness compounds of more than 80 shore A, thus improving processing safety which is essential in applications such as tubing for hydraulic hose.

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