



### Millathane® E34 and N-990 Carbon Black

Thermax N-990 is a good, non-reinforcing filler for Millathane® E34. It can be used at relatively high loading while maintaining reasonable properties and processing. Compounds in this study can be used for general molding applications where good physical properties and abrasion resistance are required.

#### SUMMARY

A study was conducted on the effects of varying levels of Thermax N-990 in a Millathane® E34 molding compound. Millathane® E34 is a millable polyether urethane rubber that has excellent physical properties and abrasion resistance. Thermax N-990 is a large particle-size thermal black produced by Cancarb Ltd. and because of its large particle size and low surface area, it can be used at high loadings in rubber compounds.

Thermax N-990 was evaluated in a sulfur-cured compound of Millathane® E34. The formulation is shown to the right.

	PARTS
Millathane® E34	100
Zinc Stearate	0.5
Struktol WB222 (Process Aid)	1
TP-95 (Plasticizer)	5
Thermax N-990	As Shown
MBTS	4
MBT	2
Thanecure® ZM	1
Sulfur	1.5

This is a fairly typical formula for Millathane® E34 and for sulfur curable millable urethanes in general. The N-990 was evaluated at 20-40-60-80 phr loadings, and original physical properties were tested along with abrasion resistance and resilience.

#### RHEOLOGY

Compounds were tested in an oscillating disk rheometer (ODR) for cure characteristics. The data below shows increasing ML and MH values as the black level increases, indicating higher compound viscosity and higher cured modulus. The ts2 values, indications of scorch times, show an initial decrease in scorch time in going from 20 to 40 phr but no change thereafter. The tc90 value, and indication of cure time, shows no significant difference between the four black levels.

ODR at 130° F (154° C)					
Parts of N-990		20	40	60	80
ML	lbf-in	4.4	4.6	5.3	5.7
	dN-m	5.0	5.2	6.0	6.4
MH	lbf-in	75.7	88.4	98.0	106.5
	dN-m	85.6	99.8	110.7	120.4
ts2, min.		4.6	3.7	3.8	3.9
tc90, min.		12.0	12.4	11.4	12.1

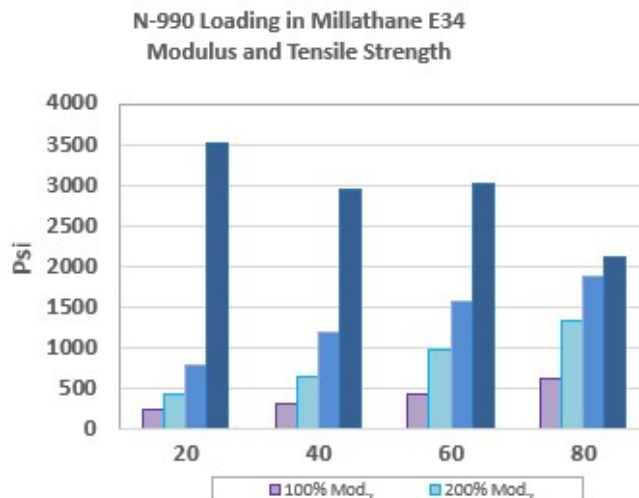
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### Millathane® E34 and N-990 Carbon Black (cont.)

#### MODULUS AND TENSILE STRENGTH

Modulus and tensile strength are shown in the chart to the right. As expected, increasing levels of N-990 increase the modulus in a linear fashion. Tensile strength drops slightly in going from 20 parts to 40 and 60 parts, with a greater drop-off from 60 to 80 parts N-990.

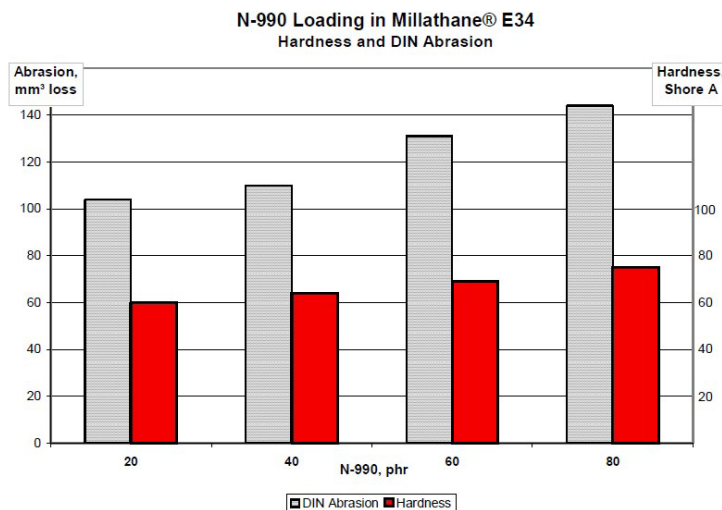


#### HARDNESS AND ABRASION RESISTANCE

Hardness, shown in the chart below, shows the expected increase in hardness as the level of N-990 increases. Unfilled Millathane E34 tests approximately 50 Shore A, so the initial 20 parts of N-990 increased hardness 10 points to 60 Shore A. Higher black additions yielded about a one Shore A durometer increase for every four parts of black.

Abrasion resistance was tested by the procedure in ASTM D5963, commonly known as the DIN Abrasion test. Samples are evaluated by sliding a cylindrical sample across the surface of an abrasive sheet attached to a rotating drum. The loss is mass is converted to a volume loss by factoring in the specific gravity of the compound. Higher losses of compound, expressed in mm<sup>3</sup>, indicate poorer abrasion resistance.

The data in the chart to the right shows the abrasion resistance getting worse as the level of N-990 increases. This is not unexpected as N-990 is not reinforcing and higher levels of black increasingly dilute the polymer.

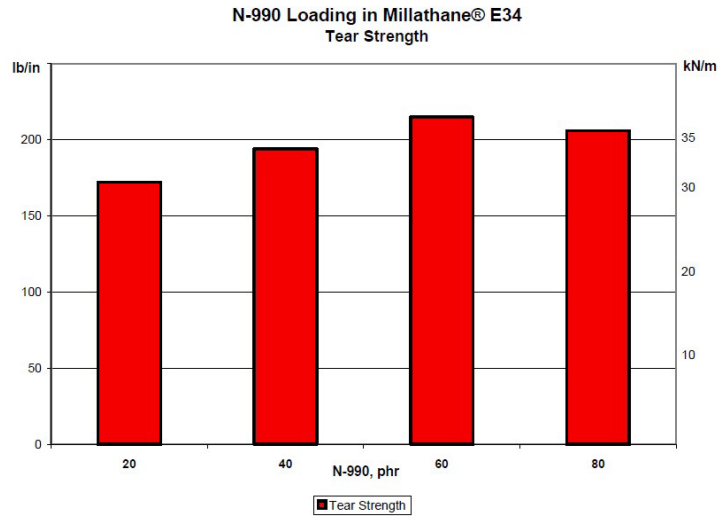




### Millathane® E34 and N-990 Carbon Black (cont.)

#### TEAR RESISTANCE

Tear resistance was tested by ASTM D624 using Die C, which uses an angular, un-nicked specimen. Data on the tear resistance of the black loadings, shown in the chart below, indicate increasing tear strength up to the 60-part level, then a slight decrease thereafter.



#### COMPRESSION SET AND RESILIENCE

Compression set, tested per ASTM D395 Method B for 22 hours at 70°C (158°F), is shown in the chart below. The compression set was relatively constant over the 20 to 80-part black range, giving values of 35 – 42%.

Resilience, tested by the Bashore Resilience test method of ASTM D2632, is also shown in the chart. The data shows the 20-part N-990 compound having very high resilience of 58%, with the higher levels of N-990 showing a slight linear drop-off of resilience, approximately 1% resilience drop per 7 to 8 parts of additional N-990.

