Thermax® N990 in Millable Polyurethane

In this report, Cancarb Thermax® N990 is evaluated in a millable polyurethane compound. Millable polyurethane is generally chosen for applications requiring excellent abrasion resistance, frictional properties, and oil resistance. Reinforcing fillers are added to the compound to meet hardness, stiffness, and strength specifications. Thermax N990 can be blended with highly reinforcing fillers for application in millable polyurethane rubber. The high loadability of N990 allows for a reduction in compound cost while maintaining processability.

The millable polyurethane test formulations are provided in Tables 1 and 2. The total filler loading and ratio of N990 to reinforcing filler were used as the independent variables in the design of experiments. The oil loading was adjusted to maintain the target durometer of 70. Cure, tensile, tear, hardness, abrasion resistance, compression set, and resilience were collected for each compound. Mixing and testing were performed by RD Abbott.

Table 1. Test Formulations

Ingredient	Loading (phr)
Millathane® E34	100
Zinc Stearate	0.5
Vanfre® AP-2	1
TP-95® plasticizer	Varies
Thermax® N990	See Table 2
N330	See Table 2
HiSil™ 233	See Table 2
SI 69	2% of HiSil 233 loading
MBTS	4
MBT	2
Thanecure® ZM	1
Sulfur	1.5
Target Shore A Hardness	**70**

The benefits of N990 found in the study were:

- Improved processing properties due to lower viscosity build-up versus small particle fillers such as N330 and HiSil 233
- Reduction in cure time allowing for faster mold cycle times
- Abrasion resistance maintained
- Lower compression set
- Higher resilience, meaning greater elasticity and less energy lost during deformation
- Decrease in cost as filler loading is increased

Compound test results are provided in the figures and tables on the following pages:

Table 2. Design of Experiments and Hardness Results

Shore A Durometer Hardness				
	N990:N330 Ratio			
Total Filler PHR	9:1	8:2	7:3	6:4
80	70	71	71	69
100	70	70	71	71
120	71	72	72	72
	N990:HiSil 233 Ratio			
Total Filler PHR	9:1	8:2	7:3	6:4
80	70	68	71	70
100	73	74	70	70
120	71	71	69	63

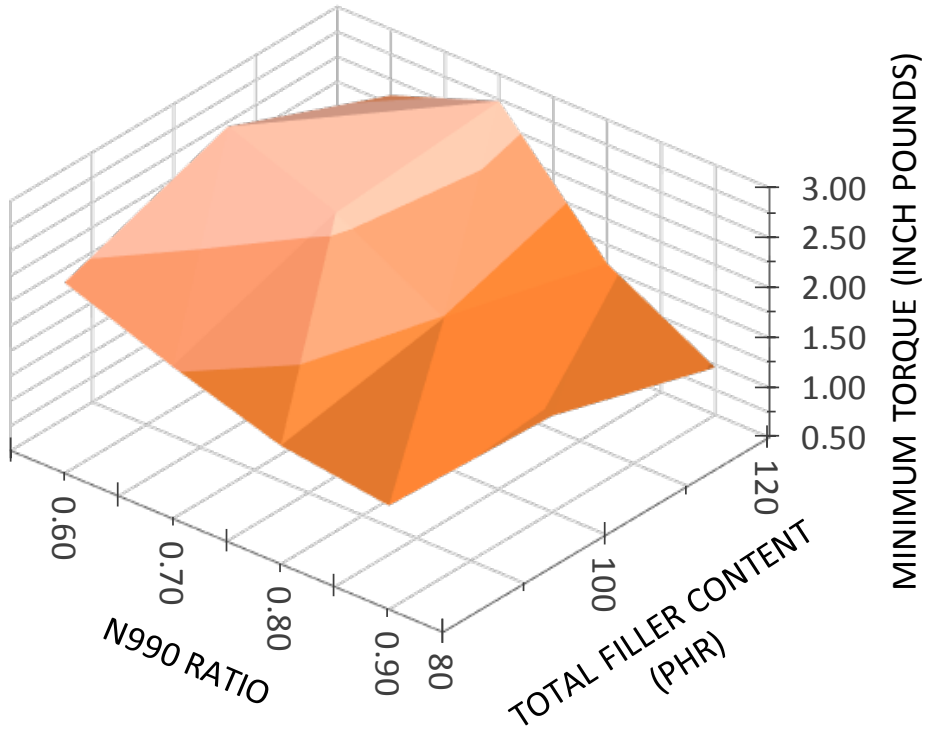

Figure 1. Minimum torque (a measure of processability) as a function of N990 ratio and total filler loading for compounds with HiSil 233. Increasing the N990 ratio (darker areas) provides improved processing properties due to the lower viscosity build-up versus small particle fillers such as N330 and HiSil 233.

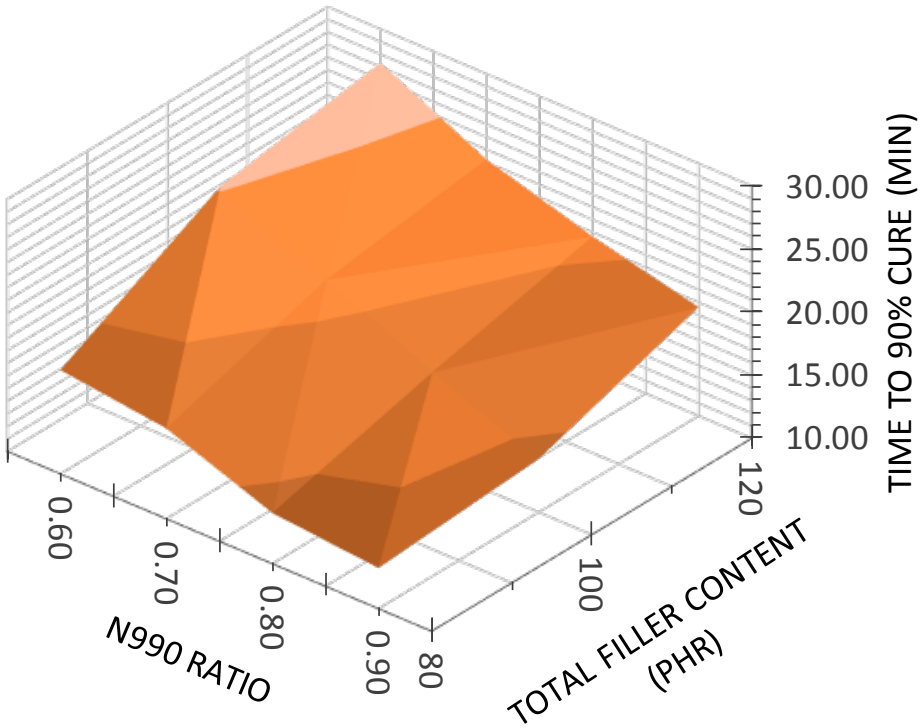

Figure 2. Cure time (Tc90) as a function of N990 ratio and total filler loading for compounds with HiSil 233. An increase in the N990 ratio provides a reduction in cure time (darkest segment) allowing for faster mold cycle times.

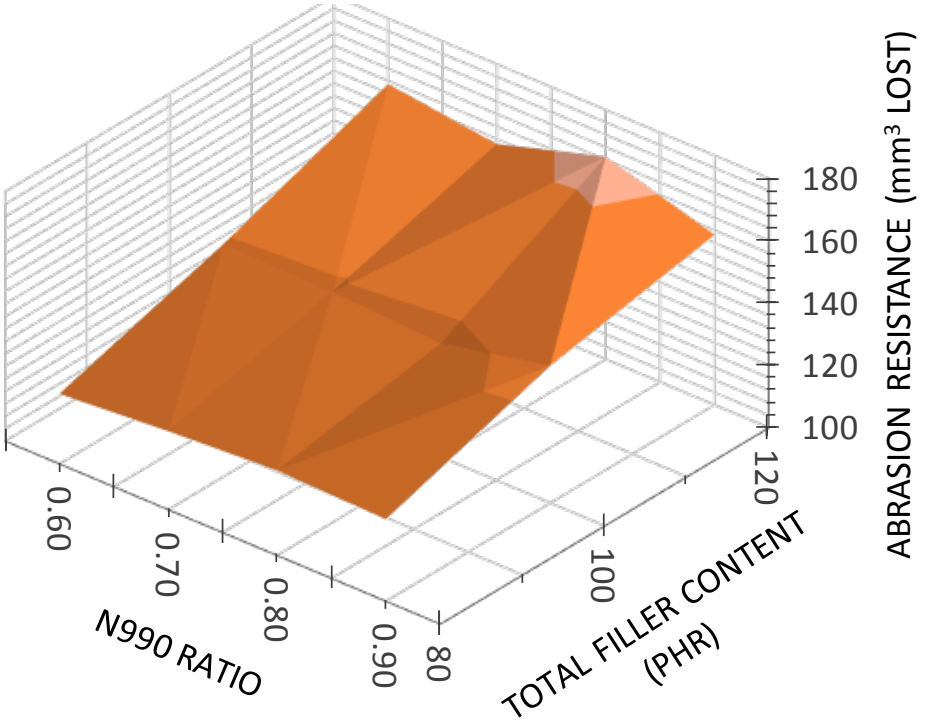

Figure 3. Abrasion resistance as a function of N990 ratio and total filler loading for compounds with HiSil 233. Abrasion resistance is maintained as the N990 ratio is increased.

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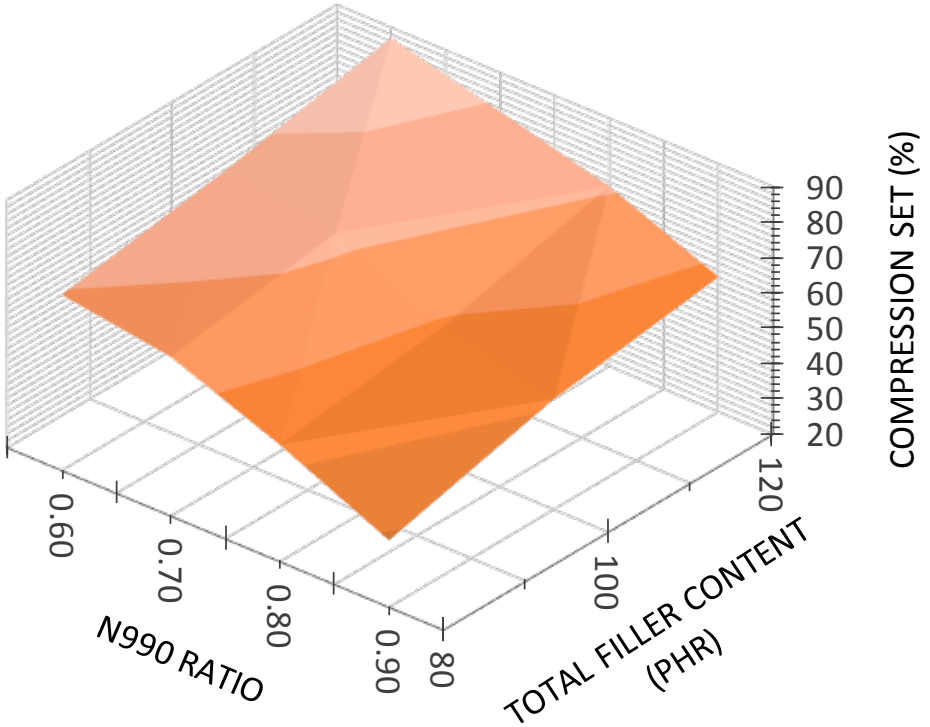

Figure 4. Compression set as a function of N990 ratio and total filler loading for compounds with HiSil 233. Compression set is improved (lowered) as N990 ratio increases.

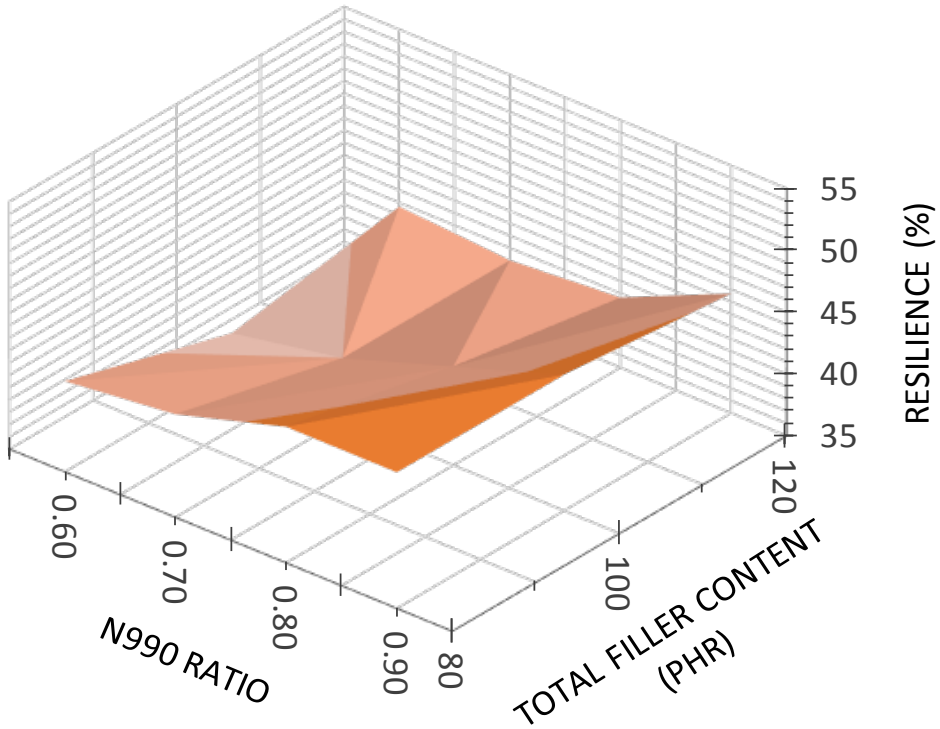

Figure 5. Resilience as a function of N990 ratio and total filler loading for compounds with HiSil 233. A higher N990 ratio results in higher resilience meaning greater elasticity and less energy lost during deformation.

Table 3. Relative compound cost per weight and volume

N990:HiSil 233 Ratio	Cost per Weight (Normalized to 1) Total Filler PHR			Cost per Volume (Normalized to 1) Total Filler PHR		
	80	100	120	80	100	120
9:1	1.00	0.92	0.85	1.00	0.93	0.88
8:2	0.99	0.91	0.85	0.99	0.93	0.87
7:3	0.99	0.90	0.84	0.99	0.92	0.87
6:4	0.98	0.90	0.84	0.98	0.91	0.87

The key findings of the study were:

- Processability metric (minimum torque) greatly improved as N990 ratio increased in compound loaded with HiSil 233.
- Scorch and cure times increased significantly for compound loaded with HiSil 233 as total filler content increased and N990 ratio decreased.
- Tensile and tear strength decreased as total filler content increased and N990 ratio increased.
- Elongation at break generally decreased for compound loaded with HiSil 233 as total filler content increased and N990 ratio increased.
- Abrasion resistance decreased significantly as total filler content increased. It was stable as N990 ratio increased.
- Compression set decreased significantly as total filler content decreased and N990 ratio increased.
- Resilience increased as total filler content decreased and N990 ratio increased.
- Decrease in cost as filler loading is increased.

For more information about this study, please contact customer_service@cancarb.com

Proprietary Materials Used

Proprietary ingredients used in compounding for this bulletin are listed below. Although these materials were selected for this study, similar ingredients from other suppliers may also work.

Product	Description	Supplier
Thermax® N990	Medium Thermal Carbon Black	Cancarb Limited
Millathane® E34	Millable Polyurethane	TSE Industries
Vanfre® AP-2	Processing Aid	Vanderbilt Chemicals
TP-95®	Plasticizer	Hallstar
HiSil™ 233	Precipitated Silica	PPG Silica Products
Thanecure® ZM	Cure Activator	TSE Industries