Thermax® N990 as a Pigment in PVC Composites

Cancarb performed testing of Thermax® N990 as a pigment in polyvinylchloride (PVC) composites. Thermax® thermal carbon black was compounded in PVC at loadings ranging from 0 to 3 percent by weight. The addition of carbon black to thermoplastics can provide UV protection and improvements in weathering performance. Testing results confirm that thermal carbon black can provide equivalent UV protection as low color furnace blacks. This indicates that thermal carbon black can be used in applications such as PVC pipes and molded goods.

The benefits of Thermax® N990 in PVC include:

- **Improved weathering resistance**
- Increased tensile modulus
- Increase in impact resistance
- Increased thermal conductivity
- High electrical resistivity (insulative compounds)
- No change in horizontal burn rate
- **Excellent black coloring with blue undertone**
- **Large particle size leads to less viscosity build-up and higher loadability.** Masterbatches can be made with an N990 loading of at least 60% by weight.

The composite formulations can be found in Table 1. The composites with Thermax® were compared to a composite with no carbon black and a composite with N762. Impact resistance, tensile properties, color, change in color after weathering, and thermal conductivity were measured for each composite. As the samples were not highly loaded with filler, they exhibited yield points in their tensile curves. The yield point represents the transition from elastic to plastic deformation. Above the yield point, permanent deformation occurs. For this reason, the yield data is typically used for design purposes and is what is reported in this study. Samples were aged 250, 500, 1000, and 2500 hours using a xenon arc apparatus following SAE J2527. Irradiance was 0.55 W/m^2 at 340 nm. The effects of N990 additions on the PVC properties can be seen in the figures on the following pages.

Table 1. PVC formulations

Material	Control	A	B	C	D
SE 650 PVC	100	100	100	100	100
Thermax® N990	-	1	2	3	-
Low Color Furnace Black N762	-	-	-	-	2
Paraplex G-62	5	5	5	5	5
Total Loading	105	106	107	108	107

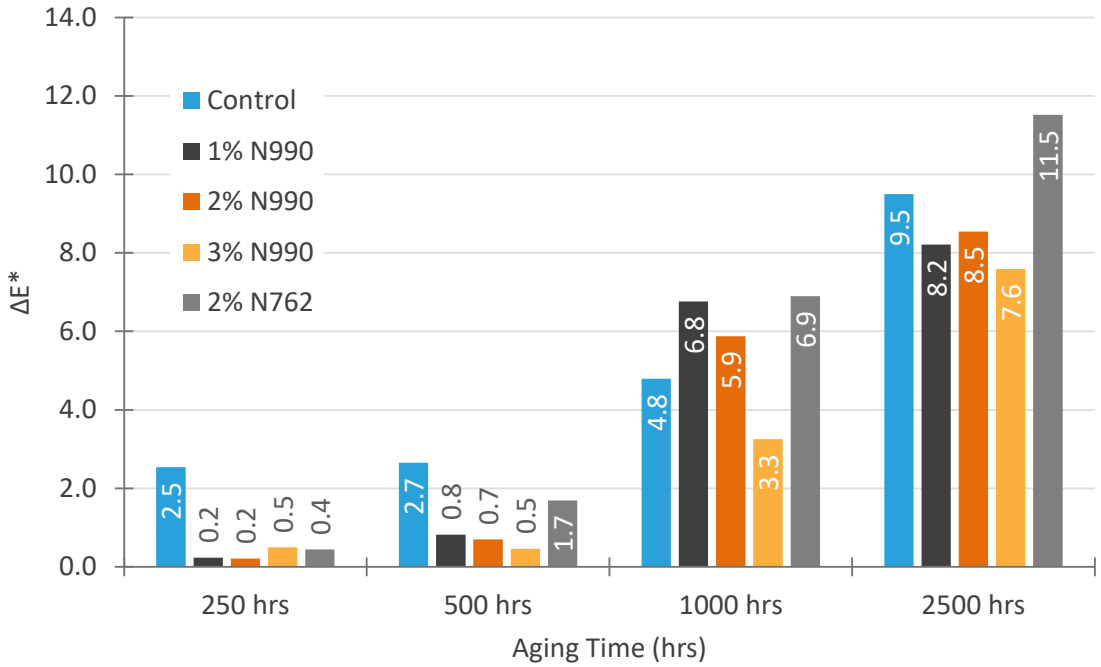

Figure 1. The ΔE* values, which measure the total color change, of the PVC composites after aging. The best performance was seen for the composite with 3% N990. The ΔE* was significantly reduced at 250 and 500 hours of aging and remained below 1 for the samples containing N990. The primary driver of the color change was the darkening of the samples.

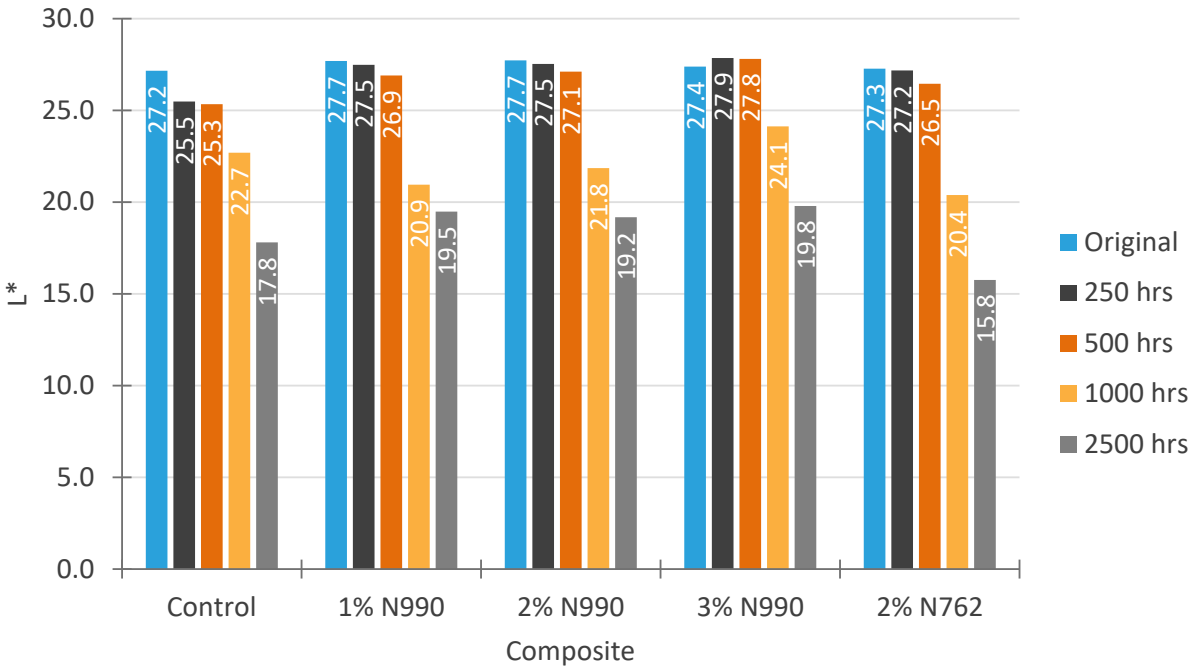

Figure 2. L* lightness values, which measure black (0) to white (100), of the PVC composites measured using CIELAB color space. The control was mixed using the processing equipment reserved for black composites which explains its dark color. Addition of thermal black resulted in less change in L*, particularly at 250 and 500 hours.

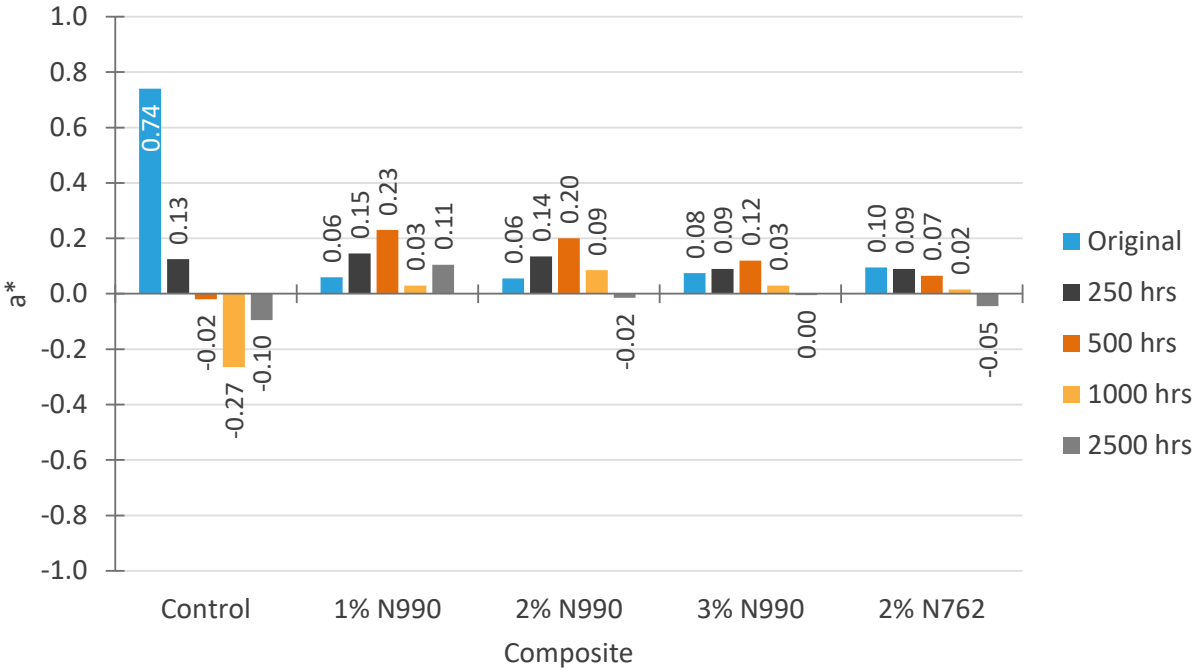

Figure 3. The a* values, which measure red (+) to green (-), of the PVC composites. There was minimal change in the a* values for the samples with thermal black.

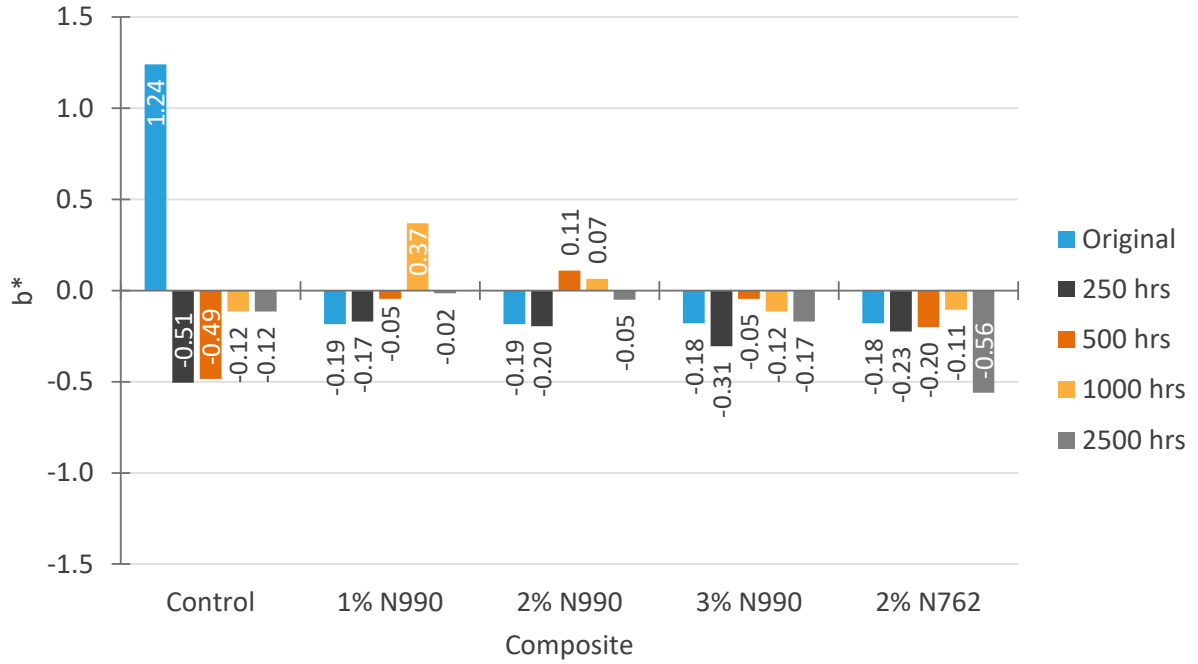

Figure 4. The b* values, which measure yellow (+) to blue (-), of the PVC composites. There was minimal change in the b* values for the samples with thermal black.

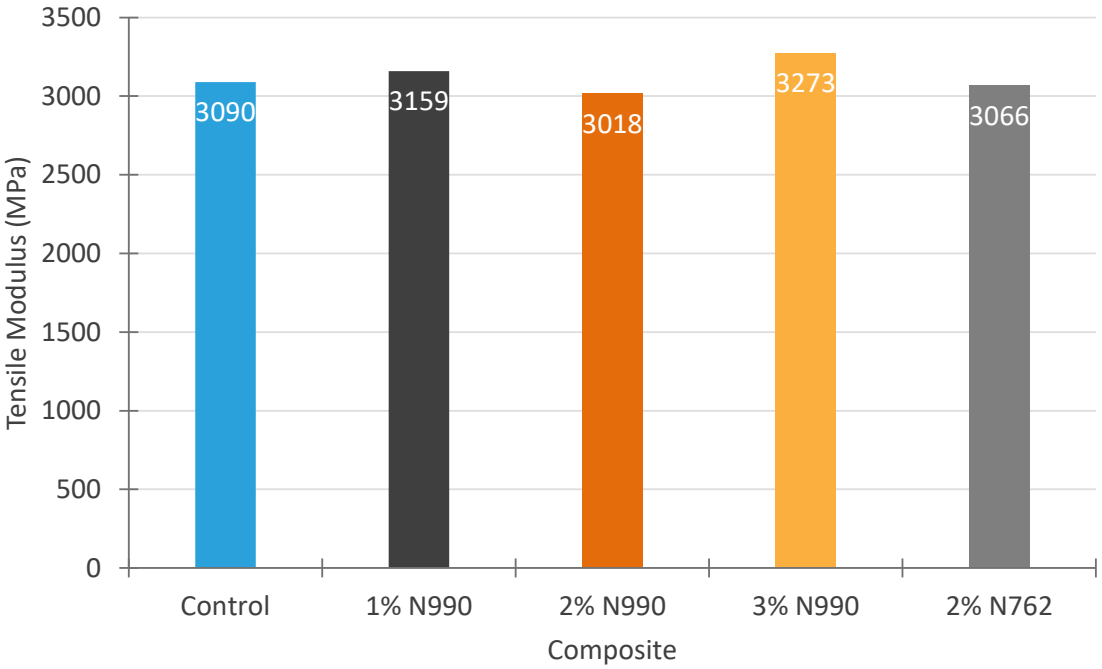

Figure 5. Tensile modulus of PVC composites. Tensile modulus tended to increase slightly as N990 was added to the formulation.

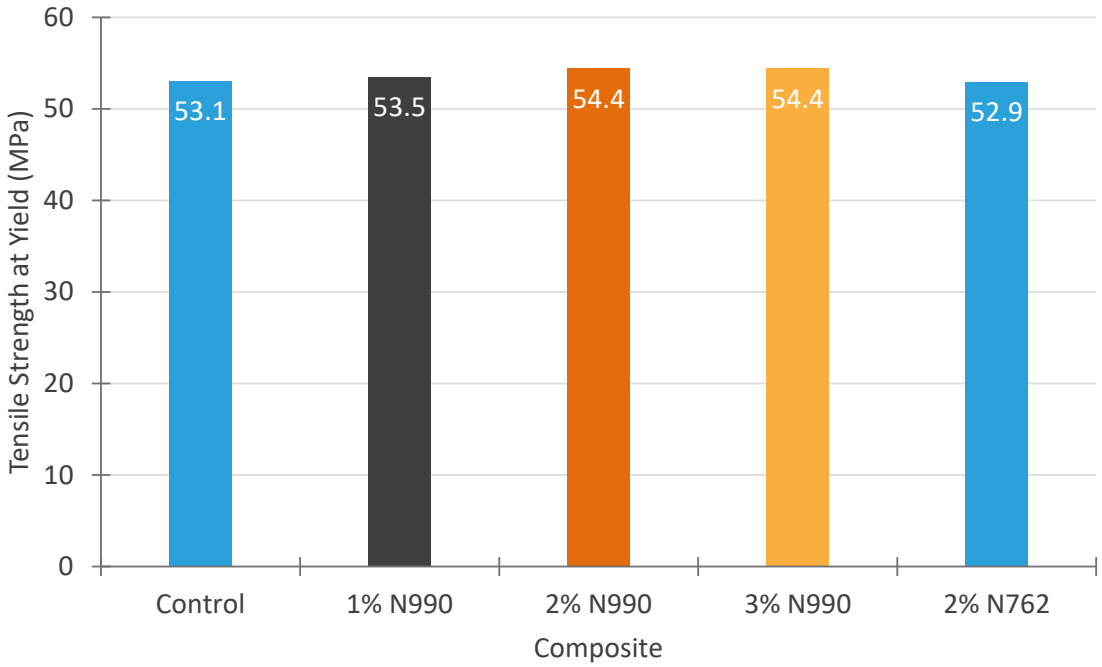

Figure 6. Tensile strength at yield of PVC composites. Tensile strength was slightly higher for the composites containing N990.

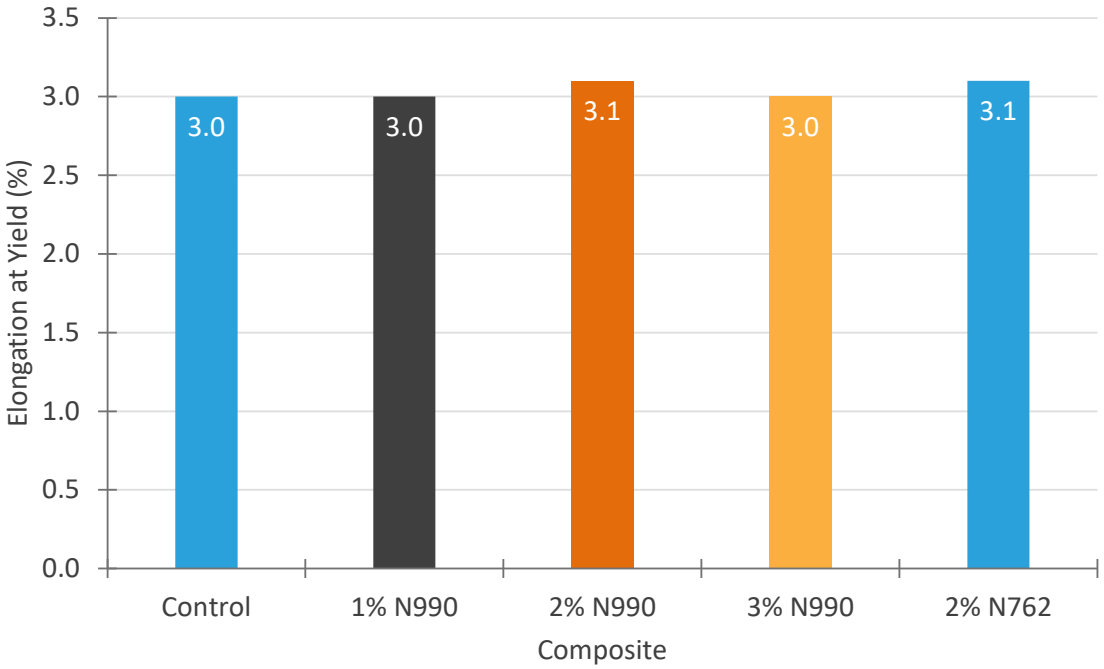

Figure 7. Elongation at yield of PVC composites. Elongation was maintained for all composites.

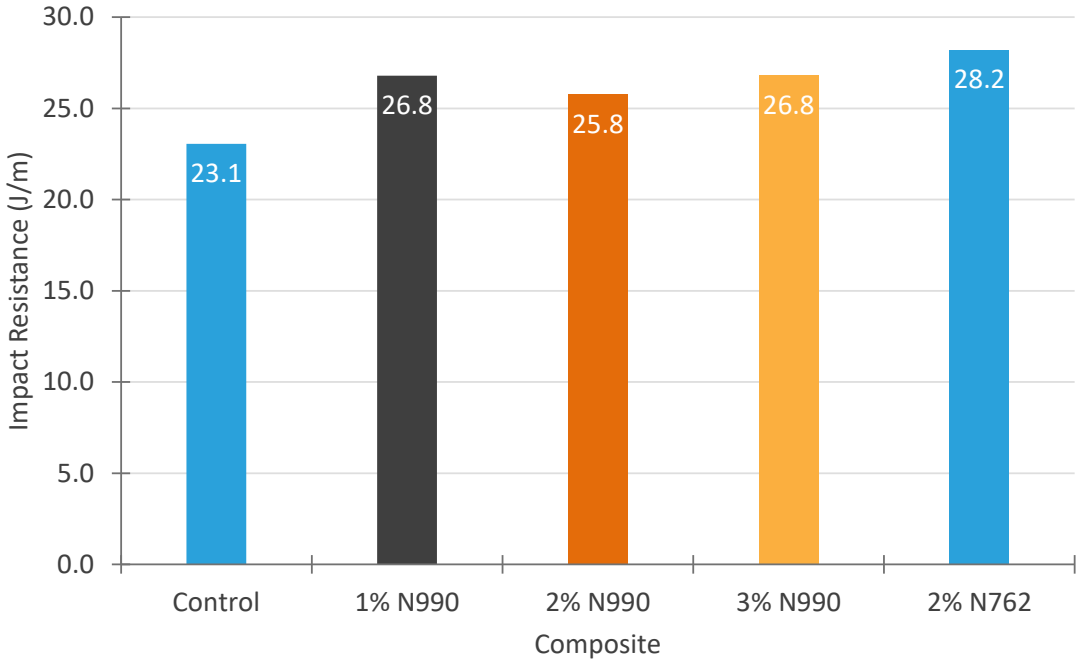

Figure 8. Impact resistance of PVC composites. Impact resistance was significantly higher for the composites with carbon black.

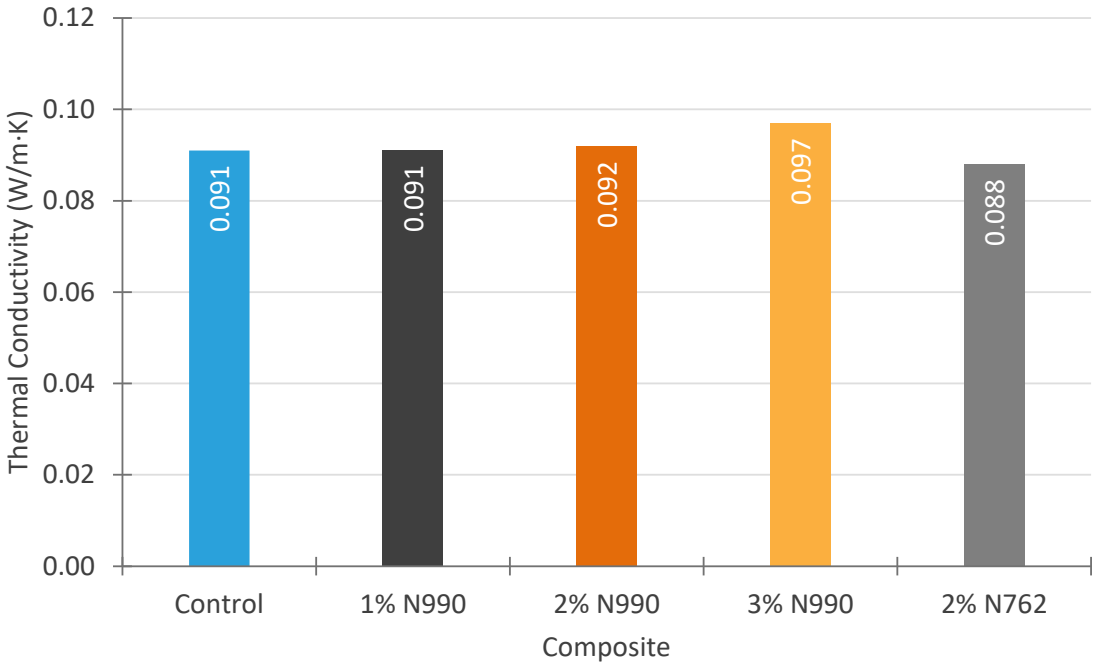

Figure 9. Thermal conductivity of PVC composites. Thermal conductivity increased as N990 was added to the composite.