Thermax® N990 as a Pigment in Polypropylene Composites

Cancarb performed testing of Thermax® N990 as a pigment in polypropylene composites. Thermax® thermal carbon black was compounded in polypropylene (PP) 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 test 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 polyolefin agricultural film and irrigation pipe.

Advantages of adding Thermax® N990 to thermoplastics:

- **Improvement in resistance to weathering**. Minimal change in strength and elongation at yield after 2500 hours of xenon arc weathering.
- **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.
- Increase in impact strength
- High electrical resistivity (non-conductive compounds)
- No change in horizontal burn rate
- **Excellent black coloring** comparable to low color furnace grade
- Class A surface finish capable

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. Melt flow rate, impact strength, tensile properties, color, weathered properties, volume resistivity, and flammability were measured for each composite. As the composites 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 for 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 effect of N990 additions on the properties of polypropylene composites can be seen in the figures on the following pages.

Table 1. Polypropylene test formulations

Control	Thermax® N990 Thermal Carbon Black			N762 Low Color Furnace Carbon Black
No filler added	1 wt.%	2 wt.%	3 wt.%	2 wt.%

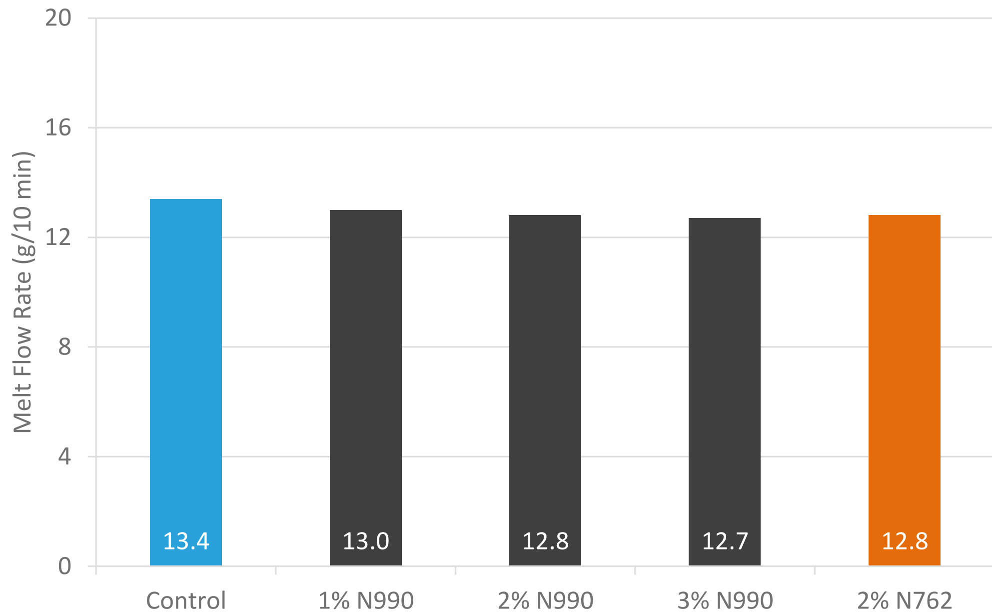

Figure 1. Melt flow rate (MFR) of polypropylene composites measured at 230°C with an applied load of 2.16 kg according at ISO 1133. The MFR decreased slightly as carbon black was added to the composite.

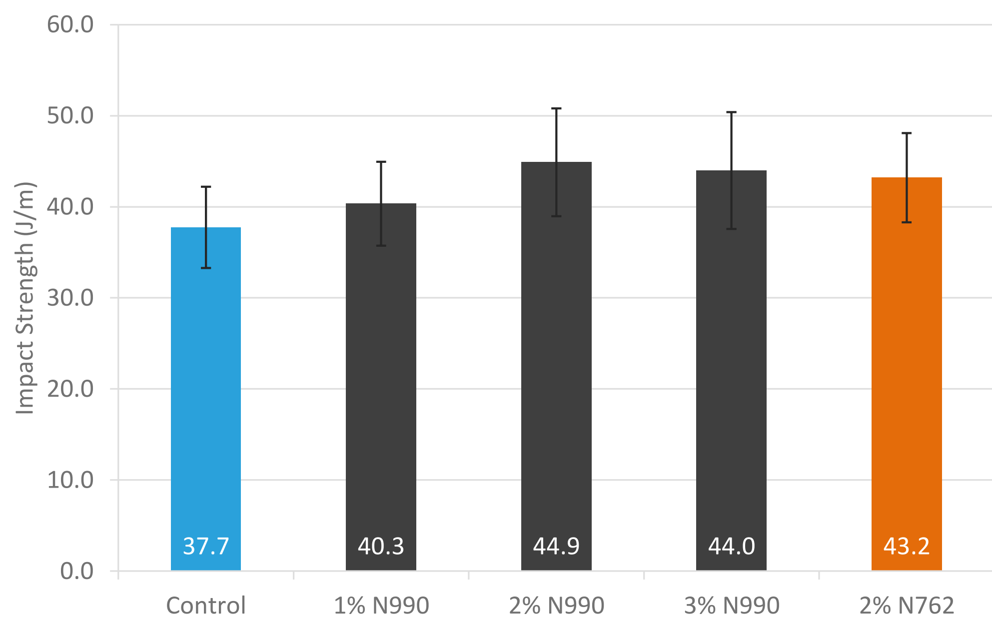

Figure 2. Notched Izod impact strength of the polypropylene composites measured according to ASTM D256. Impact strength increased with the addition of carbon black.

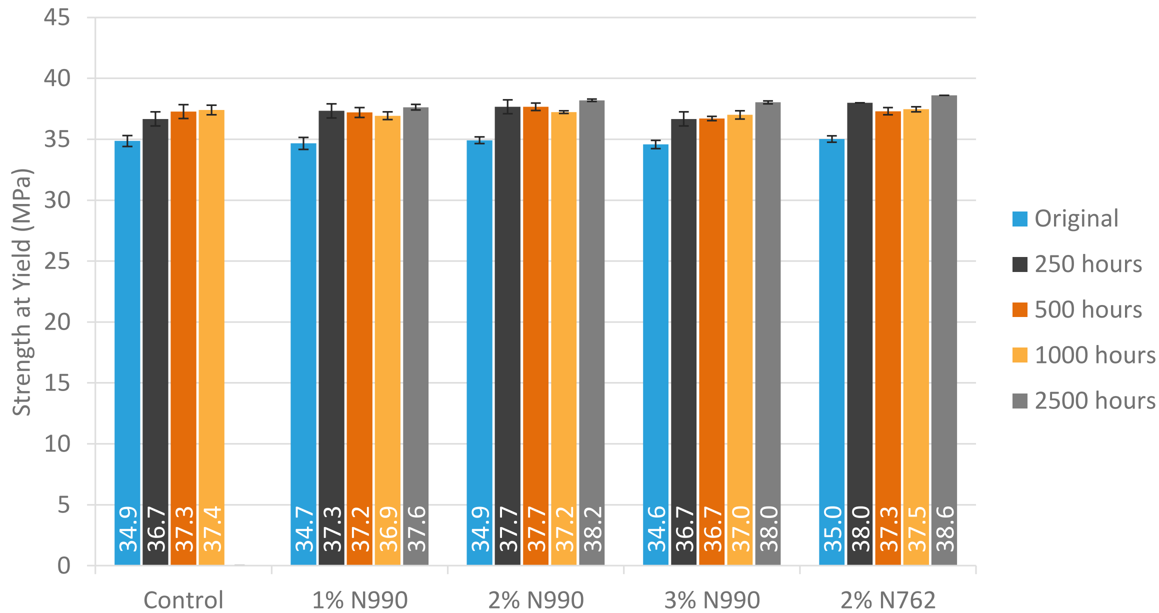

Figure 3. Tensile strength at yield, original and aged, for the polypropylene composites measured according to ASTM D638. The control sample became so brittle after 2500 hours of aging so as to break before yielding; thus, the carbon blacks showed their value in extending the life of the polypropylene composites.

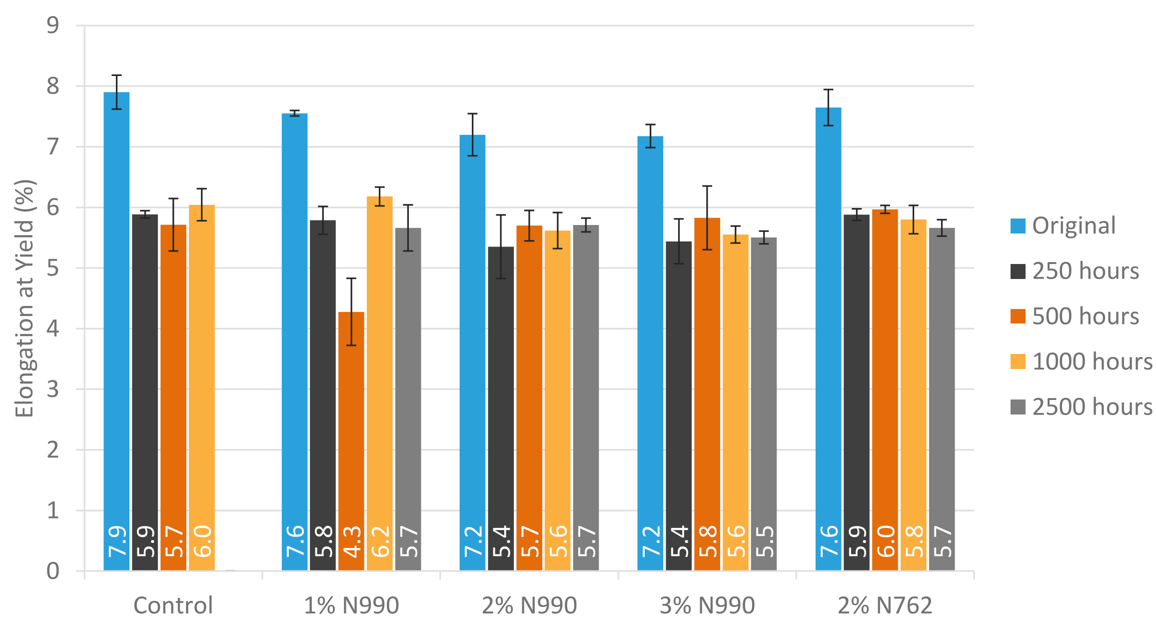

Figure 4. Elongation at yield, original and aged, for the polypropylene composites. There was a drop in elongation at yield for all samples after aging 250 hours. The elongation at yield remained stable for the remainder of the aging time except in the case of the control which didn't experience a yield point after 2500 hours of aging.

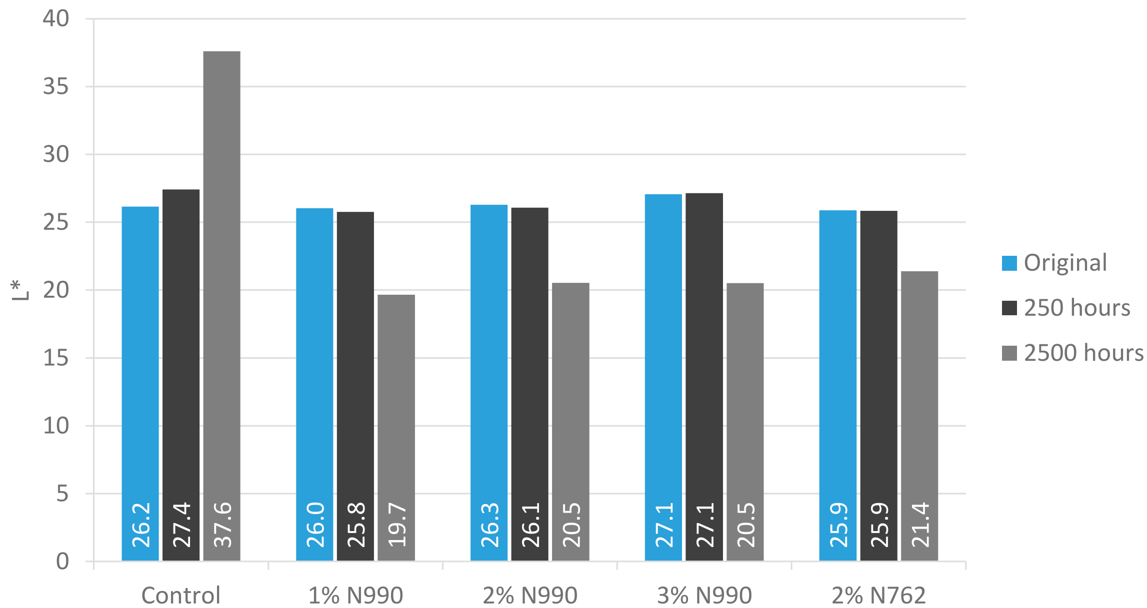

Figure 5. The L* lightness values, which measure black (0) to white (100), for the polypropylene composites measured using the CIELAB color space. The control was mixed using the processing equipment reserved for black composites which explains its darker color. As the composites aged, the samples with carbon black tended to darken whereas the control lightened considerably.

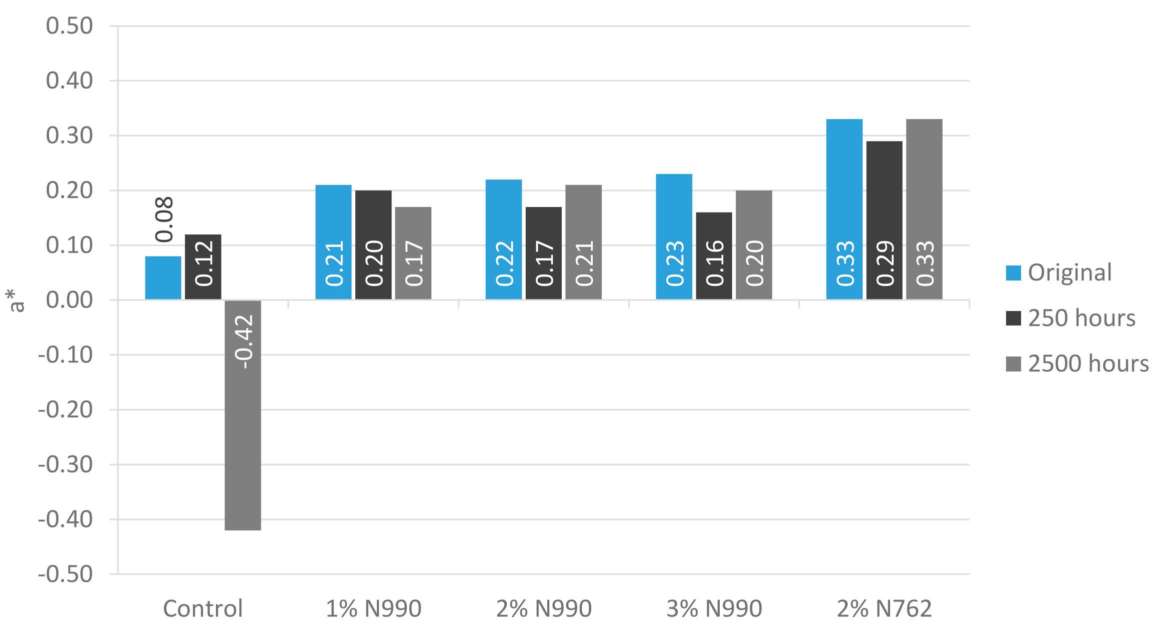

Figure 6. The a* values, which measure red (+) to green (-), for the polypropylene composites. There was very little change in the a* values for the samples with carbon black. The a* value shifted significantly for the control after aging 2500 hours.

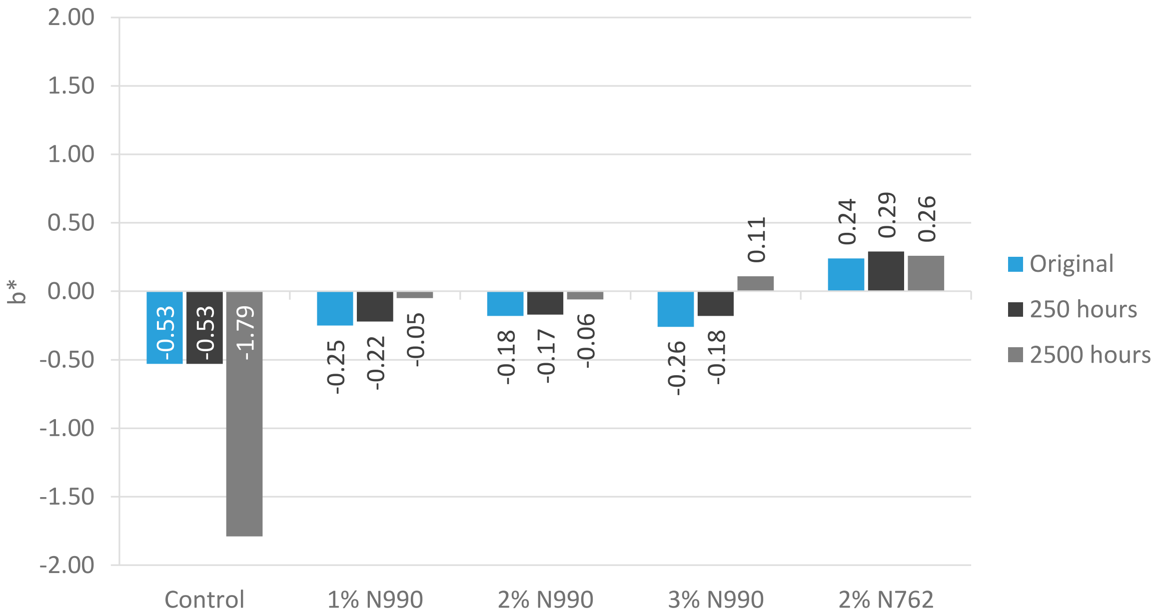

Figure 7. The b* values, which measure yellow (+) to blue (-), for the polypropylene composites. There was a slight shift in b* values for the N990 samples after aging 2500 hours. The control sample showed a significant shift in values after aging 2500 hours.

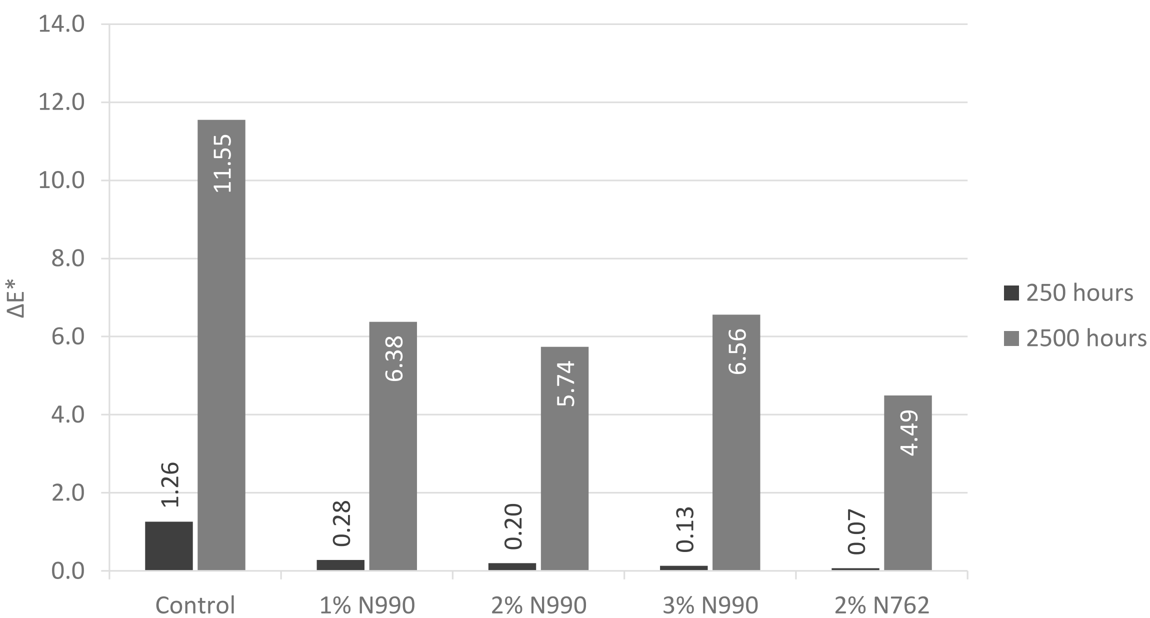

Figure 8. The ΔE* values, which measure the total color change, for the polypropylene composites after aging 250 and 2500 hours. The control had the highest total color change at both aging times. The N762 had the lowest total color change. The change in color for the carbon black samples was driven by the lowering of L* (darkening) as observed in Figure 5.

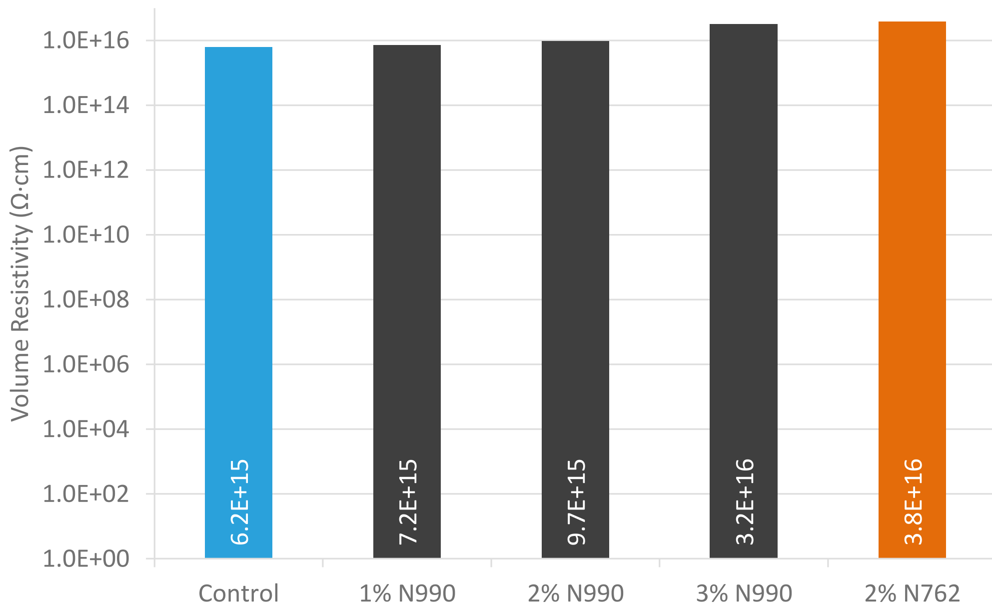

Figure 9. Volume resistivity of polypropylene composites measured according to ASTM D257. Applied voltage was 500 VDC. Resultant current was measured and used to calculate the resistivity. All samples were insulative with no significant differences between their resistivity values.

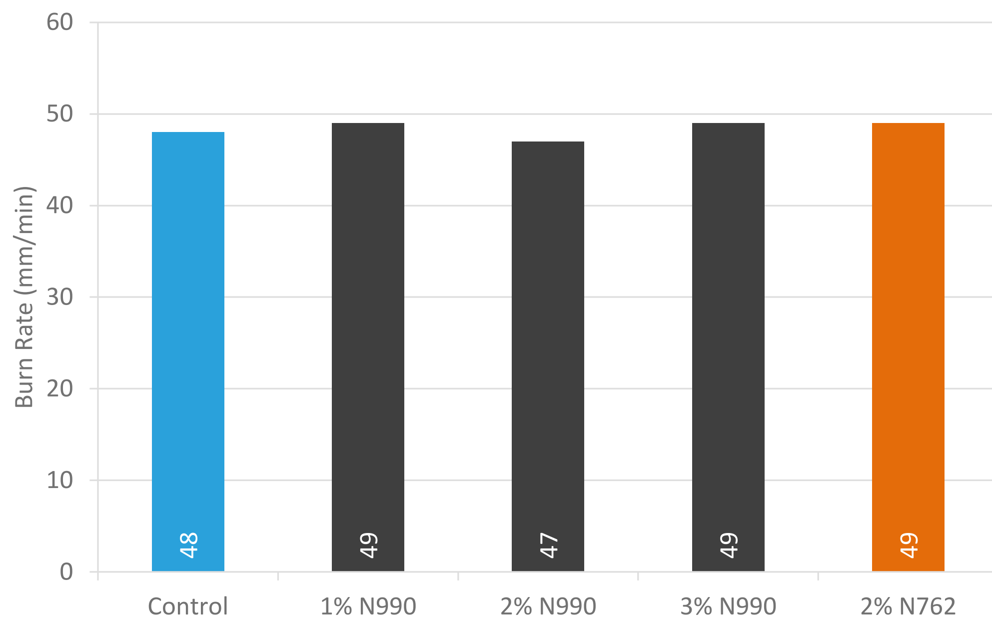

Figure 10. Burn rate of polypropylene composites measured according to ASTM D5132. Specimens were 3 mm thick. There were no significant differences in burn rate of the samples.