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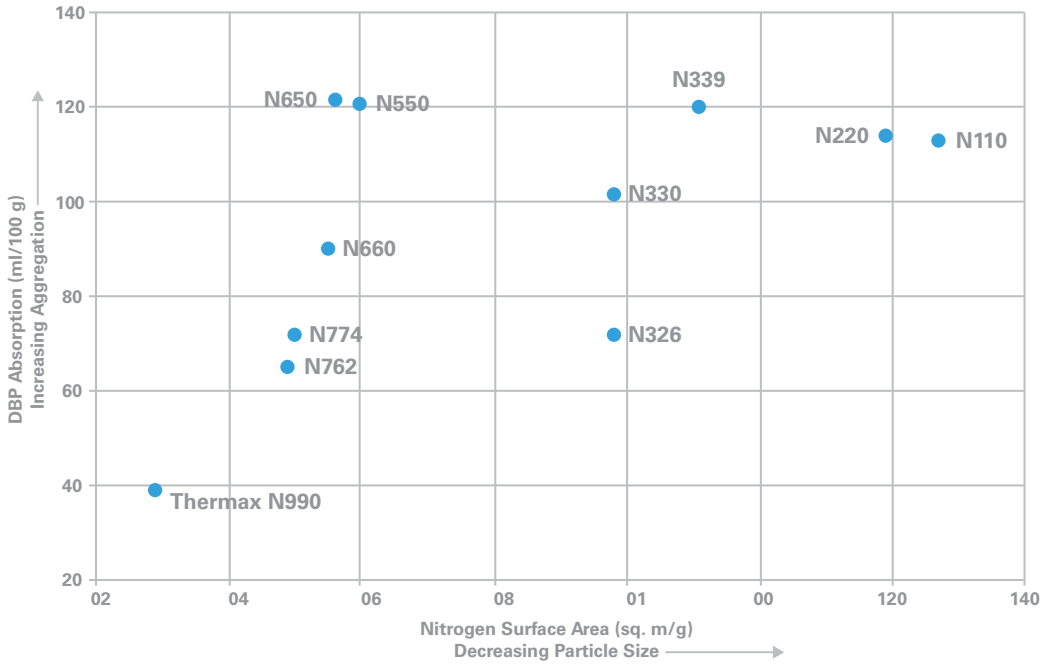
TECHNICAL BULLETIN

Plastics

Carbon black is an important and versatile ingredient for plastics compounders. It can contribute colour, opacity, electrical conductivity and protection from ultra-violet degradation. The choice of carbon black is dependent on the final product requirements. In this regard, Thermax® medium thermal carbon black N990 is unique in its ability to provide low viscosity concentrates and compounds with high volume resistivity.

Particle size and structure (degree of permanent particle aggregation) are the two most important characteristics of a carbon black in determining its performance. Thermax® N990 is notable for its very large particle size and very low structure. Since it is manufactured by the thermal decomposition of natural gas, it is also one of the most chemically pure carbons available. Chart 1 provides a graphical comparison of Thermax® N990 with other commercial carbon blacks.

Chart 1: The Carbon Black Spectrum



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Tables 1 and Table 2 provide a qualitative overview of how performance in plastics is affected by carbon black particle size and structure.

Table 1: Particle Size and Performance

Large Particle		Small Particle
Lighter	Jetness	Darker
Lower	Tint Strength	Higher
Less	UV Protection	More
Lower	Conductivity	Higher
Lower	Viscosity	Higher
Better	Dispersibility	Worse

Table 2: Structure and Performance

Low Structure		High Structure
Darker	Jetness	Lighter
Higher	Tint Strength	Lower
Lower	Conductivity	Higher
Lower	Viscosity	Higher
Worse	Dispersibility	Better

This technical bulletin summarizes aspects of a study[1] of Thermax® N990 in polyethylene performed for Cancarb by the Industrial Materials Institute of the National Research Council Canada.

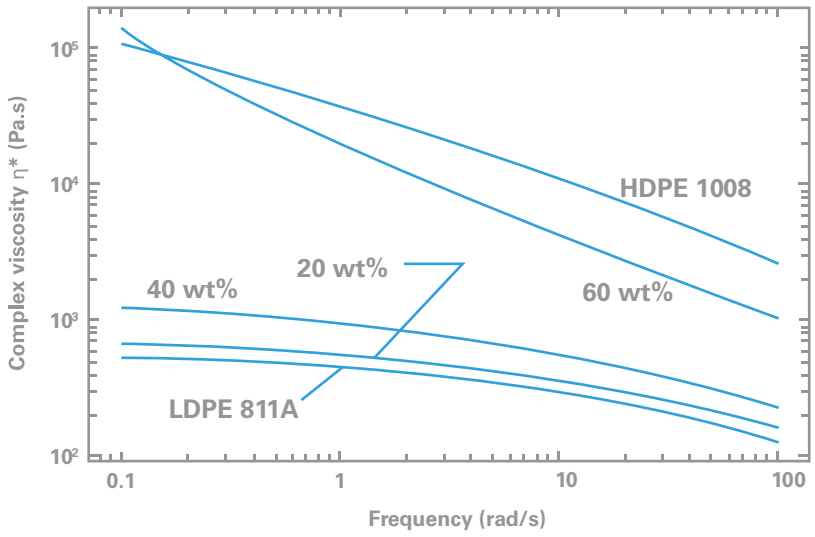
Concentrate Preparation

Concentrates of Thermax® N990 were prepared in low-density polyethylene LDPE 811A from Eastman, using a Werner & Pfeiterer ZSK-30 co-rotating twin screw extruder. Concentrates containing up to 70% Thermax® N990 showed good dispersion, with no trace of agglomeration, when evaluated in blown film with the concentrates let down with LDPE 819A from Nova Chemical to 2% N990.

Rheological Characterization

The rheological properties of 20%, 40% and 60% Thermax® N990 concentrates were evaluated using an ARES rheometer from Rheometrics. Chart 2 below shows the complex shear viscosity of the concentrates as a function of frequency. For comparison, the carrier resin, LDPE 811A and an extrusion grade resin, HDPE 1008, are also shown.

Chart 2: Complex Shear Viscosity as a Function of Frequency at 200°C



[1] Properties of Polyethylene/Carbon Black N990 Blends, Michel A. Huneault and Daniel Bourry, Industrial Materials Institute, National Research Council Canada, October 29, 1998

The factors which affect the rheology of carbon black/polymers mixtures include molecular weight and molecular weight distribution of the resin, the degree of polymer chain branching and/or cross-linking, and the interaction between the carbon black and polymer. The polymer/carbon black interaction is influenced by both the particle size and the structure of the carbon black. Decreasing particle size and increasing structure both lead to increased viscosity.

The large particle, low structure nature of Thermax® N990 leads to lower viscosity concentrates, compared with other carbon blacks at the same loading. For the concentrate manufacturer, lower viscosity can yield benefits in reduced energy consumption and higher throughput rates. As well, higher overall black concentrate loadings are possible, leading in turn to reduced packaging, storage and transportation costs.

Chart 2 demonstrates that Thermax® can provide the benefits outlined above. LDPE 811A is a low viscosity; low density polyethylene typical of the types used to make concentrates. The 20% loading with Thermax® results in negligible viscosity increase compare with the unfilled LDPE 811A. Even at 40% loading, the viscosity remains relatively low in the 10 – 100 radians/sec range which is typical in plastics processing. Even though the 60% loading shows a 10-fold increase in viscosity over the LDPE 811A, it is still comparable to the viscosity of unfilled HDPE 1008 and the concentrate is easily processable.

Of course, colour is also an important characteristic of black concentrates. As a large particle, low structure black, Thermax® has relatively low jetness and tint strength. However, the benefits of N990 can be exploited while maintaining acceptable colour performance by using Thermax® as a partial substitute for higher colour blacks.

Electrical Properties

Filling or colouring resin with carbon black always increases the electrical conductivity of the plastic. The amount of increase depends on the quantity of carbon black added and the particular type of carbon black used. Electrical conductivity is greatest for carbon blacks with small particle size and a high degree of structure. In some cases, the increased conductivity is desirable such as when static discharge is a priority. However, some applications demand black color, but conductivity similar to the unfilled resin. As the largest particle size, lowest structure carbon black available, Thermax® N990 contributes the least to conductivity increase.

Polyethylene containing a range of N990 loadings was extruded into 1-mm thick sheets. The results of volume resistivity testing on the sheets are presented in Chart 3 on the next page.

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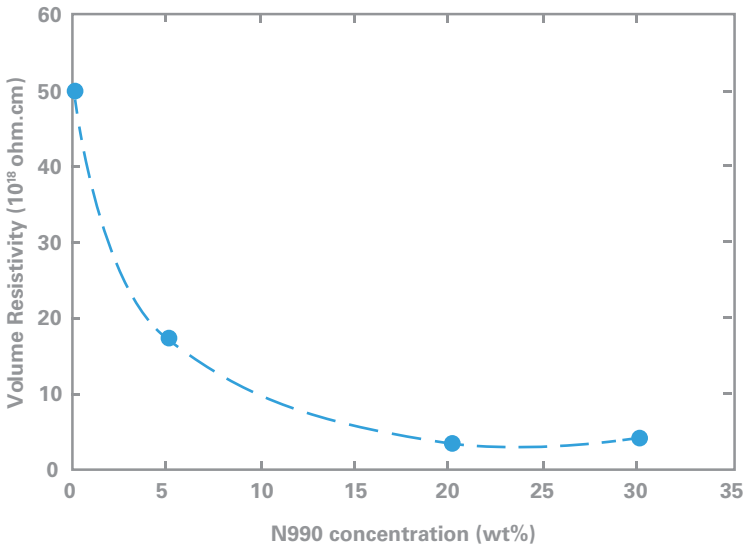
Chart 3: Volume Resistivity of Polyethylene/Thermax® N990 Compounds



Even at a loading of 30%, the Thermax® N990 produced a compound with volume resistivity of about 4 x 10^{18} (ohm-cm) which is suitable for low conductivity applications, including wire and cable compounds.

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