**THERMAX versus Furnace Blacks**

With a particle size approximately ten times that of N330 furnace black, N990 has the smallest surface area of all the blacks commonly used in compounding rubber. These characteristics result in a material with little tendency to interact with polymers or interfere with curing systems.

Although it is not a reinforcing black, it is useful to compare N990 with the furnace blacks in various rubber compounds such as butyl, natural; Neoprene W, nitrile and SBR (see Figures 1-5). As the black particle size increases, the following effects occur:

- modulus and tensile strength decline,
- hardness decreases,
- elongation increases, and
- tear strength decreases.

The level of carbon black used in this comparison is adequate for differentiating from the furnace blacks, but is not high enough to develop the optimum properties of thermal black loading. Note that the hardness of thermal black loaded natural rubber is similar at 125 phr to the hardness of the same compound containing 75 phr of furnace black. This is a graphic demonstration of the non-reinforcing properties of thermal black.
Figure 1a
N990 versus Furnace Blacks* in Butyl Rubber - Modulus

Butyl Rubber cured 20 minutes at 171°C
Source – R.T. Vanderbilt
Formula – See Appendix III

Figure 1b
N990 versus Furnace Blacks* in Butyl Rubber - tensile strength

*Butyl Rubber cured 20 minutes @ 171°C
Source – R.T. Vanderbilt
Formula – See Appendix III
Figure 1c
N990 versus Furnace Blacks* in Butyl Rubber - ultimate elongation

![Graph showing ultimate elongation of N990 versus Furnace Blacks in Butyl Rubber. The graph plots ultimate elongation (%) against carbon black loading (phr) for N990, N770, N660, N550, N330, and N220. The data shows a decrease in ultimate elongation with increasing carbon black loading.]

*Butyl Rubber cured 20 minutes @ 171C

Source – R.T. Vanderbilt
Formula – See Appendix III

Figure 1d
N990 versus Furnace Blacks* in Butyl Rubber - hardness

![Graph showing hardness (Shore A) of N990 versus Furnace Blacks in Butyl Rubber. The graph plots hardness (Shore A) against carbon black loading (phr) for N990, N770, N660, N550, N330, and N220. The data shows an increase in hardness with increasing carbon black loading.]

*Butyl Rubber cured 20 minutes @ 171C

Source – R.T. Vanderbilt
Formula – See Appendix III
Figure 1e
N990 versus Furnace Blacks* in Butyl Rubber – tear strength

*Butyl Rubber cured 20 minutes @ 171°C

Source – R.T. Vanderbilt
Formula – See Appendix III
Figure 2a
N990 versus Furnace Blacks* in Natural Rubber – Modulus

![Modulus Graph]

Figure 2b
N990 versus Furnace Blacks* in Natural Rubber – tensile strength

![Tensile Strength Graph]
Figure 2c
N990 versus Furnace Blacks* in Natural Rubber – ultimate elongation

![Graph showing ultimate elongation](image)

Source - R.T. Vanderbilt
Formula - See Appendix III

Figure 2d
N990 versus Furnace Blacks* in Natural Rubber – hardness

![Graph showing hardness](image)

Source - R.T. Vanderbilt
Formula - See Appendix III
Figure 2e
N990 versus Furnace Blacks* in Natural Rubber - tear strength

* - Natural Rubber cured 10 min @ 153 C
Source - R.T. Vanderbilt
Formula - See Appendix III
Figure 3a
N990 versus Furnace Blacks* in Chloroprene Rubber – Modulus

![Graph showing 300% Modulus (MPa) vs. Carbon Black Loading (phr) for different carbon black types (N990, N770, N660, N550, N330, N220).]

* - Neoprene W cured 20 min @ 153 C
Source - R.T. Vanderbilt
Formula - See Appendix III

Figure 3b
N990 versus Furnace Blacks* in Chloroprene Rubber – tensile strength

![Graph showing Tensile Strength (MPa) vs. Carbon Black Loading (phr) for different carbon black types (N990, N770, N660, N550, N330, N220).]

* - Neoprene W cured 20 min @ 153 C
Source - R.T. Vanderbilt
Formula - See Appendix III
Figure 3c
N990 versus Furnace Blacks* in Chloroprene Rubber - Ultimate elongation

![Graph showing ultimate elongation vs. carbon black loading for different grades of furnace blacks.](image)

Source - R.T. Vanderbilt
Formula - See Appendix III
* - Neoprene W cured 20 min @ 153 C

Figure 3d
N990 versus Furnace Blacks* in Chloroprene Rubber - hardness

![Graph showing hardness (Shore A) vs. carbon black loading for different grades of furnace blacks.](image)

Source - R.T. Vanderbilt
Formula - See Appendix III
* - Neoprene W cured 20 min @ 153 C
Figure 3e
N990 versus Furnace Blacks * in Chloroprene Rubber - tear strength

* - Neoprene W cured 20 min @ 153 C
Source - R.T. Vanderbilt
Formula - See Appendix III
Figure 4a
N990 versus Furnace Blacks* in Nitrile Rubber – Modulus

Figure 4b
N990 versus Furnace Blacks* in Nitrile Rubber – Tensile Strength
Figure 4c
N990 versus Furnace Blacks* in Nitrile Rubber – ultimate elongation

![Graph showing ultimate elongation of N990 versus Furnace Blacks in Nitrile Rubber.](image)

Source: R.T. Vanderbilt
Formula: See Appendix III
* - Nitrile Rubber cured 30 min @ 154C

Figure 4d
N990 versus Furnace Blacks* in Nitrile Rubber – hardness

![Graph showing hardness of N990 versus Furnace Blacks in Nitrile Rubber.](image)

Source: R.T. Vanderbilt
Formula: See Appendix III
* - Nitrile Rubber cured 30 min @ 154C
Figure 4e
N990 versus Furnace Blacks* in Nitrile Rubber - tear strength

* - Nitrile Rubber cured 30 min @ 154°C
Source - R.T. Vanderbilt
Formula - See Appendix III
Figure 5a
N990 versus Furnace Blacks* in Styrene Butadiene Rubber - Modulus

Source - R.T. Vanderbilt
Formula - See Appendix III

* - SBR cured 10 min @ 153°C

Figure 5b
N990 versus Furnace Blacks* in Styrene Butadiene Rubber - tensile strength

Source - R.T. Vanderbilt
Formula - See Appendix III

* - SBR cured 10 min @ 153°C
Figure 5c
N990 versus Furnace Blacks* in Styrene Butadiene Rubber – ULTIMATE ELONGATION

![Ultimate Elongation Graph]

* - SBR cured 10 min @ 153C

Source - R.T. Vanderbilt
Formula - See Appendix III

Figure 5d
N990 versus Furnace Blacks* in Styrene Butadiene Rubber – HARDNESS

![Hardness Graph]

* - SBR cured 10 min @ 153C

Source - R.T. Vanderbilt
Formula - See Appendix III
Figure 5e
N990 versus Furnace Blacks* in Styrene Butadiene Rubber – TEAR STRENGTH

* - SBR cured 10 min @ 153°C
Source - R.T. Vanderbilt
Formula - See Appendix III