Effects of THERMAX in Elastomers

Static Properties of Thermal Black in Elastomers

Thermal carbon black is used extensively in the rubber industry due to its low interaction with host compounds. The low surface area combined with low structure allow thermal black to move more easily in an elastomer, minimizing reinforcement and thereby extending the compound without appreciably modifying its physical properties. The more common physical properties of thermal black are as follows:

Modulus
Modulus is an expression of the force per cross-sectional unit area required to stretch a test piece to a given elongation. It may also be considered as resistance to elongation or stiffness in the vulcanizate.

Tensile Strength
Tensile strength is defined as the force per cross-sectional unit area applied at the rupture point of the specimen. It is calculated by dividing the applied force at rupture divided by the initial cross-sectional area of the specimen.

Elongation
Elongation is used to describe the ability of rubber to stretch without breaking. It is more accurate to describe this ability as ultimate elongation; elongation just before the point of rupture. Its value is taken as a percentage of its original length.

Hardness
Hardness in rubber is defined as the ability to resist indentation. It is expressed as a number referring to the scale on the instrument used for the measurement. All the hardness measurements in this section are on the Shore A scale commonly used for soft rubbers.

Tear Resistance
Tear resistance in rubber may be described as the resistance to growth of a nick or cut when tension is applied. It is expressed in force per unit length.

Compression Set
Compression set is the percentage by which a standard specimen fails to return to its original thickness, after being subjected to a standard compressive load or deflection for a fixed period of time.
**Low Air Permeability**
Thermal black has the widest particle size range distribution (80-550 nm) of any carbon black. This, coupled with the fact that the particles are essentially spheres, allows it to minimize void spaces at high loadings. In effect, thermal black at high loading creates longer, more tortuous diffusion paths for gas molecules. This makes thermal black ideal for applications such as hoses or inner tubes.

**Chemical and Heat Resistance**
The stable and inactive surface of thermal black and its relatively low surface area prevents or reduces its chemical interaction with oils, fuels, fuel additives and oil drilling chemicals. Thermal black also has excellent heat resistance. Many high performance elastomer compounds can incorporate thermal black without degradation of their properties; the resulting compound withstands harsher environments.

**Electrical Insulation**
Thermal black has excellent dielectric properties and, when used as a filler, allows various elastomers to retain their high volume resistivity. Its large particle size and low structure are not conducive to the mechanism of semi-conductivity, namely electron tunneling. Styrene butadiene rubber insulating materials use thermal black, as do neoprene automotive wire compounds and plugs. One of the largest uses of thermal black is in cross-linked polyethylene power cables; thermal black not only helps to extend the compound, maintain dielectric properties and reduce the nerve of the polymer, but also provides ultra-violet radiation protection and flame retardancy.

**Highly Extended Compounds**
Since thermal black does not seriously degrade inherent rubber properties, it can often be compounded at very high loading levels. In the following charts, the various physical properties illustrated show the least amount of change in properties versus loading of thermal black. This practice of high loading can also reduce overall compound costs. Neoprene mechanical rubber goods quite often contain 100-200 parts per hundred of thermal black.

In many rubber applications, thermal black is combined with a more reinforcing carbon black such as N330, N550, N660 or N762. By adding a thermal black, the dynamic properties of an already reinforced rubber compound can be enhanced. To a limited extent thermal black is used as a colorant in rubber and plastics. Its low surface area provides a blue-gray tone to such plastics as polyvinyl chloride, ABS, polypropylene and silicone.
The following charts illustrate the effects of thermal carbon black N990 on several physical properties of butyl rubber (Figure 1a-1g), EPDM (Figure 2a-2k), natural rubber (Figure 3a-3g), chloroprene rubber (Figure 4a-4g), nitrile rubber (Figure 5a-5l), polyacrylate rubber (Figure 6a-6h) and styrene butadiene rubber (Figure 7a-7g).
Figure 1a
Effects of N990 in Butyl Rubber* - compression set

Figure 1b
Effects of N990 in Butyl Rubber* - hardness

* - Butyl 268
** - 70h @ 100 C

Source - R.T. Vanderbilt
Formula-See Appendix I
Figure 1c
Effects of N990 in Butyl Rubber* - resilience

* - Butyl 268

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

Figure 1d
Effects of N990 in Butyl Rubber* - tear strength

* - Butyl 268

Source - R.T. Vanderbilt
Formula-See Appendix I
Figure 1e
Effects of N990 in Butyl Rubber* – tensile properties

Figure 1f
Effects of N990 in Butyl Rubber* – tensile strength
Figure 1g
Effects of N990 in Butyl Rubber* - ultimate elongation

* - Butyl 268

Source - R.T. Vanderbilt
Formula-See Appendix I
Figure 2a
Effects of N990 in EPDM Rubber* - compression set

Figure 2b
Effects of N990 in EPDM Rubber* - hardness

* - NORDEL 1070
After 22h @ 70 C

Source - Cancarb
Formula-See Appendix II
Figure 2c
Effects of N990 in EPDM Rubber* - resilience

![Bar chart showing the resilience of EPDM rubber with different N990 loadings.]

* - NORDEL 1070

Source - Cancarb
Formula-See Appendix II

Figure 2d
Effects of N990 in EPDM Rubber* - tensile properties

![Bar chart showing the tensile properties of EPDM rubber with different N990 loadings.]

* - NORDEL 1070

Source - Cancarb
Formula-See Appendix II
Figure 2e
Effects of N990 in EPDM Rubber* – tear strength

![Tear Strength Graph]

* - NORDEL 1070
Source - Cancarb
Formula-See Appendix II

Figure 2f
Effects of N990 in EPDM Rubber* – tensile strength

![Tensile Strength Graph]

* - NORDEL 1070
** - Aged in Air, 188h @ 150 C
Source - Cancarb
Formula-See Appendix II
Figure 2g
Effects of N990 in EPDM Rubber* - ultimate elongation

Figure 2h
Effects of N990 in EPDM Rubber* - elastic modulus

* - NORDEL 1070
** - Aged in Air, 188h @ 150 C
Source - Cancarb
Formula - See Appendix II
Figure 2i
Effects of N990 in EPDM Rubber* – viscous modulus

Figure 2j
Effects of N990 in EPDM Rubber* – tan delta
Figure 2k
Effects of N990 in EPDM Rubber* - FATIGUE

HEAT RISE (C) vs. N990 LOADING (phr)

* - NORDEL 1070
Source - Cancarb
Formula - See Appendix II
Figure 3a
Effects of N990 in Natural Rubber* - compression set

* - SMR-5

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

Figure 3b
Effects of N990 in Natural Rubber* - hardness

* - SMR-5

Source - R.T. Vanderbilt
Formula-See Appendix I
Figure 3c
Effects of N990 in Natural Rubber* - resilience

* - SMR-5
Source - R.T. Vanderbilt
Formula - See Appendix I

Figure 3d
Effects of N990 in Natural Rubber* - Tear strength

* - SMR-5
Source - R.T. Vanderbilt
Formula - See Appendix I
Figure 3e
Effects of N990 in Natural Rubber* - tensile properties

Figure 3f
Effects of N990 in Natural Rubber* - tensile strength
Figure 3g
Effects of N990 in Natural Rubber* - ultimate elongation

* - SMR-5

Source - R.T. Vanderbilt
Formula-See Appendix I
Figure 4a
Effects of N990 in Chloroprene Rubber - compression set

![Graph showing compression set percentage for different N990 loadings (in phr).]

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

Figure 4b
Effects of N990 in Chloroprene Rubber - hardness

![Graph showing hardness on Shore A scale for different N990 loadings (in phr), with unaged and aged samples.]

Source - R.T. Vanderbilt
Formula - See Appendix I
Figure 4c
Effects of N990 in Chloroprene Rubber - resilience

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

Figure 4d
Effects of N990 in Chloroprene Rubber - tear strength

Source - R.T. Vanderbilt
Formula-See Appendix I
Figure 4e
Effects of N990 in Chloroprene Rubber - tensile properties

Figure 4f
Effects of N990 in Chloroprene Rubber - tensile strength
Figure 4g
Effects of N990 in Chloroprene Rubber - ultimate elongation

Source - R.T. Vanderbilt
Formula-See Appendix I
Figure 5a
Effects of N990 in Nitrile Rubber* - compression set

![Compression Set Chart]

* - NIPOL 1042
Source - Cancarb
Formula-See Appendix II

Figure 5b
Effects of N990 in Nitrile Rubber* - hardness

![Hardness Chart]

* - NIPOL 1042
Source - Cancarb
Formula-See Appendix II
Figure 5c
Effects of N990 in Nitrile Rubber* - resilience

Figure 5d
Effects of N990 in Nitrile Rubber* - tear strength

* - NIPOL 1042
Source - Cancarb
Formula-See Appendix II

Source - Cancarb
Formula-See Appendix I I
Figure 5e
Effects of N990 in Nitrile Rubber* - tensile properties

![Figure 5e](image)

* - NIPOL 1042
Source: Cancarb
Formula: See Appendix II

Figure 5f
Effects of N990 in Nitrile Rubber* - tensile strength

![Figure 5f](image)

* - NIPOL 1042
Source: Cancarb
Formula: See Appendix II
Figure 5g
Effects of N990 in Nitrile Rubber* – ultimate elongation

Figure 5h
Effects of N990 in Nitrile Rubber* – volume/weight
Figure 5i
Effects of N990 in Nitrile Rubber* - elastic modulus

![Graph showing the effects of N990 on elastic modulus in Nitrile Rubber.][5i]

Figure 5j
Effects of N990 in Nitrile Rubber* - viscous modulus

![Graph showing the effects of N990 on viscous modulus in Nitrile Rubber.][5j]

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* - NIPOL 1042

Source - Cancarb
Formula - See Appendix II
Figure 5k
Effects of N990 in Nitrile Rubber* – tan delta

Figure 5l
Effects of N990 in Nitrile Rubber* – FATIGUE
Figure 6a
Effects of N990 in Polyacrylate Rubber* - compression set

![Compression Set Graph]

* - HYTEMP 4051 EP
** - 70h @ 100 C
Source - Cancarb
Formula-See Appendix II

Figure 6b
Effects of N990 in Polyacrylate Rubber* - hardness

![Hardness Graph]

* - HYTEMP 4051 EP
Source - Cancarb
Formula-See Appendix II
Figure 6c
Effects of N990 in Polyacrylate Rubber* – resilience

Source - Cancarb
Formula-See Appendix II

* - HYTEMP 4051 EP

Figure 6d
Effects of N990 in Polyacrylate Rubber* – tear strength

Source - Cancarb
Formula-See Appendix II

* - HYTEMP 4051 EP
Figure 6e
Effects of N990 in Polyacrylate Rubber* - tensile properties

* - HYTEMP 4051 EP
Source - Cancarb
See Appendix II

Figure 6f
Effects of N990 in Polyacrylate Rubber* - tensile strength

* - HYTEMP 4051 EP
Source - Cancarb
See Appendix II
Figure 6g
Effects of N990 in Polyacrylate Rubber* - ultimate elongation

Figure 6h
Effects of N990 in Polyacrylate Rubber* - volume/weight
Figure 7a
Effects of N990 in Styrene Butadiene Rubber* - compression set

![Compression Set Chart]

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

Figure 7b
Effects of N990 in Styrene Butadiene Rubber* - hardness

![Hardness Chart]

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

* - SBR-1500
Figure 7c
Effects of N990 in Styrene Butadiene Rubber* – resilience

![Graph showing the effects of N990 loading on resilience in Styrene Butadiene Rubber.](image)

* - SBR-1500

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

Figure 7d
Effects of N990 in Styrene Butadiene Rubber* – tear strength

![Graph showing the effects of N990 loading on tear strength in Styrene Butadiene Rubber.](image)

* - SBR-1500

Source – R.T. Vanderbilt
Formula – See Appendix I
Figure 7e
Effects of N990 in Styrene Butadiene Rubber* - tensile properties

![Graph showing tensile properties](image)

* - SBR-1500

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

Figure 7f
Effects of N990 in Styrene Butadiene Rubber* - tensile strength

![Graph showing tensile strength](image)

* - SBR-1500

Source – R.T. Vanderbilt
Formula – See Appendix I
Figure 7g
Effects of N990 in Styrene Butadiene Rubber* - ultimate elongation

ELONGATION (%)

500
400
300
200
100
0

N990 LOADING (phr)

50 100 150 200

Unaged
Aged 48h/100 C.Air

*- SBR-1500

Source - R.T. Vanderbilt
Formula – See Appendix I