cancarb
TOKAI CARBON GROUP

Basic Carbon Refractories II

Since the 1960s, carbon has been recognized as an essential component of refractories called upon to resist corrosive high temperature slags such as those encountered in basic oxygen furnaces. It was found that the addition of some form of carbon provided higher residual carbon content than resin or pitch binder alone. This led to better thermal and chemical resistance, thereby increasing the life of refractory linings and indirectly reducing steel production cost. Carbon is now an integral component of the ceramic-carbon composite for many refractory applications. State-of-the-art magnesia-carbon brick is the accepted standard for linings for basic oxygen furnaces and electric arc furnaces and for the slag lines of ladle metallurgy furnaces.

Medium thermal carbon black has been used in the manufacture of basic carbon refractories for many years. Derived from the thermal decomposition of methane gas, this amorphous carbon is preferred by the refractory industry due to its high purity, low ash and sulphur content, and low surface area, as compared to other forms of carbon black. The unique physical and chemical properties of medium thermal carbon black, found in Table 1, have made it the carbon source of choice in many basic carbon refractory products.

The advantages of Thermax® medium thermal carbon black are summarized as follows:

1. Increases brick density by filling voids, thereby reducing porosity and permeability. The wide particle size distribution and low level of particle aggregation of Thermax® N990 allow it to fill in porous voids and maximize brick density. Green strength may also be enhanced by the higher packing density.
2. Better reactivity than other carbon sources for in-situ carbide formation (e.g. Mg-C, SiC, Al_4C_3, B_4C). Thermax® provides more surface area per weight unit of carbon, thereby providing more carbon for reaction with metal additives.
3. Highest carbon purity, providing the brick with increased residual carbon content. The fixed carbon content of Thermax® is greater than 99.5%. This provides improved thermal shock resistance, chemical resistance, heat resistance, and active slag resistance. This helps to improve the wetting angle against penetration by steel, iron, and slag.
4. Large particle size and low structure allow for higher loadability and therefore higher carbon content.
5. Soft pellets for easy incorporation and dispersion during refractory manufacturing.
6. Uniform pellet size distribution allowing use in bulk and semi-bulk automated and pneumatic material handling systems.

Table 1. Fundamental Properties of Thermax® Medium Thermal Carbon Black

Test Description	Thermax® N990
Ash Content, %	0.1
Heat Loss, %	0.0
Toluene Extract, %	0.15
Sulphur, ppm	150
Nitrogen Surface Area, m^2/g	9.5
Oil Absorption Number, mL/100 g	38
Pour Density, lb/ft^3	40
Pour Density, g/cm^3	0.64
Fines Content, %	4.0
pH	10
Mean Particle Diameter, nm	280
Particle Size Distribution, nm	100-700
Specific Gravity	1.8

As can be seen in the SEM image in Figure 1, Thermax® medium thermal carbon black is characterized by large, relatively spherical particles, with a wide range of particle sizes and minimal particle aggregation. According to disc centrifuge measurements, the average particle diameter is roughly 280 nanometers, with a distribution of 100 to 700 nm.

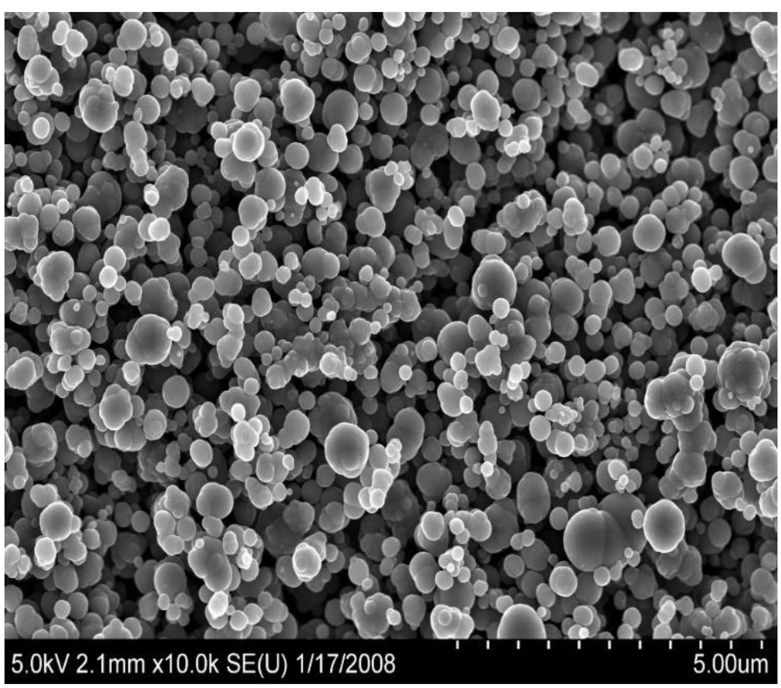

Figure 1. SEM image of Thermax® N990

The high purity of thermal carbon black, originating from the high purity methane gas feedstock, provides superior oxidation resistance. Extremely low levels of ash and sulphur and corresponding high fixed carbon content inherent in the product enhance the chemical and high temperature resistance of refractories. Figure 2 provides a typical thermogravimetric analysis (TGA) of Thermax® in air.

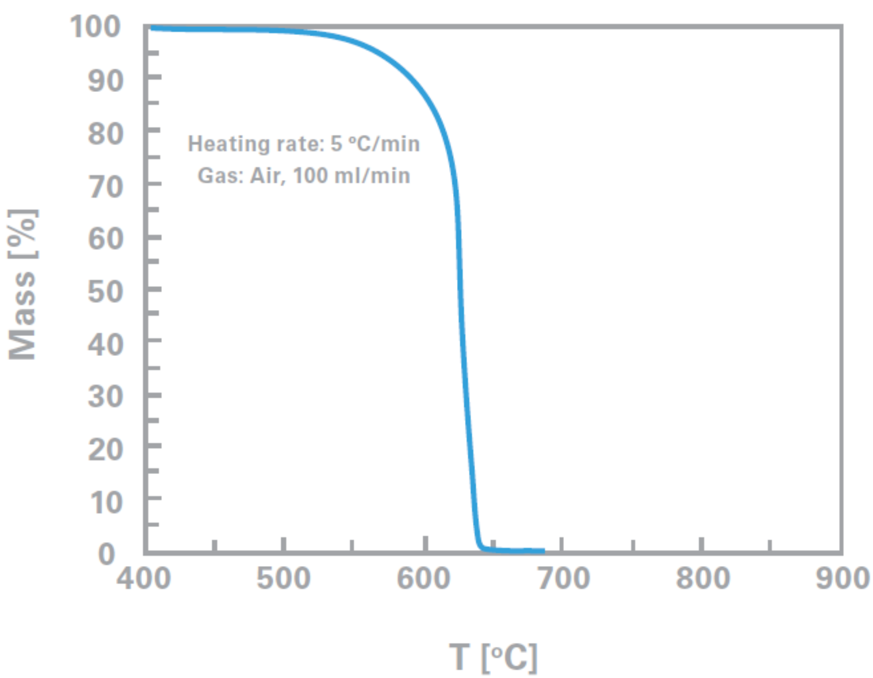

Figure 2. TGA of Thermax® N990

Surface Chemistry

Electron spectroscropy for chemical analysis (ESCA) can be used to measure the surface chemistry of materials up to a depth of 50 Å (5 nm). Thus in addition to the surface, the region near the surface is also studied. Carbon and oxygen are the only elements identifiable on the surface of Thermax® N990, confirming the high purity. Sulphur and nitrogen are not present due to the high purity methane gas feedstock. In Table 2, the surface elemental compositions of Thermax® N990 and the furnace grade N550 are compared.

Table 2. Surface Elemental Composition by ESCA

	Carbon (%)	Oxygen (%)	Sulphur (%)
Thermax® N990	98.4	1.6	Not Detected
N550	98.1	0.9	1.0

Thermax® medium thermal carbon black has been found to improve the physical properties of refractories particularly as to oxidation, chemical resistance, crushing strength, and density. The addition of Thermax® N990 or N991 into the granular refractory formulation at 0.5% to 15% by weight results in a substantial improvement in furnace service life and at the same time helps to control viscosity of the mix during manufacture. Higher densities in specialized refractories have also been accomplished as the wide fundamental particle size distribution and low level of particle aggregation help to maximize brick density. Closer packing of the carbon from both the binder and the carbon black is known to assist in the manufacture of a denser brick.

Thermax® N990 is a pelletized form characterized by soft, uniform pellets, with an average pellet diameter of approximately 0.5 mm. These pellets break apart easily and disperse readily and homogeneously in the refractory mix. Thermax® N990 is notably easier to disperse than other carbonaceous forms such as flake graphite.

Thermal black is used in both pitch and resin bonded dolomite, magnesia, and alumina refractories. It can be used in combination with other forms of carbon including flake graphite. Applications include bricks, castables, ladle slag lines, gates, degassers, and many other related products.

The long terms benefits in using Thermax® medium thermal carbon black include reduced refractory cost per ton of steel through improved refractory longevity and performance, increased thermal shock resistance and oxidation resistance of refractories, and improved steel quality by reducing refractory inclusion content.