Basic Carbon Refractories I

Thermax® N990 has been used as an ingredient in the manufacture of basic carbon refractories for many years. This unique carbon source is one of the latest to be employed by the refractory industry in what has been a long history in the use of carbon and carbonaceous materials for refractory lining of iron and ferroalloy furnaces.

The advantages of medium thermal carbon black and more specifically Thermax® in this application are summarized as follows.

Advantages of Medium Thermal Black versus Other Carbon Blacks:

1. Increases brick density by:
   a. Filling voids
   b. Reducing graphite flake rebound better than any other carbon source
2. Acts as a seed for carbon to precipitate out and form stable carbide crystals (i.e. Mg-C, SiC, Al_4C_3)
3. Is a more reactive carbon source than graphite
4. Increases residual carbon content of the brick
5. Reduces weight loss of brick after first heat treatment
6. Provides improved thermal shock resistance, chemical resistance, heat resistance, and active slag resistance

Advantages of Thermax® N990 in Basic Carbon Refractories:

1. Highest carbon purity to enhance carbon enrichment of brick
2. Lowest order of structure and widest particle size distribution to maximize brick density
3. Lowest levels of ash and acidic silica to enhance brick density
4. Highest pH for maximum compatibility with basic refractories
5. Lowest levels of sulphur for environmental considerations
6. Soft pellets for easy incorporation and homogeneity during manufacturing
7. Uniform pellet size distribution allowing use in bulk and semi-bulk automated material handling systems

As a result of these factors, the benefit to the manufacturer of carbon refractories is a quality product which will stand up under the harshest conditions found in the basic oxygen furnace, that of carbon saturated iron, blast furnace slag, and carbon monoxide atmospheres.

Carbon and carbonaceous materials have long been recognized for their resistance to high temperatures, thermal shock, and corrosive slags. The first use of carbon in refractories dates back to the use of ground coke and tar in carbon blacks and pastes for iron and ferroalloy furnaces in Europe in the 1860s. North American blast furnaces widely used carbon refractories in the mid-1940s.

The introduction of the basic oxygen furnace (BOF) and electric furnaces placed even greater demand on refractory producers. Harsher thermal and chemical environments were the result. Consequently, steel producers required better performance from refractory materials.

The most widely used refractories for these furnace applications are produced from dead burned magnesia (MgO), dead burned dolomite (CaO-MgO) or mixtures of the two. The mixes of the mentioned materials are generally bonded with a binder from coal tar pitch. The use of coal tar pitch, a carbonaceous binder, capable of undergoing pyrolytic decomposition, forms a carbon bond in the brick. Resin bonded bricks are also used in specialized applications.

In the 1960s, it was found that the addition of carbon black improved the performance and service life of basic carbon refractories when incorporated into the mixture. The addition of carbon black provided higher residual carbon content and hence better thermal and chemical resistance. Thermal carbon black was recognized as the best carbon black source. The unique physicochemical properties of medium thermal black, found in Table 1, made it the carbon black of choice in many basic carbon refractories.

Addition of Thermax® N990 into the granular refractory formulation at 2% to 10% by weight results in a substantial improvement in furnace service life and at the same time controls pitch viscosity of the mix during manufacture.

The presence of Thermax® has been found to improve the physical properties of the mix or blend particularly as to oxidation, crushing strength, and density. The larger particle size of this product compared to the furnace black grades of carbon black used to produce lower quality refractories allows more oxidation resistance. The extremely low levels of ash and sulphur and corresponding high fixed carbon contents (in excess of 99.5%) inherent in the product enhance this enrichment mechanism.

Higher densities in these specialized refractories also have been accomplished. Closer packing of the carbon from both the pitch tar and the carbon black are helpful in the manufacture of a denser brick. The large fundamental particle size distribution and low level of particle structure of Thermax® help to maximize brick density. The refractory industry as well as the steel industry gauge that the denser a carbon brick, the greater the quality as ultimately measured by furnace lining life.

Table 1. Typical Physicochemical Properties

Test Description	ASTM Reference	Thermax® N990
Ash Content, %	D1506	0.1
Heat Loss, %	D1509	0.0
Toluene Extract, %		0.15
Sulphur, ppm		150
Nitrogen Surface Area, m^2/g	D3037	9.5
Oil Absorption Number, mL/100 g	D2414	38
Pour Density, lb/ft^3	D1513	40
Pour Density, g/cm^3		0.64
Fines Content, %	D1508	4.0
pH	D1512	10
Average Particle Diameter, nm		280
Specific Gravity		1.8

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