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TOKAI CARBON GROUP

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*For a complete list of the countries where THERMAX® and CANCARB are registered trademarks go to www.cancarb.com/trademarks

THERMAX® as High Temperature Insulation

Today, more and more advanced materials are treated and produced in high-temperature furnaces and reactors, where operating temperatures can exceed 3000°C; therefore the demands on high-temperature insulating materials have increased. Medium thermal carbon blacks - with their low thermal conductivity and inertness - make excellent insulating materials in high-temperature, non-oxidizing environments.

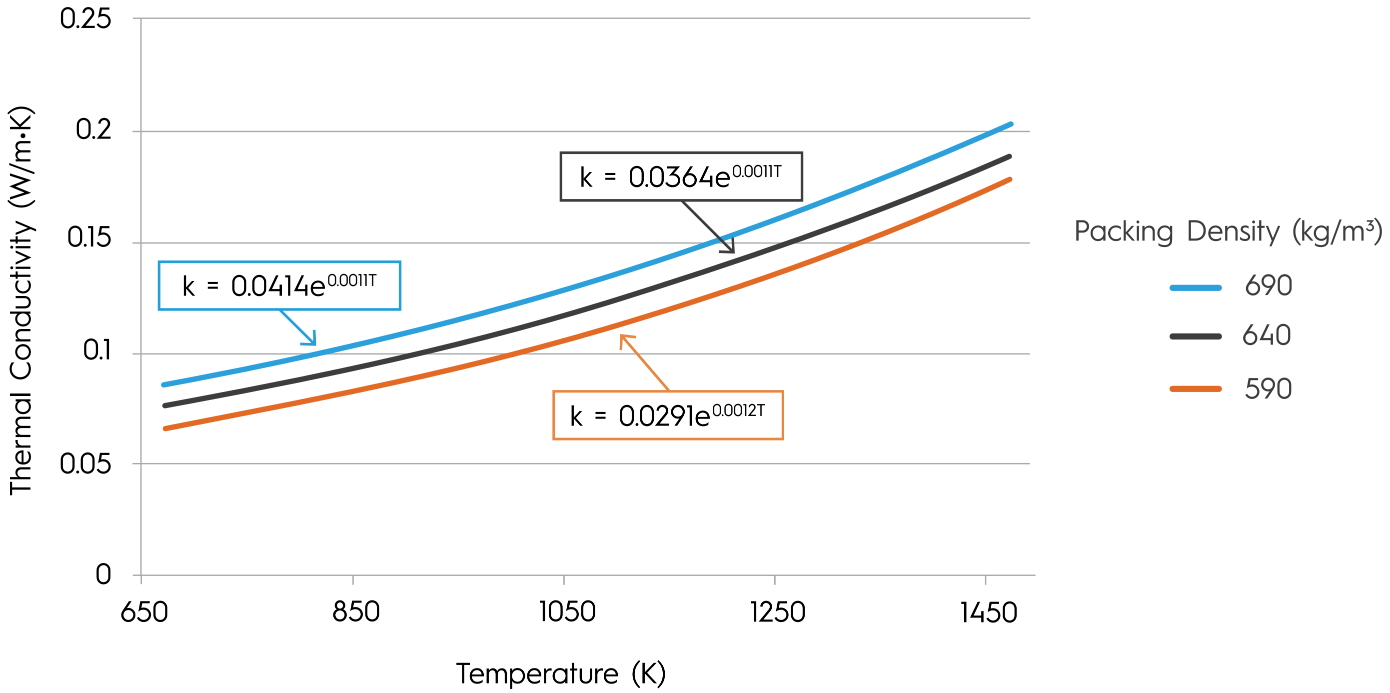
THERMAX® Powders from Cancarb are medium thermal carbon blacks produced from the thermal decomposition of natural gas. Manufactured with state-of-the-art processing and materials, THERMAX® Powders offer unsurpassed quality and consistency. Even better, they are available at only a fraction of the cost of synthetic graphite and carbon felts.

THERMAX® Advantages...

- Low combustibility and chemical reactivity due to inert surface chemistry and high carbon purity.
- Superior resistance to temperatures up to 3200°C.
- Low ash content to prevent clinker formation and reduce product combustion.
- Excellent insulation against radiant heat.
- Excellent packing with no tendency to flow or run after installation.

Thermal Conductivity Versus Temperature

Thermal Conductivity of Thermax N991 at Different Packing Densities



The exponential relationship $k = Ae^{BT}$, where A and B constants, can be used to calculate the thermal conductivity value at a given temperature. Extrapolation of conductivity values beyond the temperatures and packing densities shown above is not recommended.

Low Thermal Conductivity

A prerequisite of any candidate material for furnace and reactor insulation is low thermal conductivity. The thermal conductivity of THERMAX® is measured in accordance with standards set by the ASTM and is similar to graphite and carbon felts. (This measurement was made using the test "Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus" - ASTM C-177). Laser flash analysis (LFA) has also been used to measure thermal diffusivity.

End Use Recommendations

When employing THERMAX® Powders as an insulation medium, we recommend that the powder be packed as tightly as possible. These powders can't be "over packed". Tight packing ensures uniform conductivity and eliminates void spaces which can create hot spots and increase product combustion.

The Unique Properties of Thermax®

High Carbon Purity

Non-carbon impurities can produce clinker formation and hot spots which jeopardize reactor /furnace integrity. THERMAX Powder is produced from a sulphur-free methane gas feedstock - and Cancarb's unique processing steps ensure a final product almost completely free of impurities. Low ash and extremely low sieve residue levels exemplify the high purity of THERMAX Powders.

Inert Surface Chemistry

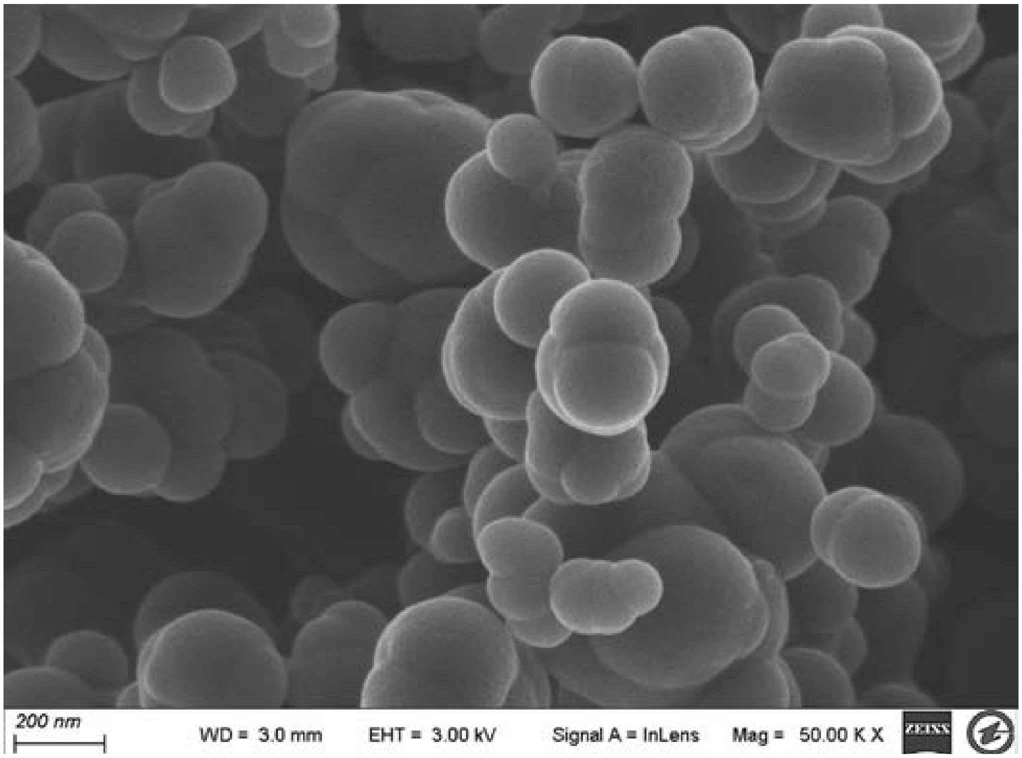
Thermal black exhibits the highest degree of layer plane order among carbon blacks, reducing both the number of exposed layer plane edges and the occurrence of chemically reactive sites. That means THERMAX Powders are much more chemically inert and less combustible, giving you insulation that can withstand elevated temperatures and hostile environments.

Low Surface Area

A large particle size provides a low surface area per unit mass. Medium thermal black has the largest particle size of any carbon black. THERMAX Powders have a typical average particle diameter of 225 nm, with a range between 100 and 600 nm. The low surface area of THERMAX Powders reduces chemical reactivity and increases the life of the insulation.

Low Structure

Carbon black particles tend to fuse into clusters or reticulate structures. Thermal black is relatively free of any structure and consists mostly of 1-3 particle aggregates. That means particles of THERMAX Powder pack very well and reduce void spaces, which in turn reduces insulation degassing time and ensures a uniform and consistent insulating layer.



A Variety of Grades to Choose From

Not all furnaces and reactors are alike, so not all customer insulation requirements are the same. That's why Cancarb offers four grades of THERMAX® Powder to meet individual requirements. All grades provide the same low thermal conductivity.

THERMAX® Powder N991

Our regular Thermax® Powder N991 offers the unique advantages of medium thermal carbon black at an economical price.

THERMAX® Stainless Powder N908

Stainless Powder is a low aromatic content (toluene extractable) grade. The low level of extractables reduces off-gassing at elevated temperatures.

THERMAX® Powder Ultra-Pure N991

This high carbon purity grade has reduced ash levels. These extremely low levels reduce carbon loss and extend the life of the insulation.

THERMAX® Stainless Powder Ultra-Pure N908

This is the highest carbon purity grade of THERMAX®, combining the advantages of Stainless and UltraPure in one product. It is one of the world's purest forms of industrial carbon.

Parameter	ASTM Designation	N991	N908	N991UP	N908UP
Sieve Residue	D1514				
60 Mesh Max %		.0030 (30)	.0030 (30)	.0005 (5)	.0005 (5)
325 Mesh Max %		.0250 (250)	.0250 (250)	.0050 (50)	.0050 (50)
Magnetics on 325 Mesh (max)		.0005 (5)	.0005 (5)	.0005 (5)	.0005 (5)
Nitrogen Surface Area, m^2/g	D6556	7.0-12.0	7.0-12.0	7.0-12.0	7.0-12.0
Oil Absorption Number (OAN) $cm^3/100g$ max	D2414	44.0	44.0	44.0	44.0
Ash Content % max	D1506	0.2	0.2	0.02	0.02
pH	D1512	9.0-11.0	9.0-11.0	4.0-8.0	4.0-8.0
Toluene Extract % max		0.5	0.15	0.5	0.15
Heat Loss % max	D1509	0.1	0.1	0.1	0.1
Total Sulphur % (ppm) max	D5453	-	-	.006 (60)	.006 (60)

*Tests are performed generally in accordance with ASTM

Thermal Conductivity and Heat Transfer Calculations

When a manufacturer heats up a furnace or reactor, thermal energy flows into the furnace walls, hearth and roof, moving from the hot face to the cold face. The refractories and insulation store part of the heat and part of it escapes to the environment.

The heat that escapes is referred to as heat loss which can be considered as fuel or energy wasted. Furthermore, the temperature outside the furnace or reactor must be low enough to provide a functional environment for equipment, materials, and personnel.

Often a process depends on maintaining a certain temperature within a furnace or reactor. This is assumed to be the steady state condition in heat transfer. The rate of heat flow through a furnace wall is proportional to the difference between the hot and cold face temperatures, proportional to the area of the wall and inversely proportional to the thickness of the wall. This proportionality can be converted into an equation by a constant, k whose numerical value depends on the material in the wall. This is called the coefficient of thermal conductivity.

Fourier's Law:

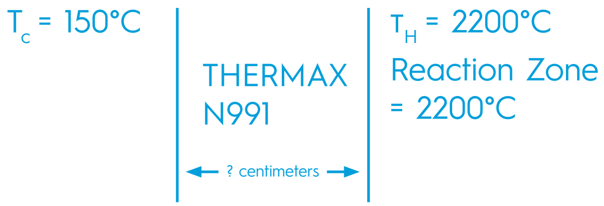
$$Q = kA\frac{dT}{dx} = kA\frac{T_H - T_C}{L}$$

Where:
- Q = rate of heat loss
- k = thermal conductivity
- T_H = temperature of the hot face
- T_C = temperature of cold face
- A = area of the wall
- L = thickness of the wall

In many heat transfer problems, the hot face temperature and the desired cold face temperature will be known approximately, but the amount of heat lost has to be estimated.

The following simplified heat transfer calculation is shown to illustrate the use of THERMAX® POWDER in a typical application.

For example, suppose a project. calls for the use of carbon insulation in a high temperature furnace. A thin wall graphite tube encloses the main reaction zone. The steady state surface temperature will be 2200°C. The furnace designer wishes to obtain a 150°C cold face temperature and a corresponding heat loss of 2050 W/m². What thickness of packed THERMAX® POWDER (N991) is required?



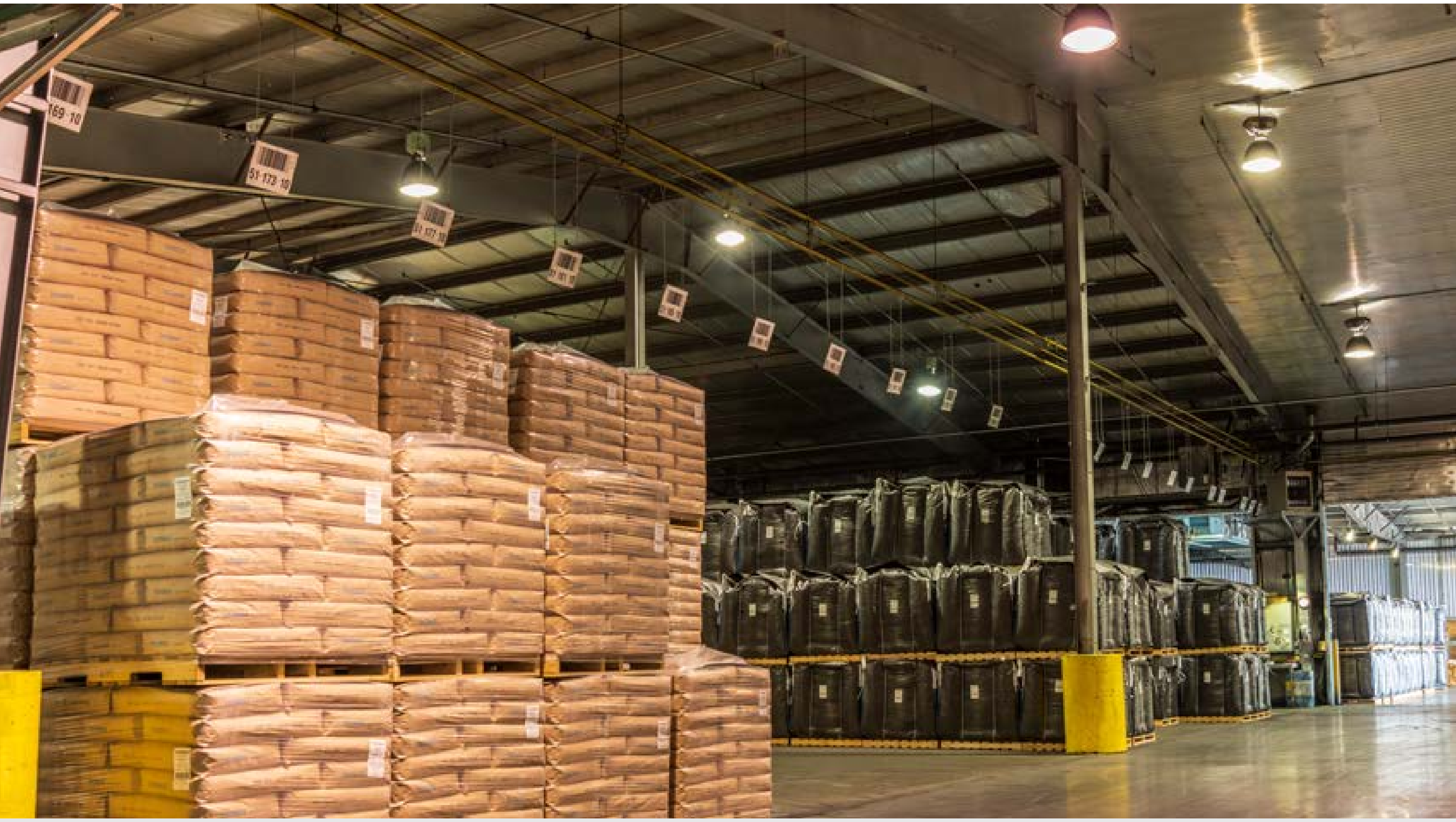
As a first approximation, the thermal conductivity of packed THERMAX POWDER N991 can be taken as 0.35 W/mK over the whole temperature range.

$$L = \frac{k\,(T_H - T_C)\,A}{Q}$$

$$L = \frac{0.35\ W/mK\ (2050K)\ (1m^2)}{2050W}$$

$$L = 0.35m\ \text{or}\ 35cm$$

Approximately 35 centimeters of packed THERMAX POWDER would be required in this particular application.



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For further information contact Cancarb or any of our distributors located around the world.

1702 Brier Park Crescent N.W.
Medicine Hat, Alberta, T1C 1T9 Canada
www.cancarb.com
customer_service@cancarb.com