

Babcock & Wilcox**Kaowool® Ceramic Fiber Products****Strip**

B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

Physical Properties:

Kaowool ceramic fiber is a highly efficient insulator. Kaowool's low shot content gives more usable fiber for your insulating dollar. Kaowool's longer fibers give it the high tensile strength and resiliency to withstand vibration and physical abuse. Kaowool is self-supporting—will not separate, sag or settle. Kaowool has low thermal conductivity, low heat storage, and is extremely resistant to thermal shock.

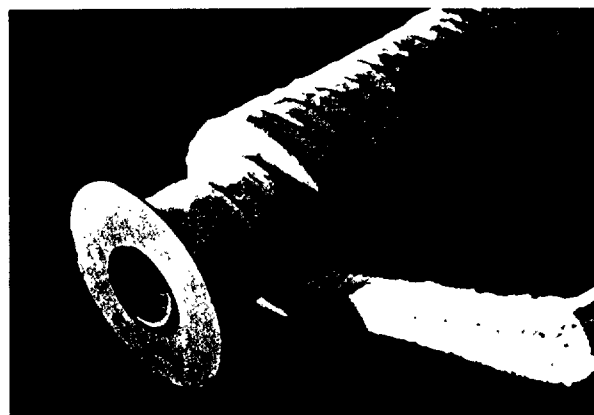
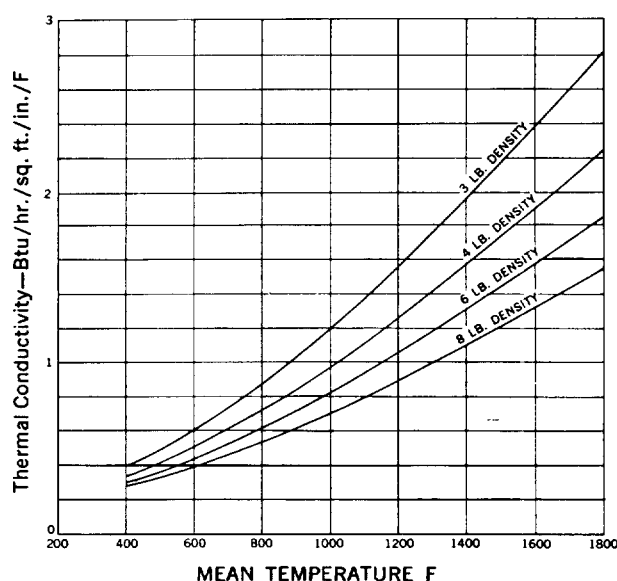
Color	White
Fiber Diameter	2.8 microns (average)
Fiber Length	4" (average) (to 10")
Specific Gravity	2.56 (ASTM C188)
Specific Heat at 1800 F mean	0.255 Btu/lb/F
Tensile Strength, Fiber	1.9×10^5 /lb/sq. in.
Tensile Modulus, Fiber	16.8×10^6 /lb/sq. in.
Use Limits:	
Continuous	2300 F
Single Application	3000 F
Melting Point	3200 F
Hardness	6—MOH's scale
	700—Knoop's scale—100 gr loading

Chemical Properties:

B&W Kaowool ceramic fibers possess excellent resistance to chemical attack. Exceptions are hydrofluoric acid, phosphoric acid and strong alkalis. Kaowool is unaffected by oil or water. Thermal and physical properties are restored after drying.

Chemical Analysis

	%
Alumina, Al_2O_3	45.1
Silica, SiO_2	51.9
Iron Oxide, Fe_2O_3	1.3
Titania, TiO_2	1.7

**THERMAL CONDUCTIVITY AT VARIOUS DENSITIES**

Magnesia, MgO	Trace
Calcium, CaO	0.1
Alkalies as Na_2O	0.2
Boric Anhydride, B_2O_3	0.08

Typical Applications:

Expansion Joints
High Temperature Filtration
Gaskets
Acoustical Service for Missiles, Rockets and Jet Engines
High Temperature Insulation

Wet Felt

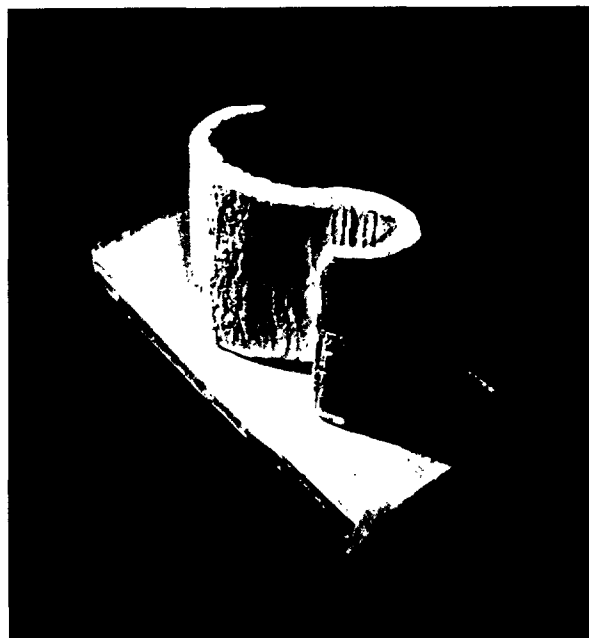
B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

B&W Kaowool wet felt is manufactured by combining Kaowool ceramic fiber with an inorganic bonding agent. It is very pliable and has good green strength. Wet felt may be cut into any size or shape, or it may be formed or molded. It will conform to any surface or contour. When dried or fired, it becomes a lightweight resilient insulator which can be sawed, cut, or sanded. It will not crack or spall or be wet by molten aluminum. Used in temperatures up to 2200F.

Physical Properties:

Kaowool ceramic fiber is a highly efficient insulator. Kaowool's low shot content gives more usable fiber for your insulating dollar. Kaowool's longer fibers give it the high tensile strength and resiliency to withstand vibration and physical abuse. Kaowool is self-supporting—will not separate, sag or settle. Kaowool has low thermal conductivity, low heat storage, and is extremely resistant to thermal shock.

Color	White to off white
Density	24 lbs./cubic foot
Use temperature	Up to 2200F.
Melting point	Above 3200F.
Modulus of Rupture	115 psi (dry)
Air Permeability	3 cu. ft./min. @ 2" w. gauge



Chemical Analysis:

Al ₂ O ₃	—37.6
SiO ₂	—59.8
Na ₂ O	—0.5
B ₂ O ₃	—0.1

Thermal conductivity

Mean temp.	Btu/hr/sq. ft./F/in.
500F	0.5
1000F	0.9
1500F	1.1
2000F	1.4

Linear Shrinkage (%):

After 24 hours at 1800F	—1.9%
After 24 hours at 2100F	—3.1%

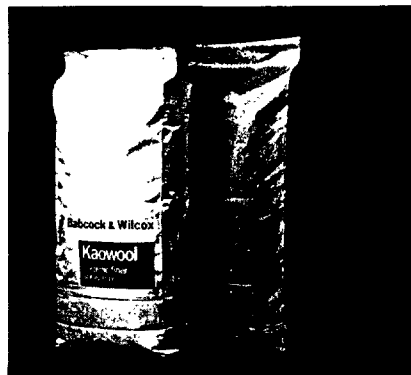
Kaowool Spray Mix

B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

B&W Kaowool Ceramic Fiber Spray Mix is a lightweight high temperature ceramic fiber insulation designed for pneumatic gun placement. It is composed of Kaowool ceramic fiber and inorganic binders, which after being mixed with water at the spray gun nozzle, will adhere to the surface to be insulated.

Physical Properties*

Density 12-13 lb. /cu. ft.
Use limit 1800F



Hot Face Shrinkage, %

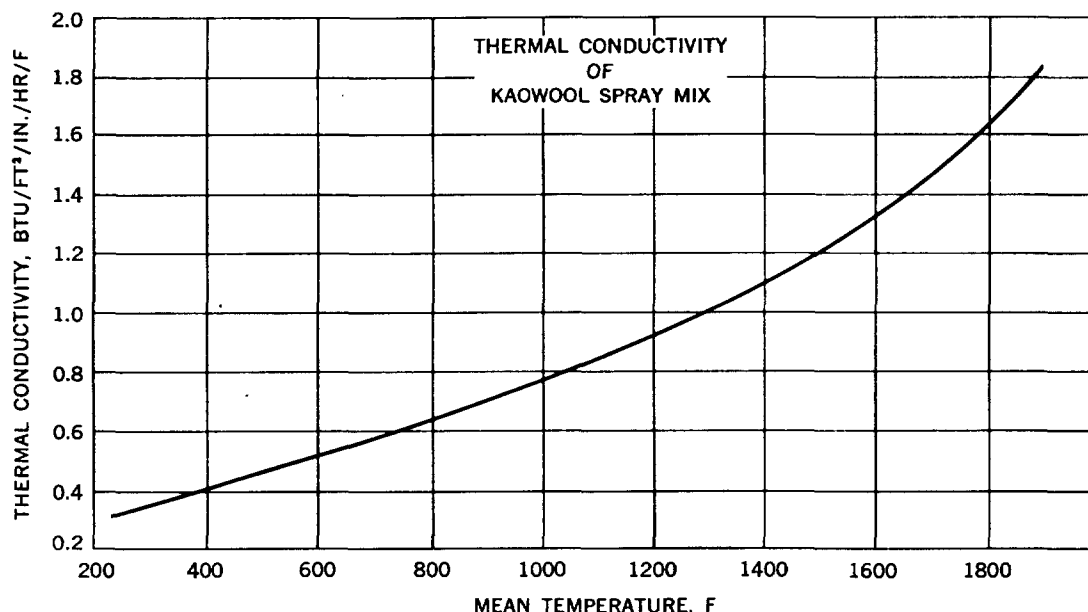
24 hrs @ 1600F 0.6-0.8
24 hrs @ 1800F 1.0-1.4

Compressive Strength, psi

5% Deformation 0.6
10% Deformation 1.6
20% Deformation 3.8

Data are average results of control tests and are subject to normal variation. Results should not be taken as maximum or minimum requirements for specifications.

Moisture Content, As Applied 65%



B&W Kaowool spray mix offers the specific advantages of a monolithic Kaowool lining. Kaowool spray mix can be applied on irregular surfaces and will fit perfectly eliminating possibility of air circulation between the Kaowool mix and the surface being insulated. Some application areas would be: large ducts and piping, furnace linings, doors, process heaters, etc.

Spray Mix

1350 Spray Mix 750 Spray Mix

B&W 1350 Spray Mix & 750 Spray Mix are quality mixtures of virgin African asbestos fibers and inorganic heat-resistant binders. The components have been combined by a controlled blending process which assures product uniformity and optimum consistency for spray application.



Physical Properties:

	750 SPRAY MIX	1350 SPRAY MIX
DENSITY	7.5-15.0 lbs./cu. ft.	7.5-15.0 lbs./cu. ft.
USE LIMIT	750F	1350F
THERMAL CONDUCTIVITY	BTU/Ft ² /In./Hr/F	BTU/Ft ² /In./Hr/F
MEAN TEMP.,F		
200	.37	0.37
500	.47	0.49
800		0.68
COMPRESSIVE STRENGTH	5-7 lbs./sq. in. 25% Deformation	5-7 lbs./sq. in. 25% Deformation
WEATHER RESISTANT		
Not affected by rain, snow, or freezing conditions.		

Approximate Material Usage (Plain Surfaces)

THICKNESS	POUNDS/SQ. FT.	SQ. FT./50 LB. BAG
½"	.5	100.0
1"	1.0	50.0
1½"	1.5	33.3
2"	2.0	25.0
3"	3.0	16.7
4"	4.0	12.5
5"	5.0	10.0
6"	6.0	8.3
7"	7.0	7.1
8"	8.0	6.3
9"	9.0	5.5
10"	10.0	5.0

Note: Material usage will vary with applicator (mechanic) and complexity of surface. It is suggested that a 10 percent safety factor be included.

In estimating requirements, an inexperienced applicator could conceivably use up to 25% more material than indicated in the above tables.

Typical Applications:

B&W 1350 Spray Mix and 750 Spray Mix are used for insulation on all pieces of equipment where the temperature does not exceed 1350F and 750F respectively. Applications include boilers, breeching ducts, piping over 18 in. dia., tanks, vessels and other process plant equipment. Also used as back-up spray for B&W Kaowool Spray Mix.

Die-cut shapes

B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

Die-cut pieces of Kaowool blanket or paper are available on special order. Standard products are used in accordance with the customer's requirements for a specific thickness and density. Rectangular pieces of 18 in. by 20 in. and circular pieces of 18 in. diameter are the maximum sizes which can be cut.

Physical Properties:

Kaowool ceramic fiber is a highly efficient insulator. Kaowool's low shot content gives more usable fiber for your insulating dollar. Kaowool's longer fibers give it high tensile strength and resiliency to withstand vibration and physical abuse. Kaowool is self-supporting—will not separate, sag or settle. Kaowool has low thermal conductivity, low heat storage, and is extremely resistant to thermal shock.

Color	White
Fiber Diameter	2.8 microns (average)
Fiber Length	4" (average) (to 10")
Specific Gravity	2.56 (ASTM C188)
Specific Heat at 1800F. Mean	0.255 Btu/Lb/F
Tensile Strength, Fiber	1.9×10^5 Lbs./Sq. in.
Tensile Modulus, Fiber	16.8×10^6 Lbs./Sq. in.
Use Limits:	
Continuous	2300F
Single Application	3200F
Melting Point	3200F
Hardness	6—MOH's Scale
	700—Knoop Scale 100 grams loading



Chemical Properties:

B&W Kaowool ceramic fibers possess excellent resistance to chemical attack. Exceptions are hydrofluoric acid, phosphoric acid and strong alkalies. Kaowool is unaffected by oil or water. Thermal and physical properties are restored after drying.

Chemical Analysis is that of the product form from which the pieces are cut—blanket or paper.

Tolerances:

On inquiries and orders for die-cut pieces, a drawing of the part is necessary. Exceptions are made for repeat orders and for orders for simple rectangular or circular pieces whose dimensions can be simply and accurately described. Acceptable tolerances should be stated.

Typical Applications:

Engineered insulation parts
Gaskets
Seals
Parting layer

M Board

B&W Kaowool ceramic fibers are converted into a wide variety of useful forms. The fiber raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. The resultant fibers have a 3200F melting point. Individual product use limits range from 2000 - 3200F depending upon the application. Kaowool ceramic fibers are specially processed for each conversion technique and when combined with appropriate binder systems produce a range of products having wide application.

B&W Kaowool M Board is vacuum formed from a slurry consisting of combinations of specially processed Kaowool ceramic fibers and binders. Each piece is formed to a predetermined thickness and dried. The board edges are machined to be true and square. One surface is a mold surface and presents a textured screen-like appearance. The other surface is more rough, and has a bark-like texture. B&W Kaowool M Board has high strength for ease of handling and installation.

Chemical Properties

Kaowool ceramic fibers from which M Board is produced have the following chemical analysis:

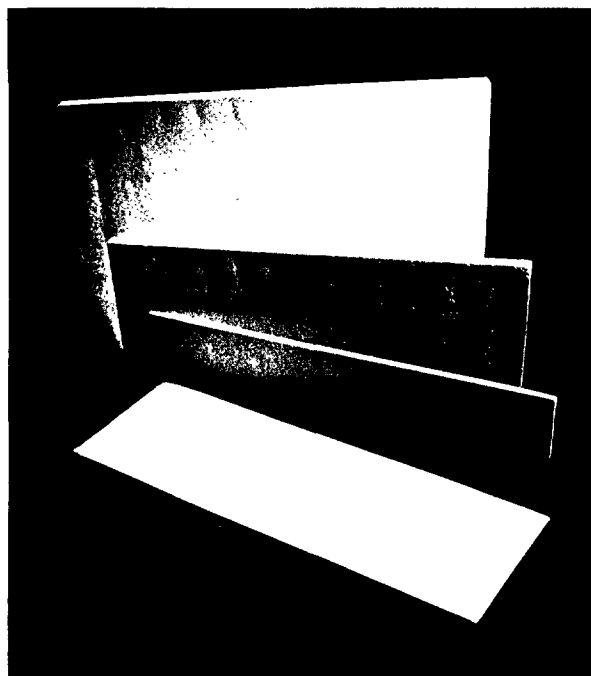
Alumina, Al_2O_3	45.1%
Silica, SiO_2	51.9%
Ferric Oxide, Fe_2O_3	1.3%
Titania, TiO_2	1.7%
Magnesia, MgO	Trace
Calcium, CaO	0.1%
Alkalies such as Na_2O	0.2%
Boric Anhydride, B_2O_3	0.08%

The binder is primarily silica with a small constituent of organic material. In service, the organic constituent will burn out at approximately 500°F and at approximately 1000°F, the part will present a near white appearance.

B&W Kaowool M Board possesses excellent resistance to chemical attack. Exceptions are hydrofluoric acid, phosphoric acid, and strong alkalis. It is unaffected by oil or water. Thermal and physical properties are fully restored after drying, should the board become wetted.

Physical Properties:

Color	Beige
Density, lbs./cu. ft.	12-16
Melting point, °F	3200
Modulus of rupture, psi	120



Compressive strength, lbs./sq. ft.	
@ 5.0% Deformation	800-1400
@ 10.0% Deformation	1400-2800
Linear shrinkage, % (max.)	
@ 1400°F	0.0
@ 1600°F	0.4
@ 1800°F	2.0
@ 2000°F	2.3
@ 2200°F	3.7
@ 2400°F	5.0
Thermal conductivity—Btu/sq. ft./in./hr./F	
@ Mean Temp. of 400	.44
600	.51
800	.60
1000	.71
1200	.83
1400	.97
1600	1.12
Loss on ignition, %	4-7

These data are average results of control tests on standard production products. The data will vary for boards of different thickness. The results should not be taken as minimums or maximums for specification purposes.

Typical Applications

Kaowool M Board is ideal for combustion chamber construction in either oil or gas fired combustion systems. Its good insulating value and high strength recommend it for this application.

Kaowool M Board for furnace and kiln construction. M Board can be readily impaled on alloy studs for efficient and sound furnace design. Ask for B&W installation data.

Kaowool M Board is ideal for launder covers conveying molten metal and molten salt.

Kaowool M Board is ideal for launder and trough linings in contact with aluminum and some other non-ferrous metals. M Board surfaces can be strengthened to be more erosion-resistant to molten metal flow by the addition of surface rigidizing.

Kaowool M Board is ideal for insulation as a back up to firebrick, insulating firebrick, castables and rammed plastics. M Board prevents high temperature gases from penetrating to the furnace shell should openings or cracks develop in the refractory hot face lining. M Board reduces the thickness of back up insulation up to 50% when replacing insulating firebrick or insulating castables. Thinner sections of hot face refractory can be utilized because of the high refractoriness of M Board versus other common back up insulating products. When used behind castables, a moisture barrier is recommended. While water will not damage M Board, the water it will absorb could reduce the castable strength.

Basic Fiber – Bulk

B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

B&W Kaowool bulk fiber is available in many forms.

- Kaowool Bulk A—Lubricated fiber for ease of handling.
- Unlubricated Kaowool fibers for vacuum forming or other processing are available. Contact your B&W sales representative for further information.

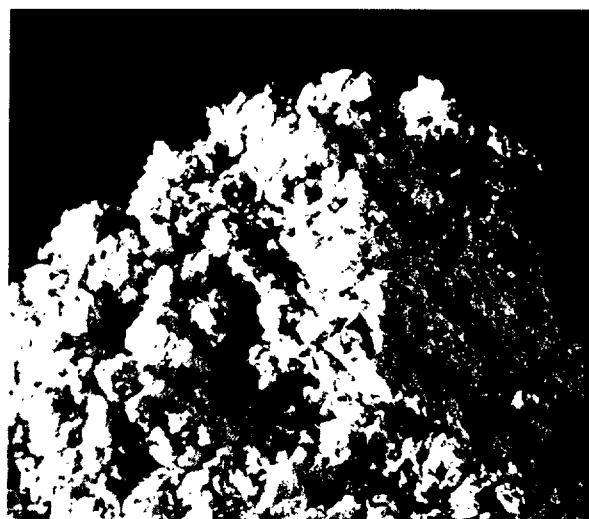
Physical properties

Color	white
Fiber diameter, microns	2.8
Fiber length, inches	4 (avg) to 10
Specific gravity (ASTM C 135)	2.56
Specific heat, Btu/lb/F @ 1800F mean	0.255
Fiber tensile strength, psi	1.65×10^5
Fiber tensile modulus, psi	12.2×10^6
Use limit, F	
Continuous	2300
Melting point, F	3200
Hardness:	
MOH	6
Knoop (100g load)	700

Kaowool ceramic fiber is a highly efficient insulator. Kaowool's low shot content gives more usable fiber for your insulating dollar. Kaowool's longer fibers give it the high tensile strength and resiliency to withstand vibration and physical abuse. Kaowool is self-supporting—will not separate, sag or settle. Kaowool has low thermal conductivity, low heat storage, and is extremely resistant to thermal shock.

Chemical properties

B&W Kaowool ceramic fibers possess excellent resistance to chemical attack. Exceptions are hydrofluoric acid, phosphoric acid and strong alkalis. Kaowool is unaffected by oil or water. Thermal and physical properties are restored



Kaowool Bulk A

after drying. The lubricant in Bulk A should be burned out at 1000F prior to usage in proximity to liquid oxygen.

Chemical analysis, %

		Kaowool	Kaowool High Purity Fiber
Alumina	Al ₂ O ₃	45.1	47.0
Silica	SiO ₂	51.9	52.9
Ferric oxide	Fe ₂ O ₃	1.3	0.05 (0.1 max)
Titanium oxide	TiO ₂	1.7	0.07 (0.15 max) trace inorganics
Magnesium oxide	MgO	trace	
Calcium oxide	CaO	0.1	
Alkalies, as	Na ₂ O	0.2	
Boron oxide	B ₂ O ₃	0.08	

Maximum quantities of water leachable elements on surface of fiber.

	PPM
Boron	100
Chlorine	5
Fluorine	50
Sulphur	10

Typical applications

Insulation: Kiln car tops, walls and crowns of annealing, brazing, heat treating and holding furnaces. Fill for roofs and walls of furnaces and kilns.

Packing: Expansion joints, emergency repair and patching. Secondary product processing: Paper, block, spray mix, vacuum formed shapes, monolithics, etc.

Reinforcement for composite structures: Plastics, resins, etc.

Blanket

B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

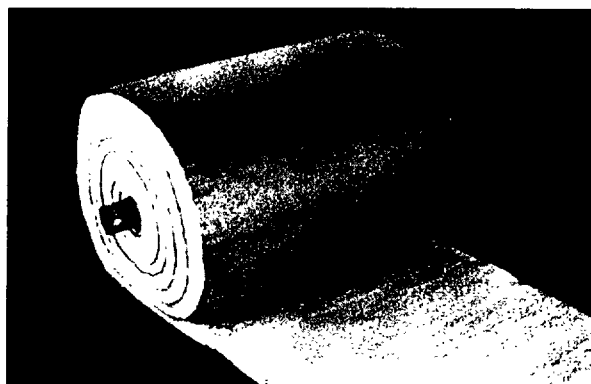
B&W Kaowool blanket contains no organic binder or other organic constituents. Blanket will not contaminate furnace atmospheres or emit offensive odors. Available in nominal densities of: 3, 4, 6 and 8 lb/cu ft. Width: 2 ft and 4 ft. Length: 25 ft.

High purity blanket is also available for reducing conditions or in applications where low percentages of iron oxide and titania are required in the fiber.

Thickness

B&W Kaowool blankets are manufactured in the following thicknesses for the indicated density:

	3 lb cu ft	4 lb cu ft	6 lb cu ft	8 lb cu ft
¼ in.	—	—	yes	yes
½ in.	yes	yes	yes	yes
1 in.	yes	yes	yes	yes
1½ in.	yes	yes	yes	yes
2 in.	yes	yes	—	—

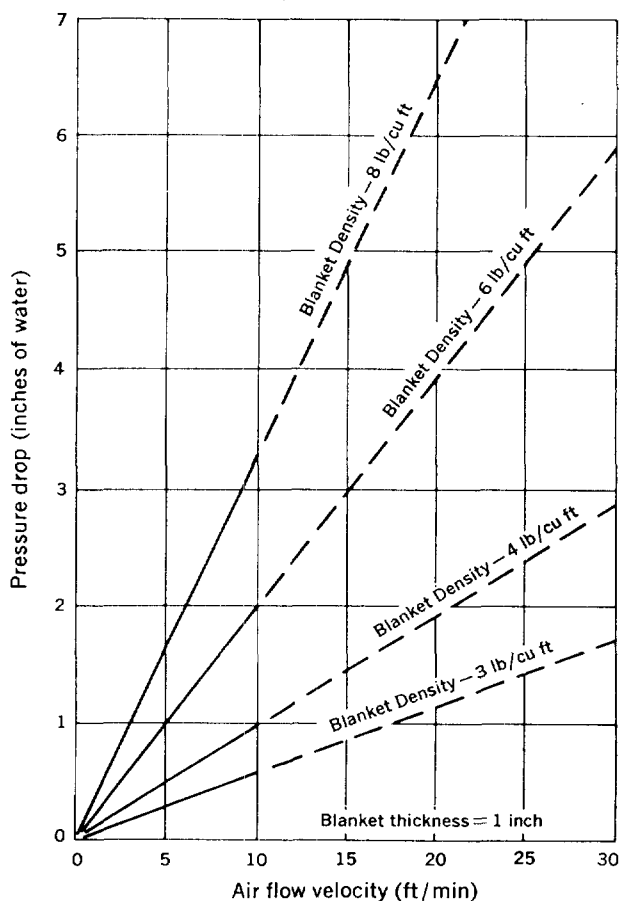


Physical properties

Color	white
Fiber diameter, microns (avg)	2.8
Fiber length, inches	4 (avg) to 10
Specific gravity (ASTM C 135)	2.56
Specific heat, Btu/lb/F @ 1800F mean	0.255
Fiber tensile strength, psi	1.65 x 10 ⁵
Fiber tensile modulus, psi	12.2 x 10 ⁶
Use limits, F	
Continuous	2300
Single application	3000
Melting point, F	3200
Hardness	
MOH	6
Knoop (100g load)	700

Kaowool ceramic fiber is a highly efficient insulator. Kaowool's low shot content gives more usable fiber for your insulating dollar. Kaowool's longer fibers give it the high tensile strength and resiliency to withstand vibration and physical abuse. Kaowool is self-supporting—will not separate, sag or settle. Kaowool has low thermal conductivity, low heat storage, and is extremely resistant to thermal shock.

B&W Kaowool Blanket
Pressure drop across Kaowool Blankets



Chemical properties

B&W Kaowool ceramic fibers possess excellent resistance to chemical attack. Exceptions are hydrofluoric acid, phosphoric acid and strong alkalis. Kaowool is unaffected by oil or water. Thermal and physical properties are restored after drying.

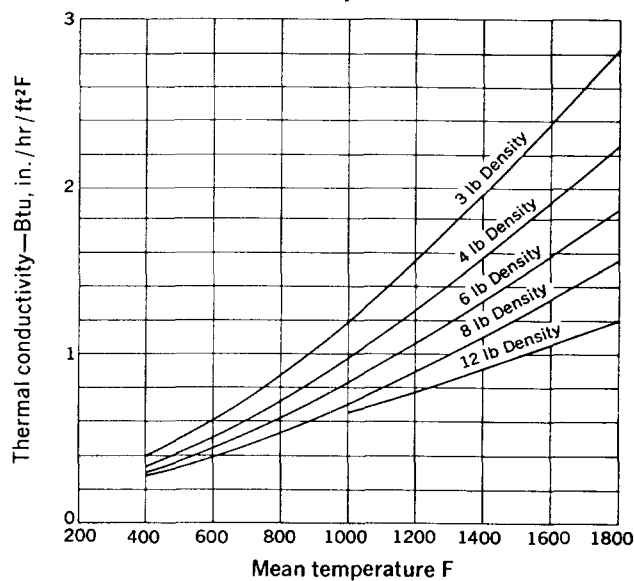
Chemical analysis, %

		Kaowool	Kaowool
		High Purity Blanket	
Alumina	Al ₂ O ₃	45.1	47.0
Silica	SiO ₂	51.9	52.9
Ferric oxide	Fe ₂ O ₃	1.3	0.05 (0.15 max)
Titanium oxide	TiO ₂	1.7	
Magnesium oxide	MgO	trace	0.07 (0.15 max)
Calcium oxide	CaO	0.1	trace inorganics
Alkalies, as	Na ₂ O	0.2	
Boron oxide	B ₂ O ₃	0.08	

Maximum quantities of water leachable elements on surface of fiber.

	PPM
Boron	100
Chlorine	5
Fluorine	50
Sulphur	10

B&W Kaowool Blanket
Thermal conductivity at various densities



Typical applications

Furnace linings
Boiler combustion chambers and heat exchangers, oil-fired
Catalytic mufflers and automotive afterburners
Gas turbines
Fans—high temperature
Laboratory ovens
Steam valves of headers and steam separators
Thin wall kilns—backup
Water and steam tubes—backup
Petroleum catalytic crackers
Protection on water-cooled risers and cross-over rails—reheating furnaces
Oven linings
Superheater seals
Wrapping pipe and tubing after welding for stress relieving
Furnace repair
Acoustical service for missiles, rockets, and jet aircraft
Cryogenic vessel fire protection
Furnace door linings and seals
Expansion joint packing
High temperature filters
Wrapping investment casting molds
Annealing cover seals
Soaking pit cover seals

Vacuum Formed Shapes

B&W Kaowool ceramic fibers are converted into a wide variety of useful forms. The fiber raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. The resultant fibers have a 3200F melting point. Individual product use limits range from 2000-3000F depending upon the application. Kaowool ceramic fibers are specially processed for each conversion technique and when combined with appropriate binder systems produce a range of products having wide application.

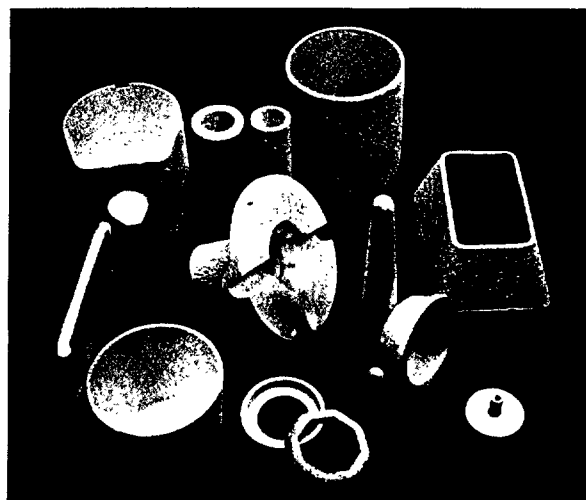
B&W Kaowool vacuum formed shapes are drawn from a slurry consisting of combinations of Kaowool ceramic fibers and a suitable binder system. The shapes are dried to a predetermined hardness. While certain shapes such as sleeves, cones, and board are highly standardized, most Kaowool vacuum formed shapes are engineered products and each is manufactured to specific specifications. The non-wetting characteristic of Kaowool ceramic fibers to many metals and their high refractoriness, recommend Kaowool vacuum formed shapes for a multiplicity of molten metal contact applications.

Vacuum forming is the most common method of converting ceramic fibers into special shapes, but special shapes can also be produced by other techniques such as die cutting blanket or paper, laminating and machining blanket and paper products, and still others.

Physical properties

Color	beige
Density, lb/cu ft	10-17
Melting point, F	3200
Thickness range, inches	
Dependent upon shape configuration	1/8-2
Thermal shock resistance	excellent

Some properties of vacuum formed shapes are dependent upon factors of the shape configuration. For example: thermal conductivity varies with density, which can vary with shape thickness. If there are some properties that are critical to an application, ask a B&W sales engineer to obtain these for the particular shape in question.



Basic shapes



Specialty shapes

Chemical properties

B&W vacuum formed shapes possess excellent resistance to chemical attack. Exceptions are hydrofluoric acid, phosphoric acid, and strong alkalis. Vacuum formed shapes are unaffected by oil or water. Thermal and physical properties are fully restored after drying should the shapes become wetted.

The binder is primarily silica with a small constituent of organic material. In service, the organic constituent will burn out at approximately 500F and at approximately 1000F, the part will present a near white appearance.

Chemical analysis, %

Alumina	Al ₂ O ₃	45.1
Silica	SiO ₂	51.9
Ferric oxide	Fe ₂ O ₃	1.3
Titanium oxide	TiO ₂	1.7
Magnesium oxide	MgO	trace
Calcium oxide	CaO	0.1
Alkalies, as	Na ₂ O	0.2
Boron oxide	B ₂ O ₃	0.08

Production tooling

Kaowool vacuum formed shapes are produced on specially designed screen molds by a vacuum induced inside the mold which deposits the fibers from the slurry onto the mold surface. Each shape requires its own unique set of production tooling, depending upon the complexity of the part and the quantity being produced. Quotations will include a production tooling charge which is the B&W cost for manufacturing this tooling.

Basic vacuum formed shapes

The control surface of a shape is next to the mold, and this surface will present a textured screen-like appearance. The other surface is less smooth and is called the bark surface. Part thickness is controlled by time sequence dipping of the mold into the slurry.

The basic shape is drawn on a male mold. The outside of the part will be the bark surface. Regular density is standard in the basic shapes. All contours of the part will have the same thickness of ceramic fiber.

Every effort should be made to use the basic shape in design as it is the least expensive method of production. This manufacturing method is particularly suitable for sleeves, cones, rectangular or circular flat boards, and a variety of hot top shapes.

Specialty vacuum formed shapes

Many variations in manufacturing techniques are available to meet specialized applications. These are some of the more commonly specified variations.

Female molding is used where the outside surface must be controlled or where greater exterior smoothness is required. In this part, the bark surface will be on the inside.

High density renders a part more rigid, stronger, more resistant to compression, and more resistant to mechanical abuse. Minimum additional expense is involved for this specification.

Surface rigidizing can be applied to one or both surfaces. The rigidizer is inorganic and highly refractory. The re-

sultant surface is very resistant to mechanical abuse. This specification is common for molten metal contact parts.

Super rigidizing renders an almost rock-hard shape with very great resistance to mechanical abuse. The part is treated with sufficient rigidizer to harden not only the surfaces but the inside of the fibrous body as well. This is the strongest vacuum formed shape, and extremely wear-resistant, as freshly rigidized fibrous material is constantly exposed as wear progresses.

Machining operations can be performed on a part for tighter dimensional tolerances, to vary thicknesses in different areas of the part, or to render a smoother surface.

Variable thickness can be achieved by machining the shape or by cementing two or more pieces together.

Cemented parts can be produced in our manufacturing plant or in the field. Quite large shapes can be manufactured in this manner. The cemented joint is strong and reliable.

Dimensional tolerances

Standard tolerance for the basic vacuum formed shape is $\pm \frac{1}{8}$ ". The mold surface is generally more closely sized. Machining can reduce the tolerance to $\pm \frac{1}{16}$ " and commonly is required on only one or two areas of a shape.

B&W engineering services

Thoughtful preparation in the design and specifications of a vacuum formed shape is important to assure a part will fulfill the intended purpose at the optimum price. A B&W sales engineer can be of great help in this, by allowing him to review an application in great detail. Specification recommendations can then be made to best utilize the advantages of the vacuum forming process. Please request our "assorted vacuum formed samples" to illustrate several of the shape variations available.

Typical applications

General

- Combustion chambers—oil and gas firing
- Electrical heater element holders
- Gaskets—complex configurations
- Recuperator tube gaskets
- Board for kiln and furnace linings
- Special shapes for hobby kilns and lab furnace linings
- Peep hole plugs
- High temperature pipe insulation
- Flue liners
- Burner blocks
- Electric range burner insulation
- Radiant heater burners and parts
- Diffusion furnace parts
- Gas turbine insulation

For molten metal contact situations

- Aluminum furnace tap out cones
- Metal pouring tundishes
- Sprue liners
- Riser sleeves—all metals
- Hot tops—all metals
- Bottom seals of pipe molds
- Aluminum launders and troughs

Kaowool Block

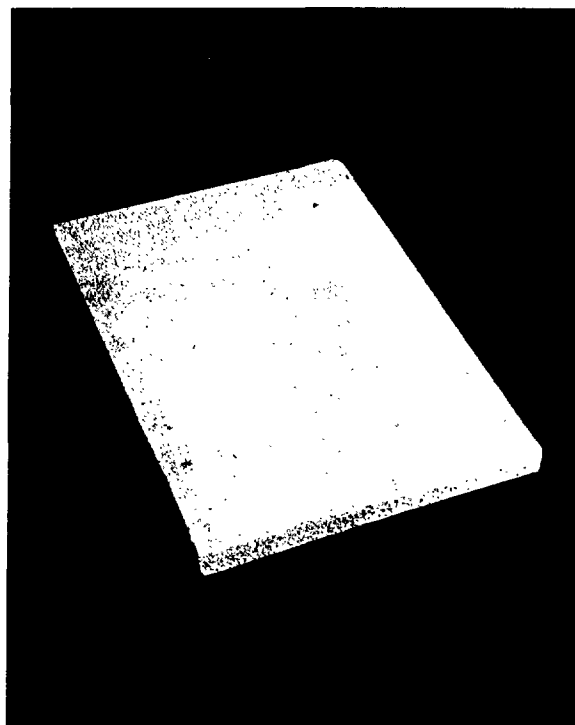
B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

B&W Kaowool block is formed on insulating block manufacturing machinery from specially processed Kaowool ceramic fibers and a combination of organic and inorganic binders to achieve a highly refractory block insulation. It has optimum physical properties for both installation and service.

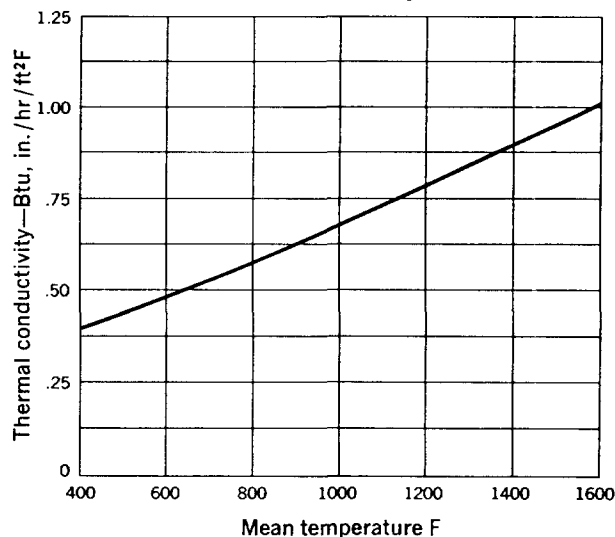
Physical properties

Color	off-white
Density, lb/cu ft	14-18
Use limits, F	
Continuous	2300
Intermittent	2400
Melting point, F	above 3100
Humidity resistance	excellent
Modulus of rupture, psi	55
Compressive strength, psi	
@ 5% deformation	3500
@ 10% deformation	4000
Linear shrinkage, % (max)	
@ 1800F	0.0
@ 2000F	0.5
@ 2100F	0.75
@ 2200F	1.00
@ 2300F	1.25
@ 2400F	2.00
Loss on ignition, %	5.0-5.5
Thickness range, inches	1/2 thick increments to 4

For optimum results, a moisture barrier should be placed against the block if a castable is to be placed against it.



B&W Kaowool Block
Thermal conductivity



Chemical analysis, % (by weight approx)

Alumina	Al_2O_3	41.8
Silica	SiO_2	51.6
Ferric oxide	Fe_2O_3	0.9
Titanium oxide	TiO_2	1.6
Magnesium oxide	MgO	0.3
Alkalies, as	Na_2O	0.006

Typical applications

Furnace, kiln, and oven linings.

Backup insulation to all types of refractory.

Can replace insulating refractory as backup insulation.

A leak barrier in glass and aluminum furnaces.

Furnace door linings.

Block Insulation

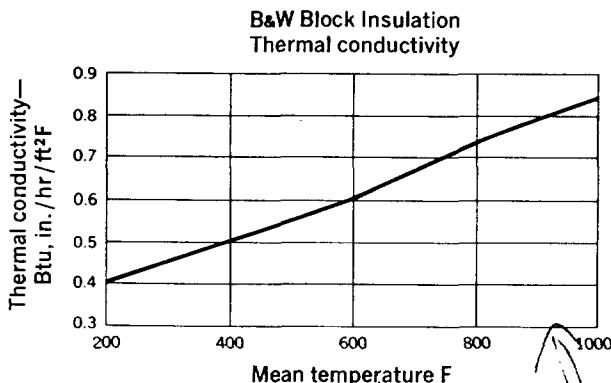
B&W block insulation (asbestos-free) is a unique combination of mineral wool, high tensile glass fiber and other inorganic materials. It is designed to be an asbestos-free, high-temperature, backup insulation, for refractory installations. B&W block insulation has the high strength, low density and other characteristics necessary for ease in handling and installation.

B&W block insulation is highly resistant to moisture and is free from corrosive ingredients. It requires only normal protection against excessive wetting in storage or during placement. It will not contribute to corrosion of metals with which it comes in contact.

B&W block insulation is a resilient mineral fiber block which has been formed and cut to precise dimensional tolerances. The mineral fiber block has high breaking strength coupled with low thermal conductivity, which results in an economical and efficient backup insulation material. It is easily cut with a knife and is directly installed by impaling on studs. Available thicknesses: 1" to 4½". Available widths are 6", 12", 18" and 24". All pieces are 3' long.

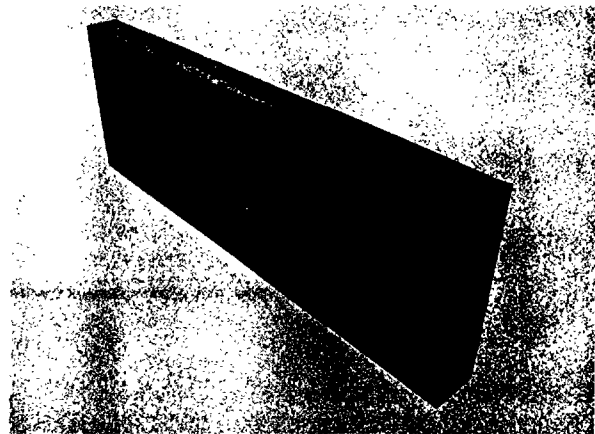
Physical properties

Recommended use limit, F (one face exposure)	1900
Density, lb/cu ft	13-17
Humidity resistance	excellent
Fire resistance	incombustible
Corrosiveness	none
Linear shrinkage, % @ 1900F soaking heat	3.0-5.0
Ignition loss, % @ 1900F	3.0 max by wt
Modulus of rupture, psi	40-45
Compressive strength, psi	
@ 8% deformation after 20 hr	8



Data are average results of tests conducted under standard procedures and are subject to variation. Results should not be used for specification purposes.

220-1
10-1-74



Application information

B&W block insulation weighs 13 to 17 lb per cubic foot, and is lighter than most high temperature insulating blocks. Its strength is such that it readily withstands handling in transit and during application. It can be easily cut with a minimum effort using a knife or other hand tools.

Any of the methods commonly employed can be used to install B&W block insulation. Because of its low resistance to penetration by studs or wires, impaling is the method most often selected. Installation time is held to a minimum regardless of the method used. A wide variety of sizes and thicknesses are available for most applications.

Another important advantage of B&W block insulation over hard, rigid types of insulation is its ability to conform to irregularities in the surface over which it is being applied. Rivets, welds, bolt heads, etc., can be pressed into the block. The outer surface remains flat and uniform, and blocks lie flat against the surface.

Caution

Ventilate the enclosure during initial heating of the block to permit the escape of combustible water-repellent.

Warning

Flash ignition of the combustible water-repellent upon initial opening of electrically heated, or non-ventilated enclosures may endanger exposed skin areas.

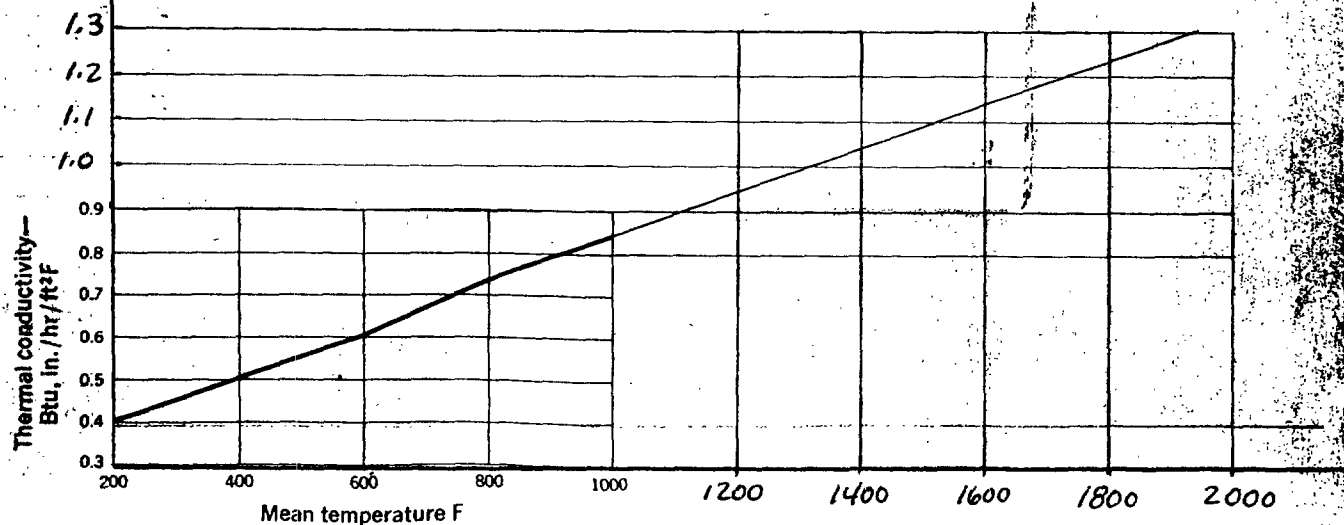
Typical applications

B&W block insulation is an effective backup insulation for all types of refractories, including gunned materials. B&W block insulation has been used as backup insulation in oil refineries, steel mills, pulp and paper mills, smelters, chemical, petrochemical, and gas treatment plants. Other typical applications include:

Furnace refractory	Turbines
Heat treating furnaces	Boiler walls
Kilns for glass and ceramics	Melting tanks
Annealing furnaces	Hot air ducts
Lehrs	Pit covers
Ovens	Chilling pits
Tanks	Precipitators
Towers	

1900°F BLOCK INSULATION

K - FACTORS EXTRAPOLATED
to 1900°F



Data are average results of tests conducted under standard procedures and

Riser Sleeves

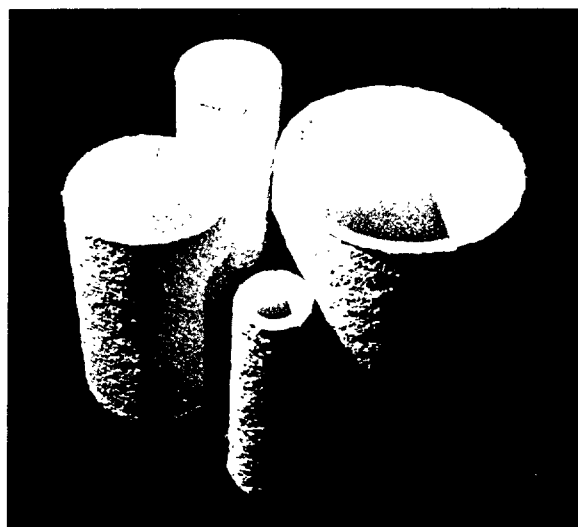
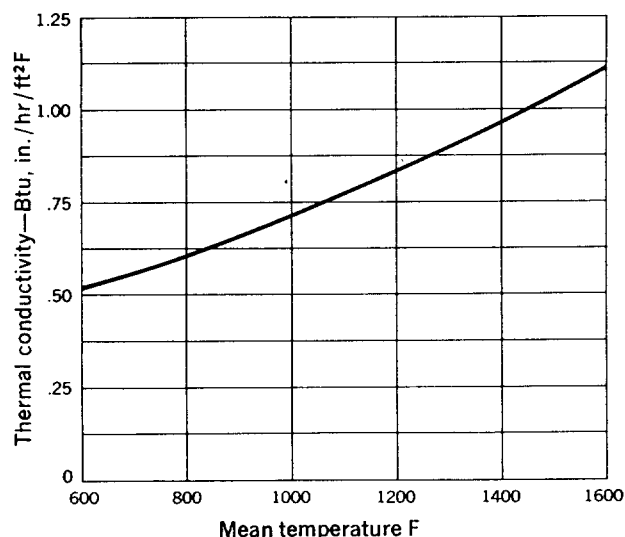
B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

B&W Kaowool riser sleeves are strong, lightweight and thin insulators which reduce heat loss from risers. The superior insulation derived from B&W Kaowool riser sleeves allows time to permit more efficient mold feedback, thereby enabling foundrymen to design smaller risers than with sand risers. In addition, the number of risers required may be reduced in such a design and the combination of these factors result in increased yield per pound of metal castings, sounder castings and fewer rejects.

Physical properties

Color beige
Density, lb/cu ft 12

B&W Kaowool Riser Sleeves
Thermal conductivity



Manufacturing

B&W Kaowool riser sleeves are drawn from a slurry consisting of processed Kaowool ceramic fibers and suitable binder systems. The sleeves are then dried to a determined hardness.

B&W Kaowool riser sleeves have a controlled inside diameter surface which is closely sized. The outside diameter surface and length may vary by $\pm \frac{1}{8}$ in., and the wall thickness is maintained within a $+\frac{1}{16}$, -0 in. range.

Typical applications

B&W Kaowool riser sleeves may be used for both ferrous and non-ferrous castings. The sleeves are strong enough to insure foundry handling and may be cut to any desired length in the field. Because very little organic binder is used in their manufacture, the sleeves will not break down in mold-drying ovens. Nor will the material composition of the riser sleeves contaminate the molding sand.

Since riser sleeves insulate the molten metal, they will not produce heat or noxious vapors as exothermic sleeves do. This improves the quality of the air for the men who work within the foundry and reduces cleaning costs.

B&W Kaowool riser sleeves are available in closely sized inside diameters from 1 to 24 in. Wall thickness up to 16 in. ID measures $\frac{1}{2}$ in. All sleeves come in 12-in. lengths. Special shapes, such as those required for blind risers and other special shapes that help foundrymen solve their thermal problems, are also available.

Paper

B&W Kaowool ceramic fibers are converted into a wide variety of useful forms. The fiber raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. The resultant fibers have a 3200F melting point. Individual product use limit ranges from 2000-3000F depending upon the application. Kaowool ceramic fibers are specially processed for each conversion technique and when combined with appropriate binder systems produce a range of products having wide application.

Kaowool paper is produced from a combination of Kaowool ceramic fibers and organic binders on conventional paper-making machinery. It is a thin ceramic fiber form noted for outstanding handling characteristics and high insulating value at high temperatures.

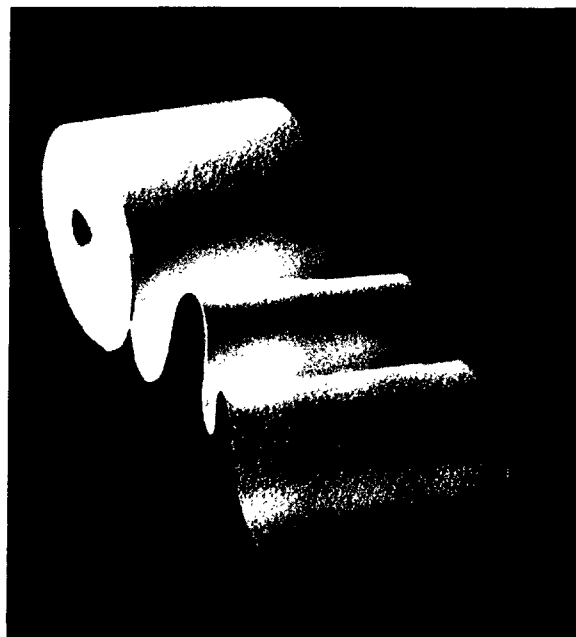
Kaowool paper is easy to handle in application. It can be cut, folded, wrapped, rolled and can go around sharp corners. By the use of Kaowool rigidizer and cement, attachment is simplified and dense, hard laminated or built-up shapes can be produced. B&W can supply factory produced laminated tubes and shapes, die-cut gaskets and other parts, and mesh enclosed pieces.

Physical properties

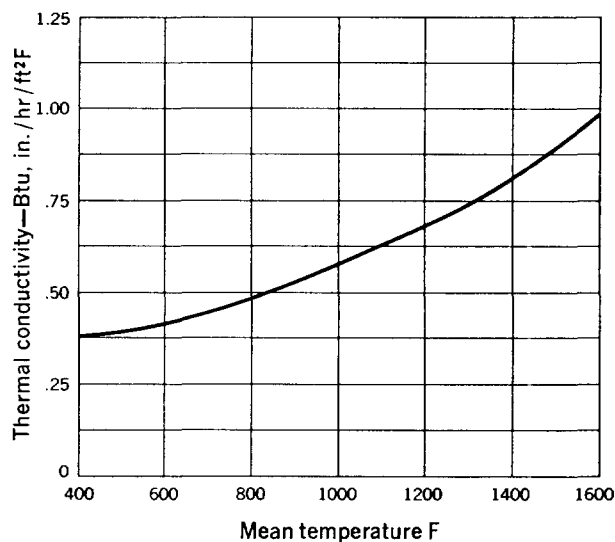
Color	white
Density, lb/cu ft	
Uncompressed	12-13
Use limit, F	
Continuous	2300
Melting point, F	3090
Thickness data	20mil 40mil 80mil
@ 8 psi compression, inches	.020 .040 .080
(Per TAPPI Method T-411n 44)	
@ Uncompressed,	
inches (approx)	1/32 1/16 1/8

Chemical properties

Kaowool ceramic fiber materials have good chemical stability with resistance to most chemicals, with the exception of hydrofluoric and phosphoric acid and strong alkalis. There is no water of combination, and extremely low boron content. Kaowool ceramic fibers are not affected by wetting with water.



B&W Kaowool Paper
Thermal conductivity



Typical applications

Molten metal contact applications

Aluminum and zinc launder and trough linings.
Gasketing between aluminum and zinc trough sections.
Aluminum furnace tap out plug cover and parting agent.
Aluminum distributor pan linings.
Super alloy ingot mold linings and hot tops.

Other applications

Brazing operations

Parting agent between parts and conveyor belt for brazing furnace operations.

Heat distribution and diffusion and mechanical cushioning in aircraft honeycomb brazing.

Glass sagger mold linings.

Combustion chamber linings in oil-fired residential heating units.

Blast furnace blow-pipe backup insulation.

Gaskets for any high temperature application.

For use with conventional refractories

B&W Kaowool paper can help firebrick and special refractory shapes do a better job. All dense refractories expand upon being heated, some much more than others. One or more layers of compressible Kaowool paper around these refractories will take up this expansion and equalize internal mechanical stresses. Similarly, some refractories, like high alumina and zirconia bodies, are prone to breakage from uneven temperature distribution. Wraps of highly insulating Kaowool paper will greatly minimize these problems. An example of both types of problems is the burner block cracking that exists in many high temperature furnaces. $\frac{1}{8}$ " or $\frac{1}{4}$ " of Kaowool paper around these burner blocks will extend their life by reducing internal stresses caused by the thermal expansion of the burner block and the firebrick wall and the uneven temperature distribution within the block.

Surface Coatings

(Kaowool Cement)

Kaowool cement is an air setting ceramic fiber cement for use with Kaowool products. It may be used for spray, dip or brush application. The cement sets with a strong hard film which will develop a ceramic bond above 1600F but still maintains excellent resistance to thermal shock.

Physical properties

Appearance	white paint
Density, lb/cu ft	115-122
Use limit, F	
Continuous	2300
Melting point, F	3200
Compressive strength, psi	
After air drying	6500
Linear shrinkage, % (first firing only)	
(Per ASTM C 356)	
After 24 hr @ 1832F	2.13
After 24 hr @ 2300F	3.19
Specific heat, Btu/lb/F @ 1022F mean	.27
Drying temperature, F (max)	150

Chemical properties

Kaowool cement is mildly alkaline and requires complete air drying to form a strong set. After drying Kaowool cement is not soluble in water.

Chemical analysis, %

Alumina	Al ₂ O ₃	41.0
Silica	SiO ₂	57.0
Magnesium oxide	MgO	0.4
Alkalies, as	Na ₂ O	0.8
Boron oxide	B ₂ O ₃	0.6
Trace inorganics		0.2

Handling

Kaowool cement should be protected from freezing. Adequate ventilation and precautions against inhalation of particles during spray application should be provided.

Application information

The surface to be coated should be clean and dry. For best adhesion smooth surfaces should be roughened. With a coating of 0.010 in., approximately 120 square feet will be covered per gallon.

(Kaowool Rigidizer)

Kaowool rigidizer is a colloidal silica compound for treating surfaces of Kaowool ceramic fiber products to provide a degree of surface hardness and resistance to erosion. Kaowool rigidizer is stabilized against damage from freezing during exposure to cold; however, repeated freezing should be avoided.

Physical properties

Color	bluish off-white
Solids content, % silica (approx)	28-29
Weight per gallon, lb (approx)	10
Density, lb/cu ft (wet) (approx)	.75
Use limit, F	2300
Freezing temperature, F	28
Viscosity, centipoises @ 25 Centigrade	4
Specific gravity @ 25 Centigrade	1.203
pH	9.7

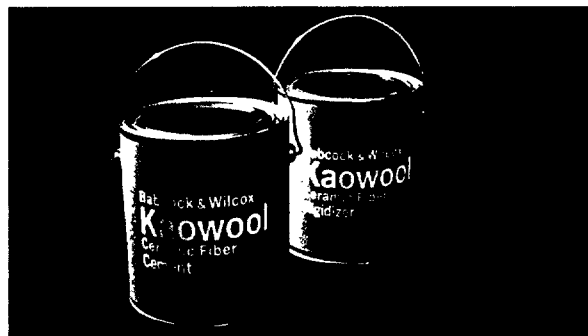
Application information

Kaowool rigidizer is applied by brushing, dipping, rolling, and spraying. Suitable respiratory protection and ventilation are required when applied by spraying.

Materials to be rigidized should be free of all grease and oil.

Kaowool rigidizer receives its bonding action from the removal of physical water. Bonding may be accelerated by heating or oven drying. Curing is a function of the size of the shape and its geometry.

An application rate of one gallon per 100 square feet of ceramic fiber surface will render a hard surface without completely rigidizing the interior of the ceramic fiber body.



Mesh Covered

B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

Kaowool ceramic fiber in either standard blanket or bulk is used for fabricating mesh enclosed shapes in the form of blankets, strip, cable or wrap.

Blankets of ½ in., 1 in., 1½ in. and 2 in. thicknesses are used in standard densities of 6 and 8 lb/cu ft. Other density blankets may be used, and other thicknesses may be fabricated by using multiple layers of blanket. Areas up to 4' x 8' are normal manufacturing standards. Special shapes or sizes, custom-designed blankets are also available. Blankets are normally tufted on 12 in. to 16 in. centers to maintain shape and stability.

Strip in widths of 4 in., 6 in., 8 in. and 12 in. and thicknesses of ½ in. and 1 in. is standard. Lengths up to 100 ft can be provided.

Cable with diameters up to 1½ in. are made in single strand construction. Larger diameters are made by combining jacketed single strands within a larger diameter outer jacket.

Wrap is similar to strip, but includes a 1 in. tab on each edge for lacing or stapling the wrap around piping or tubing. Pipe with outside diameters up to 12 in. may be easily insulated with standard 1 in. or 2 in. thicknesses.

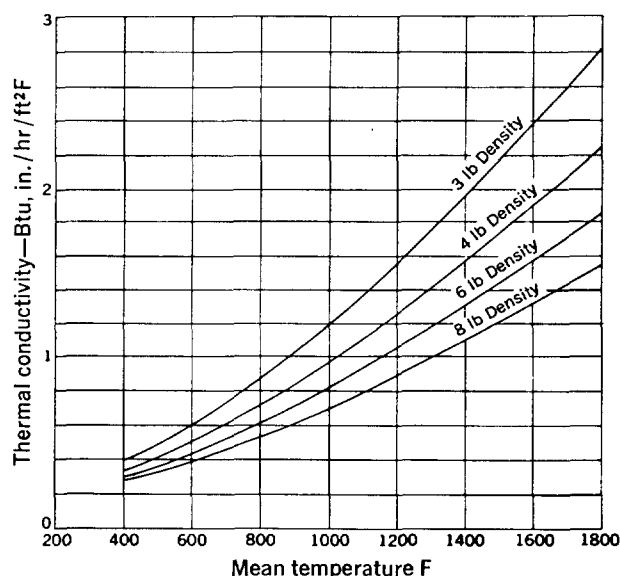
Material specifications

Standard components used to fabricate mesh enclosed shapes are the following:

Tufting wire	alloy wire
Tufting buttons	alloy
Lacing hooks	alloy
Mesh	stainless steel



B&W Mesh Covered Kaowool
Thermal conductivity at various densities



Physical properties

Color	white
Fiber diameter, microns (avg)	2.8
Fiber length, inches	4 (avg) to 10
Specific gravity (ASTM C 135)	2.56
Specific heat, Btu/lb/F @ 1800F mean	0.255
Fiber tensile strength, psi	1.65 x 10 ⁵
Fiber tensile modulus, psi	12.2 x 10 ⁶
Use limits, F	
Continuous	2300
Single application	3000
Melting point, F	3200
Hardness	
MOH	6
Knoop (100g load)	700

Chemical properties

B&W Kaowool ceramic fibers possess excellent resistance to chemical attack. Exceptions are hydrofluoric acid, phosphoric acid and strong alkalis. Kaowool is unaffected by oil or water. Thermal and physical properties are restored after drying.

Chemical analysis, %

Alumina	Al_2O_3	45.1
Silica	SiO_2	51.9
Ferric oxide	Fe_2O_3	1.3
Titanium oxide	TiO_2	1.7
Magnesium oxide	MgO	trace
Calcium oxide	CaO	0.1
Alkalies, as	Na_2O	0.2
Boron oxide	B_2O_3	0.08

Ordering information

Standard blankets

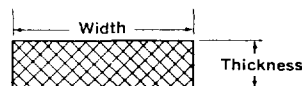
1. Specify length, width (excluding 1 in. lip) and thickness.
2. Select density of ceramic fiber (6, 8 lb/cu ft density).
3. Tufting buttons are normally located on 12 in. centers.
4. Specify locations of lacing hooks, if required.

Special blankets

Submit sketch to your B&W district Sales Office for design help or quotation.

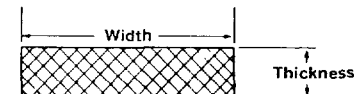
Standard strip

1. Specify cross section—width and thickness.
2. Select density of ceramic fiber (6 or 8 lb/cu ft).
3. State length or lengths required.



Standard wrap

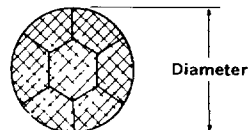
1. Specify cross section width and thickness—or give OD of pipe to be insulated.
2. Choose density of ceramic fiber (6 or 8 lb/cu ft).
3. State length or lengths required.



Standard cable

1. Give diameter required.
2. State length or lengths.
3. If attachment fin is desired, specify width of fin.

Note: Strip, wrap and cable are available in cut, finished lengths at slight additional cost.



Special parts

Production techniques permit custom design and manufacture of non-standard items. When ordering special parts, please include an outline drawing and the information required above for ordering standard parts.

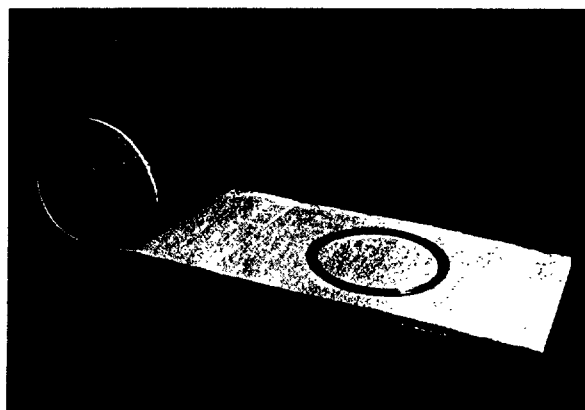
Water-cooled Pipe Insulation Kit—Blanket

B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

The water-cooled pipe insulation kit consists of 100 sq ft of B&W Kaowool blanket, 8 lb density, 1 in. thick (2 rolls 2 ft x 25 ft) and 200 lin ft of stainless steel annealed wire. The kit is designed to wrap and tie Kaowool blanket with wire around water-cooled riser and horizontal pipe to form a very effective high temperature insulation.

Estimated coverage

6" pipe	40 lin ft
4" pipe	64 lin ft
2½" pipe	88 lin ft



Physical properties

Kaowool ceramic fiber is a highly efficient insulator. Kaowool's low shot content gives more usable fiber for your insulating dollar. Kaowool's longer fibers give it the high tensile strength and resiliency to withstand vibration and physical abuse. Kaowool is self-supporting—will not separate, sag or settle. Kaowool has low thermal conductivity, low heat storage, and is extremely resistant to thermal shock.

Weld Insulation Kit (WIK)

B&W Kaowool ceramic fiber is the basic fiber from which the Kaowool family has grown. The raw material is kaolin, a naturally occurring, high purity, alumina-silica fireclay. Kaowool has a melting point of 3200F, a normal use limit of 2300F, but can be used at even higher temperatures in certain applications. B&W Kaowool has fiber lengths up to 10 in., average lengths of 4 in. These long fibers, thoroughly interlaced in the production process, provide Kaowool blanket, bulk, and strip products with unsurpassed strength without the addition of a binder system. Other forms are processed from basic Kaowool ceramic fiber.

The Weld Insulation Kit (WIK) is made from B&W Kaowool blanket, 8 lb density, 1 in. thick covered with high temperature alloy mesh, tufted with alloy buttons and tufting wire. The WIK is normally reusable at least six times.

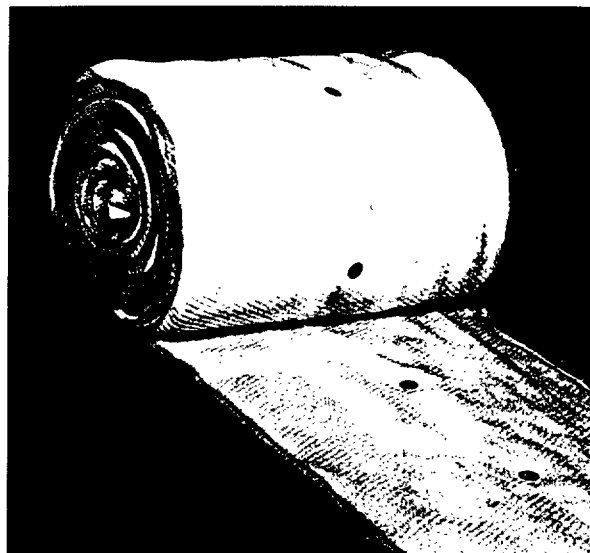
Two WIK's are available:

WIK-2 ft 50 sq ft (2 ft x 25 ft) B&W Kaowool, 8 lb density, 1" thickness. Covered both sides with high temperature alloy mesh, plus sewing kit to close cut ends.

WIK-4 ft 100 sq ft (4 ft x 25 ft) B&W Kaowool, 8 lb density, 1" thickness. Covered both sides with high temperature alloy mesh, plus sewing kit to close cut ends.

Physical properties

Kaowool ceramic fiber is a highly efficient insulator. Kaowool's low shot content gives more usable fiber for your insulating dollar. Kaowool's longer fibers give it the high tensile strength and resiliency to withstand vibration and physical abuse. Kaowool is self-supporting—will not separate, sag or settle. Kaowool has low thermal conductivity, low heat storage, and is extremely resistant to thermal shock.



Tufting and lacing

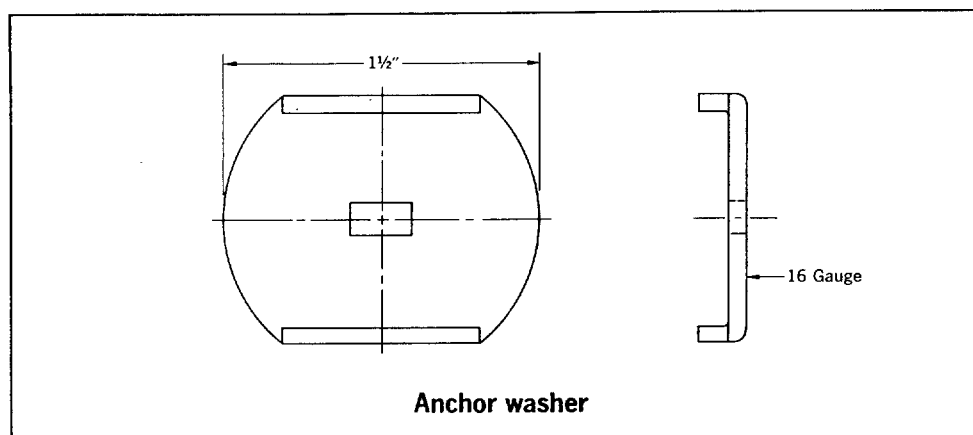
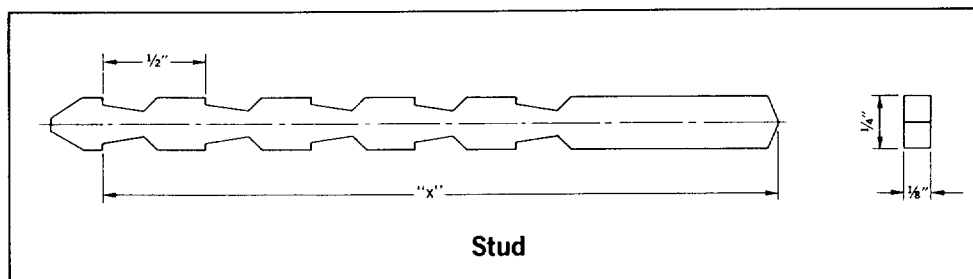
One-inch diameter tufting buttons are located as follows:

WIK-2 ft	WIK-4 ft
11 tufts	22 tufts
12" center lines	16" center lines
12" between tufts	12" between tufts

Tufting wire—alloy wire

Buttons—alloy

Kao-Lok Anchoring System



Kao-Lok standard size	"X"	Alloy	Lining thickness range
Stud 304 SS x 3 1/2	3.187	304 SS	1 1/2"-3 1/2"
Stud 310 SS x 4 1/2	4.187	310 SS	2 1/2"-4 1/2"
Stud 310 SS x 6	5.687	310 SS	4"-6"
Stud 330 SS x 6	5.687	330 SS	4"-6"
Stud Inconel 601 x 6	5.687	Inconel 601	4"-6"