FROM JAMES E. HINES
INGOT CASTING DIVISION
ALCOA TECHNICAL CENTER - B

TO MEMORANDUM

1979-11-08

PLAINTIFF'S EXHIBIT AL-1438

DATA LETTER

RE: ASBESTOS-FREE MOLTEN ALUMINUM BACKUP INSULATIONS

Summary

As part of Pittsburgh Mechanical Engineering Division—Furnace Section's and AL Ingot Casting Division's program to better design and construct furnaces and metal transfer equipment, a study was made to find acceptable asbestos-free insulating backup materials to refractories in contact with molten aluminum. Since each application must be considered individually as to the proper amount and type of insulation, this report points out the advantages and limitations of nine commercially available products.

Introduction

Refractory insulating materials offer significant advantages in the construction and operation of furnaces and refractory-lined vessels. Proper selection and application of insulation result in important savings of fuel, time, space and weight. In addition, insulation helps maintain close temperature control and contributes to more comfortable working conditions for operators.

Savings of fuel is one of the most important reasons for insulating. Heat flows through a wall or roof from an inner hot face to the outer cold face where it is dissipated and lost by radiation and convection. The amount of heat lost often constitutes a considerable portion of the total heat input required to maintain the desired operating temperature. Such losses would be greatly minimized by building the walls partly or entirely out of high-temperature insulation, either as backing to denser refractories, or when conditions permit, as an inner lining exposed directly to furnace atmospheres.

When desirable, the use of insulation also allows economy of space, weight and time. If used in place of part of an existing dense refractory wall insulation, it may permit thinner walls and the weight of the refractory structure could be significantly reduced. This would permit both a lighter foundation and a lighter furnace superstructure. At a given rate of heat input with available burner capacity, the time required to bring a cold refractory unit to operating temperature depends on the heating capacity of the refractory lining and upon the heat penetrating it. Through the use of insulation, the heat storage capacity is substantially reduced and the time required to bring the unit to temperature could be considerably decreased.

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When selecting high-temperature insulation, many factors must be considered. One determining factor when insulation is used as a backing for a more refractory lining material is the interface temperature. The insulation obviously must be chosen such that it is refractory enough at the interface to withstand the temperature. In addition, one must consider thermal conductivity, weight, and heat capacity of the working refractory as well as destructive factors such as duration of heating, nature of fuel, refractory expansion and growth, and for lower walls, molten metal attack. When choosing an insulation for a melting or holding furnace which operates semicontinuously, high heat storage in the refractories is a definite benefit because of its cushioning effect against excessive fluctuations in temperature. The best construction for these furnaces is with composite walls and roof, consisting of dense refractories backed with compressible insulation. With a high furnace temperature and a high degree insulation, however, the mean temperature may become higher than that which the refractory can withstand. Hence, adding insulation may result in needing a material with higher refractoriness and requiring redesign to reduce deformation. Therefore, heat savings and other benefits of insulation must be carefully balanced against the possible increased costs associated with more rapid refractory degradation or in upgrading the working lining to high quality refractories. If this type of problem is approached in a systematic manner through computerized calculations and selection of proper materials, a refractory system can be designed which will give optimum heat savings and service life.

Insulation Materials

Listed below are the asbestos-free insulations materials examined and a brief description of each:

Eagle-Picher PV Supertemp block is composed of mineral wood fibers with specially prepared inorganic binders which has been one of Alcoa's recommended backup insulations for years. Temperature limit is 1040°C (1900°F).

Keene Mono-Block, also a mineral wool insulation, has fibers which have been specially interlocked to form a lightweight and rigid, yet resilient block. Temperature like PV Supertemp is 1040°C (1900°F).

Keene Delta-T is a felted, spun ceramic clay fibers bonded with inorganic binders. Temperature limitation is higher than mineral wool at 1260°C (2300°F).

Rim Products 410-03, a ceramic fiber product, is made by bonding alumina-silica fibers with high purity alumina. Temperature rating is 1300°C (2372°F). This insulation was reported to be nonwetting to molten metal, making this insulation particularly attractive.

International Vermiculite IV-19 block insulation is manufactured from vermiculite granules and high-temperature bonding inorganics; like the mineral wool insulations, it is good to 1037°C (1900°F).

International Vermiculite IV-20 block insulation is asbestos-free as are all of these other insulations. IV-20 consists of diatomaceous silica with a hydraulic binder for service to 1093°C (2000°F).

Johns-Manville Superex products have been used in combination with Eagle-Picher's PV Supertemp for reverberatory furnaces. A combination of silica, lime, clay and fibers make up these products.
Superex 2000, a high-density, low-calcium oxide content block, was designed for low shrinkage and top performance up to 1100°C (2000°F).
Superex 1600, on the other hand, has a high-calcium oxide content and lower density than Superex 2000. This formulation gives better strength and insulating properties for situations where temperatures do not exceed 870°C (1600°F).

Skamol Skamolex PM-10 (formerly Skamolex GX 1000) is also a white calcium-silicate material. This product is distributed by Dolomite Brick Corp. in the United States but manufactured in Denmark.

See attached manufacturer sheets for more details.

In Table I are the chemical analysis and X-ray diffraction data collected for the nine products studied. The purest material is the Rim 410-03 which contains the highest alumina content and is essentially all amorphous. Three insulations--PV Supertemp, Mono-Block, and Delta-T--are montmorillonite ($CaMgSiO_4$) based. Delta-T has the lowest impurities, whereas Fe_2O_3, MgO and alkali are high for both PV Sumpertemp and Mono-Block.[3] IV-19, as characterized as X-ray diffraction, is largely comprised of talc and silica. IV-20, on the other hand, is identified as a diatomaceous earth composition which has silica and calcite. Cristobalite and alpha quartz forms of silica make up Superex 2000. Superex 1600 and Skamolex PM-10 both are calcium-silicate hydrates.

Evaluation and Test Procedure

Outside of the compressibility testing, all physical property data were determined using ASTM methods. Bulk Density, linear change, and loss on ignition were all examined. Compression tests were accomplished with a Dillon dynameter. Square samples measuring 50.8 mm (2 inches) were aligned in the Dillon machine and compressed initially to 90% of its original height. (Fibrous materials were positioned so their fibers were perpendicular to the pressing

direction.) The load was then recorded. Compression measurements were continued for every 10% deformation up to a reduction of 40%. Any fracture or unusual behavior was noted.

Corrosion resistance to molten aluminum was determined by Alcoa's modified B-Immersion test. Simply, this test consists of preheating the sample to 540°C (1000°F), then immersing three-fourths of its length into 7075 alloy at 760°C (1400°F) for 24 hours. After being cleaned, the percent sample weight retained is recorded. If possible and results are warranted, a second cycle is performed. Again, precent sample weight retained is determined.

Results

Please refer to Table II for physical property data. Maximum recommended service temperatures are recorded first. As seen, the higher the temperature the fewer materials are available. The major drop-off points were at 875°C (1603°F), 980°C (1800°F), and 1320°C (2400°F). Rim 410-03 had the highest rating at 1300°C (2372°F); Delta-T followed at 1275°C (2300°F). All the other insulations are suggested for less than 1000°C (1832°F), except Superex 1600 which is only rated at 870°C (1600°F).

Other properties which determine allowable exposure temperatures include linear firing shrinkages and loss on ignition. For these measurements, 2.5 X 2.5 X 15-cm (1 X 1 X 6-in.) samples were exposed to temperatures of 540°C (1000°F) and 1100°C (2000°F) after which they were measured and weighed. Photographs of some of the specimens after exposure are given in Figures 1-8. At 540°C (1000°F) only slight dimensional changes were apparent, but loss on ignitions were high for IV-19, Superex 2000, and Skamolex PM-10. (Loss on ignition measurements give an indication of the weight of chemically bonded water and organic materials.) Therefore, these three materials show structural hydrate changes even at this low temperature. At a temperature of 1100°C (2000°F), very few insulations retain their structural integrity. Only Rim 410-03 and Delta-T materials remain relatively unaffected.

Crushing strengths were performed up to a deformation percentage of 60%. For most backup insulations the material should be rigid enough to install but have a crushing strength to meet refractory expansion without overstressing and deforming the furnace outside shell. Eagle-Pichers's PV Supertemp has been the perferred material in melting and holding furnace construction. It compresses steadily up to 50% before its strength suddenly doubles. At no time during the testing did the sample fracture. Other insulations (Mono-Block, Delta-T, and Rim 410-03) behaved similarly. Rim 410-03, although exhibiting an initial lower strength, more closely resembles the compressibility of PV Supertemp than any other insulation. IV-19, IV-20, and Skamolex PM-10 all fractured at

approximately 34.5 MPa (5,000 psi). The Superex products, although not showing a brittle fracture, had exceedingly high strenghs up to 345.0 MPa (50,000 psi) after only 40% compression, the highest of all insulations.

The apparent thermal conductivity of mass insulations is a combination of the following heat transfer mechanisms: thermal conductivity of air, thermal conductivity of the solid components of the insulating structure, the convective heat transfer within the pore structure, the radiation heat transfer within the structure, and the interactions of these mechanisms. The thermal conductivity term itself refers to an intrinsic property of a homogeneous material, but because of these many heat transfer mechanisms it is subject to much theorectical questioning when referring to insulations. For comparison purposes however, the manufacturer's thermal data are given. As shown, the thermal conductivities of all the insulations evaluated are nearly the same. The greatest difference is between IV-20 and PV Supertemp, 0.13 W/m·K (0.89 Btu·in/h·ft^2·°F) compared to 0.10 W/m·K (0.69 Btu·in/h·ft^2·°F), respectively. In this regard, the choice of which insulation to use will be dependent upon other factors discussed.

In many circumstances, molten aluminum may come in contact with the insulation. Molten metal may penetrate to the insulation through lower wall refractories which crack during installation, dryout or other reasons. To evaluate those conditions, the modified B-Immersion test was used. Results are found in Table III and Figures 1-8. Although all the insulations showed good to excellent to molten aluminum resistance as indicated by the high weight retention, the mineral wool products, PV Supertemp and Mono-Block, did shrink and bowed excessively upon metal contact. In actual service conditions, this type of behavior may leave gaps in the lining allowing further metal penetration. For fibrous products, Rim 410-03 and Delta-T, metal resistance was good; both materials remained intact even though some penetration was seen in the Delta-T. The other materials (IV-19, IV-20, Superex 2000, Superex 1600, and Skamolex PM-10) performed excellently; the metal skull retained could be easily removed.

Safety Statement

Although these materials do not contain asbestos, some are composed of free crystalline silica (see Table I for analyses). It is the uncombined silicon dioxide (SiO_2) in these insulations which may lead to lung disease. Of primary concern is silicosis, a noncancerous disease of the lungs. Silicates, although consisting of silicon and oxygen, combined with other elements in a complex molecules. With the exception of asbestos and some talcs, silicate dusts should not ordinarily cause disabling lung conditions such as produced by free silica. It is uncombined or free silica

however that is most important in industrial dust exposure. To detect an exposure properly, the percentage of uncombined silica must be determined by petrographic analysis, preferably by X-ray diffraction or infrared techniques.

It is generally stated that the size of the offending dust particles is of extreme importance in determining the concentration of particles that may be suspended in the air. The size of particles also determines the depth to which these particles penetrate into the lung along with the quantity that may become deposited and retained. Particulates less than 10 microns in size are potentially the most harmful. Generally, when airborne particles are larger than 10 microns, they are not of concern because they are unable to penetrate into the lung where they could be damaging. Instead they are removed and collected by the nasal passages or upper respiratory system.

Also, it has been generally stated that the duration of dust inhalation is of extreme importance. Persons who for many years have continuously inhaled free silica dust have a great likelihood of contracting a silica-related disease. Those who only intermittently inhale the dust have less risk of injury. In addition, those persons who smoke will increase the risk which otherwise exists.

It is important to be aware that exposure to silica dust can occur during the installation of some of these products that contain free silica as well as during tear-out and repair of facilities where these products were previously installed. It is recommended that personnel working with these insulations wear respirator and eye protection, and that the area be properly ventilated. Periodic safety monitoring of the free silica should be scheduled also.

Conclusions

1. Major insulation materials in the high temperature range are (listed in ascending order of temperature resistance):

   a. Mineral Fiber, 540 to 1040°C (1000 to 1900°F)--PV Supertemp and Mono-Block.

   b. Calcium Silicate and Silica, 870 to 1100°C (1600 to 2000°F)--IV-19, IV-20, Superex 2000, Superex 1600, and Skamolex PM-10.

   c. Ceramic Fibers Based on the Al_2O_3–SiO_2 Systems, 1100 to 1260°C (2000 to 2300°F)--Delta-T and Rim 410-03.

2. High compression strengths were found for IV-19, IV-20, Superex 2000, Superex 1600, and Skamolex PM-10, whereas fibrous materials (PV Supertemp, Mono-Block, Delta-T, and

Rim 410-03) show the least resistance to deformation or high compressibility.

3. Thermal conductivity values did not vary significantly between the insulation types examined.

4. Although exhibiting nonwettability, mineral wool insulations (PV Supertemp and Mono-Block) do shrink excessively in contact with molten aluminum. Other products (calcium silicate, silica or ceramic fiber materials) all have good-to-excellent resistance.

5. Products IV-19, IV-20, Superex 2000, Superex 1600, and Skamolex PM-10 have been identified as containing free crystalline silica. Largest contents were found in Superex 2000, IV-20 and IV-19.

Recommendations

Again, each application must be considered individually when recommending insulation. One must consider the thermal conditions imposed by service along with each particular insulation's qualities of mechanical strength, chemical compatibility, weight, compactness, heat flow resistance, and so forth. In many cases it must be recognized that local availablility and delivery will at times necessitate the use of a product in a specific class.

For ingot melting and holding furnaces, one of the most important developments by Pittsburgh Mechanical Engineering in the past year was the development of a computer program to investigate temperature profiles. On the basis of a computer study and this present work, lower furnace walls are now being backed up with 50.8 cm (2 in.) of Rim 410-03 or Delta-T insulation in place of 50.8 cm of PV Supertemp and 50.8 cm of Superex 2000. This design has established a more realistic metal freeze plane with insulations that are both compressible and molten metal resistant. This construction should prevent frequency of furnace bleedouts and conserve energy. Other ingot applications such as troughing, filter units, etc., are being reviewed, and better materials and designs are being plant tried. With proper design and material selection, improved service life and more comfortable working conditions should be realized.

Finally, in handling some of these products studied, particularly Superex 2000 and IV-20, special precautions must be taken to minimize dusting. Without adequate ventilation and respirators, a safety problem does exist.

TABLE I

ANALYSES OF ASBESTOS-FREE INSULATIONS — MANUFACTURER'S DATA

Manufacturer and Product	Chemical Analyses, %								X-ray Diffraction Analyses
	Al_2O_3	SiO_2	CaO	Fe_2O_3	TiO_2	MgO	ZnO	Alkalies	
Eagle-Picher PV Supertemp	13-17	39-43	23-27	10-14	--	4-8		2-4	Lge montmorillonite; Sml unidentified.
Keene Mono-Block	10	50	17	9		5	1.4	1.5	Montmorillonite.
Keene Delta-T	44.5	51.4	1.3	1.2	1.2	0.4		-	V Lge montmorillonite; V Sml alpha quartz.
Rim Products 410-03	54	46							Amorphous.
International Vermiculite IV-19	9.2	54.4	11.5	5.4	--	13.2		4.6	Lge $Mg_3Si_4O_{10}(OH)_2$ (talc); Sml SiO_2 (cristobalite); Trace α-SiO_2 (alpha quartz).
International Vermiculite IV-20	3.9	79.0	6.8	1.3	--	3.8		--	Med SiO_2 (cristobalite); Sml $CaCO_3$ (calcite); V Sml α-SiO_2 (alpha quartz); Trace unidentified; Balance amorphous.
Johns-Manville Superex 2000	4.3	74.8	6.0	2.0	0.3	0.8		2.7	Med SiO_2 (cristobalite); Sml α-SiO_2 (alpha quartz); V Sml unknown; Balance amorphous.
Johns-Manville Superex 1600	1.2	49.6	37.6	0.3	Trace	0.2		--	Lge $Ca_5(OH)_2Si_6O_6 \cdot 4H_2O$ (tobermorite); Sml α-SiO_2 (alpha quartz).
Skamol Skamolex PM-10	1.4	47.2	48.3	0.6					Lge $Ca_6Si_6O_{17}(OH)_2$; V Sml α-SiO_2 (alpha quartz).

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TABLE II

PROPERTIES OF ASBESTOS-FREE INSULATIONS

	Eagle-Picher FV Supertemp	Keene Mono-Block	Keene Delta-T	Rim Products 410-03	International Vermiculite IV-19	International Vermiculite IV-20	Johns-Manville Superex 2000	Johns-Manville Superex 1600	[illegible]
Price/board ft.	$0.50	$0.55	$2.90	$3.80	$1.04	$1.19	$0.76	$0.72	[illegible]
Max Recommended Service Temp, °C	1037	1037	1275	1300	1037	1093	1100	870	1000
°F	1900	1900	2300	2372	1900	2000	2000	1600	1832
Bulk Density, kg/m³	256-288	192	288	256-288	328	392	384	224	250
, pcf	16-18	12	18	16-18	20.5	24.5	24	14	156
Compressive Strength, MPa (psi)									
After 10% deformation	0.07 (1512)	0.07 (1512)	0.05 (1098)	0.03 (720)	1.01 (21 060)	1.25 (25 999)	0.95 (19 800)	2.12 (44 100)	0.87 (17 900)
20%	0.09 (1836)	0.12 (2448)	0.11 (2378)	0.05 (1080)		0.80 (16 714)	1.30 (27 000)	1.86 (38 700)	0.75 (15 400)
30%	0.10 (2160)	0.21 (4284)	0.18 (3842)	0.09 (1764)		0.76 (15 725)	1.81 (37 800)	1.94 (40 500)	
40%	0.14 (2880)	0.31 (6516)	0.27 (5671)	0.12 (2520)			2.59 (54 000)	2.42 (50 400)	
50%	0.20 (4248)	0.53 (11 124)	0.38 (7866)	0.20 (4104)			4.58 (95 400)	3.59 (74 700)	
60%	0.44 (9108)	1.11 (23 040)	1.04 (21 585)	0.49 (10 296)			8.21 (171 000)	5.62 (117 000)	
Linear Change, %									
After:									
540°C (1000°F)	-0.30	-0.30	-0.10	-0.01	-0.50	-0.30	-0.2	-0.4	-0.3
1100°C (2000°F)	-4.2	-3.9	-2.3	-1.2	-5.8	-2.7	-2.8	-4.3	-2.0
L.O.I., %									
After:									
540°C (1000°F)	-3.6	-1.5	-1.7	-0.64	-8.0	-3.4	-5.4	-6.2	-7.0
1100°C (2000°F)	-2.5	-2.6	-2.4	-2.6	-11.6	-6.1	-8.9	-11.8	-12.0
*Thermal Conductivity, W/m·K (Btu·in/h/ft²/°F)									
100°C (200°F)	0.04 (0.28)	0.05 (0.36)	0.06 (0.43)	0.04 (0.26)	0.08 (0.56)	0.08 (0.57)	0.08 (0.58)	0.07 (0.46)	0.06 (0.45)
200°C (400°F)	0.06 (0.38)	0.06 (0.42)	0.08 (0.52)	0.05 (0.36)	0.09 (0.64)	0.09 (0.65)	0.09 (0.62)	0.07 (0.48)	0.07 (0.[illegible])
300°C (600°F)	0.07 (0.49)	0.07 (0.51)	0.09 (0.60)	0.07 (0.46)	0.10 (0.72)	0.10 (0.70)	0.09 (0.65)	0.08 (0.55)	0.09 (0.65)
400°C (800°F)	0.09 (0.59)	0.09 (0.62)	0.11 (0.74)	0.08 (0.57)	0.12 (0.80)	0.11 (0.77)	0.10 (0.70)	0.10 (0.68)	0.10 (0.70)
540°C (1000°F)	0.10 (0.69)	0.11 (0.75)	0.13 (0.84)	0.10 (0.67)	0.13 (0.88	0.13 (0.89)	0.12 (0.80)	0.13 (0.87)	0.12 (0.[illegible])

*Manufacturer's data

JE Hines/1979-11-05

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TABLE III

MOLTEN ALUMINUM CORROSION RESISTANT INSULATIONS

Material and Manufacturer	Weight % Retained	Rating	Comments
PV Supertemp Eagle-Picher	87.5	Very Poor	Sample badly shrunk below metal line, little penetration.
Mono-Block Keene	93.1	Very Poor	Metal easily removed but sample shrunk and bowed out of shape.
Delta-T Keene	92.0	Good	Metal penetrated into sample from traces to 1/8".
410-03 Rim Products	91.4	Good to Excellent	Metal skull easily removed, however some fibers do pull loose.
IV-19 International Vermiculite	90.1	Excellent	Metal easily removed.
IV-20 International Vermiculite	94.0	Excellent	Metal very easy to remove.
Superex 2000 Johns-Manville	87.6	Excellent	No visible penetration.
Superex 1600* Johns-Manville	86.3	Excellent	No visible penetration.
Skamolex PM-10* Skamol	87.2	Excellent	No visible penetration.

*Photos not shown due to fragile nature.

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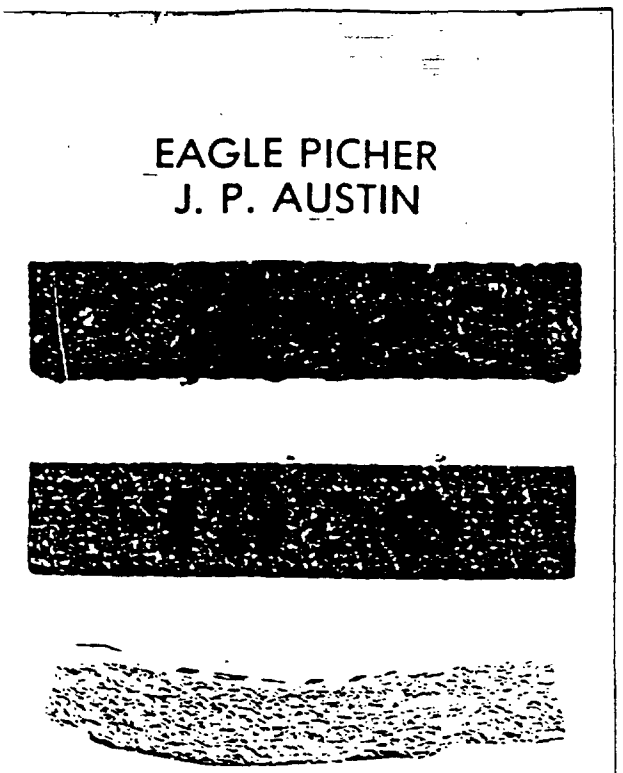

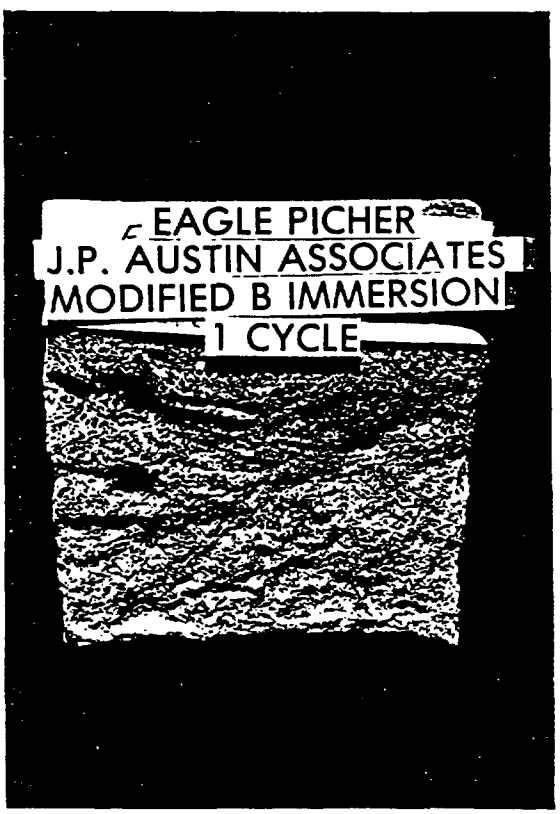

FIGURE 1

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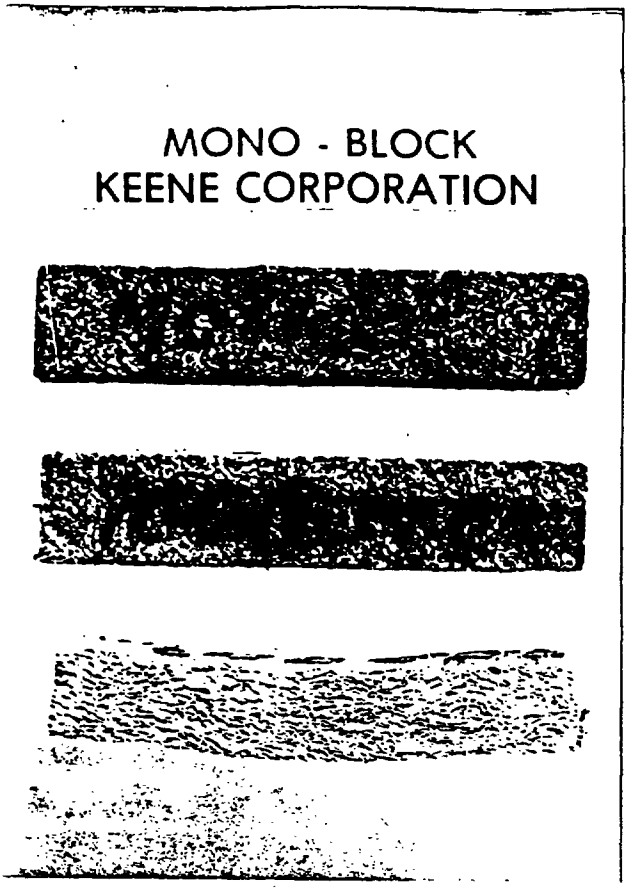

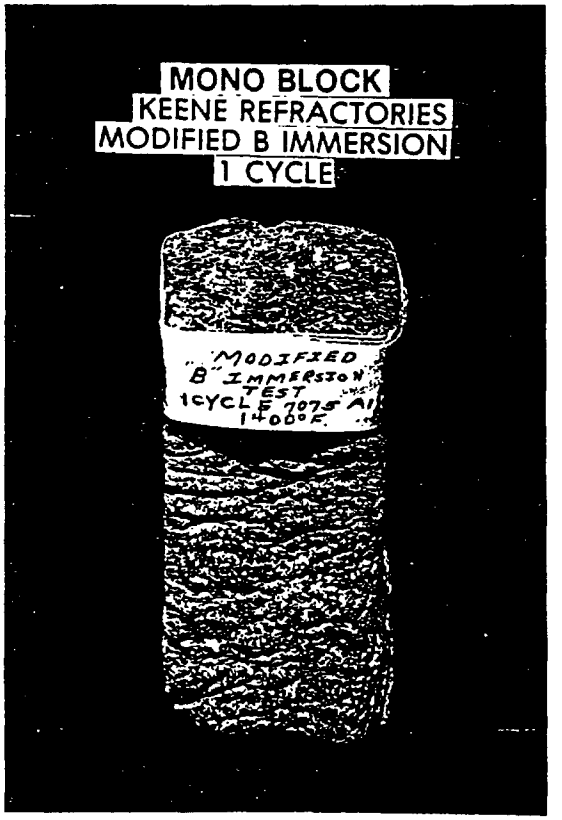

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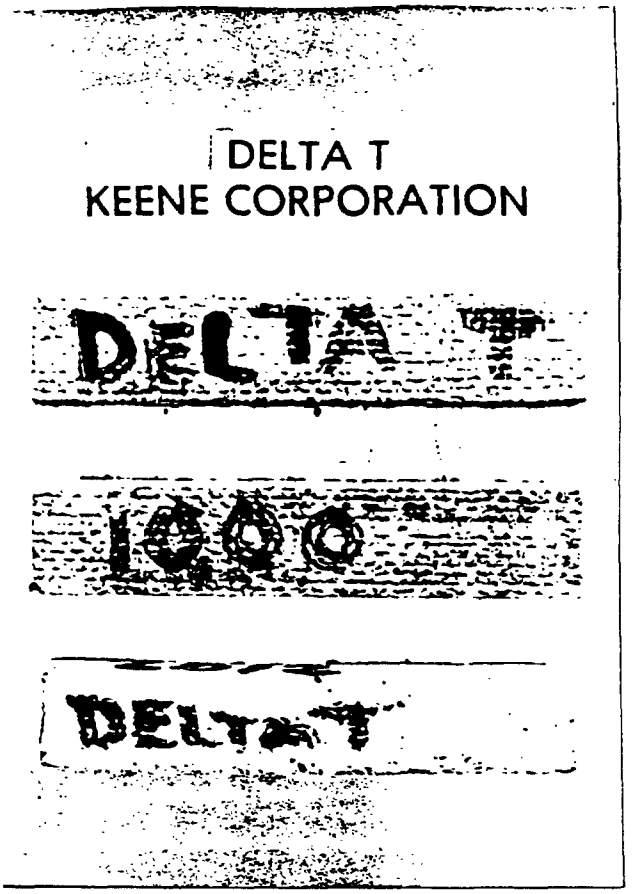
FIGURE 2



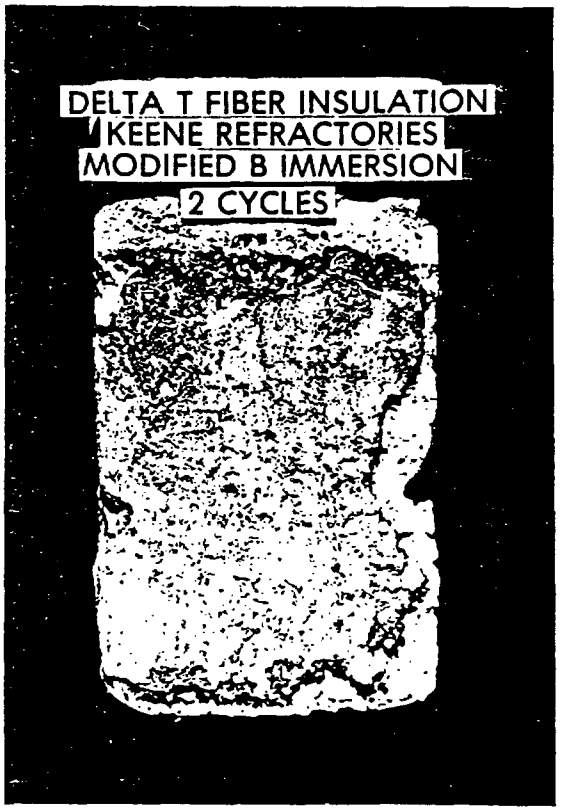


FIGURE 3

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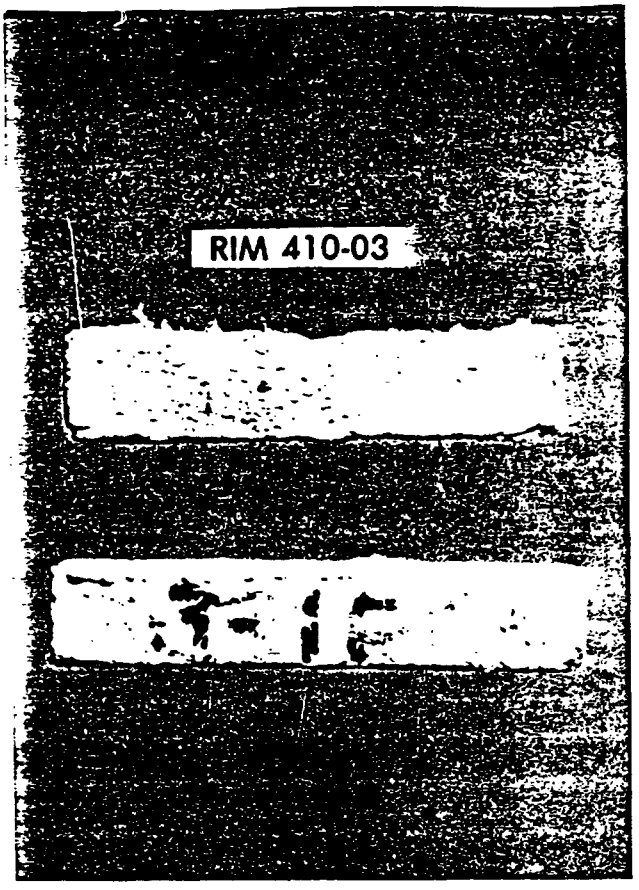

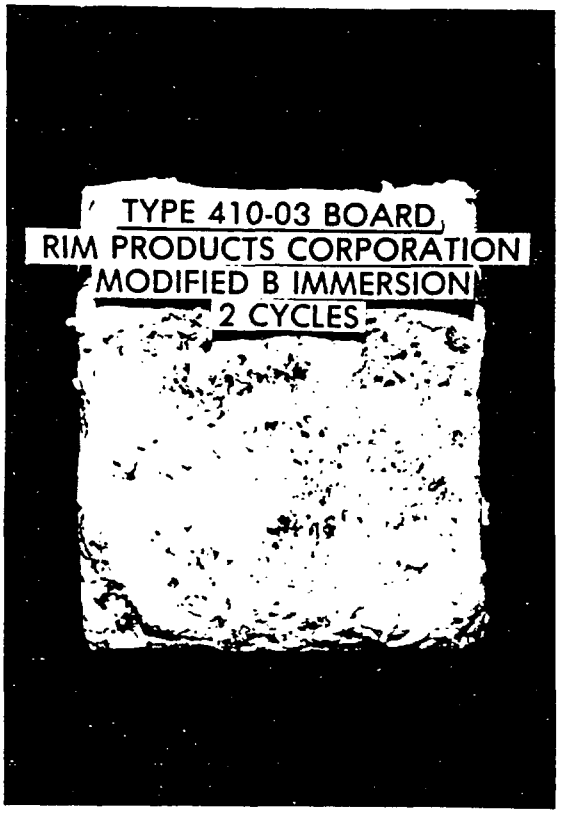

FIGURE 4

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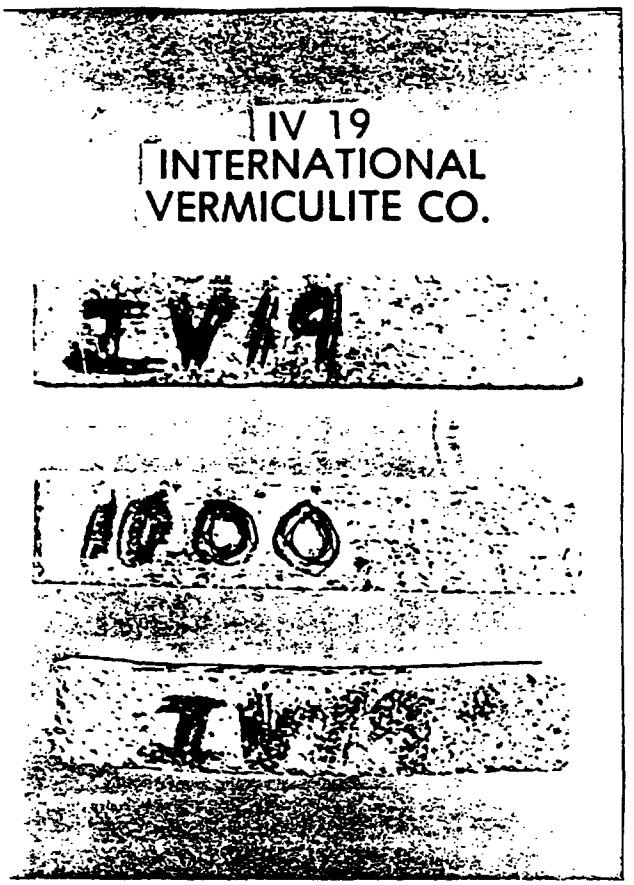

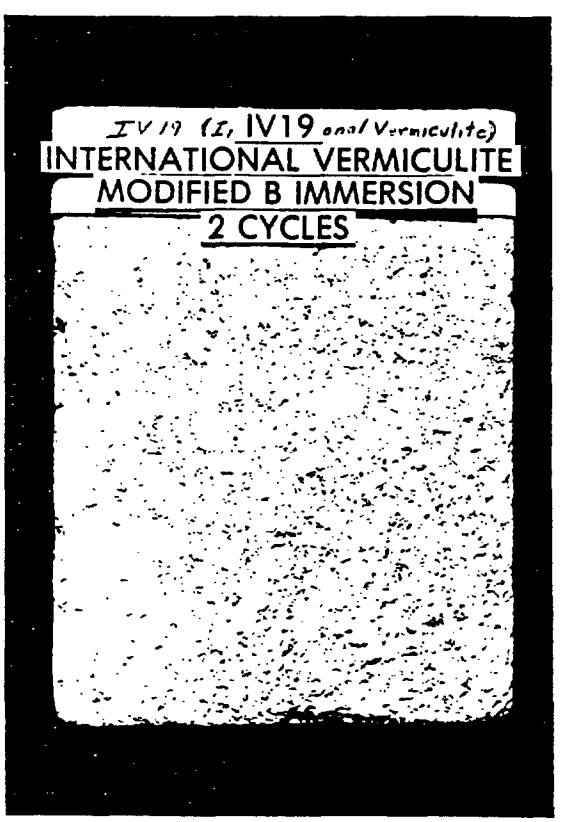

FIGURE 5

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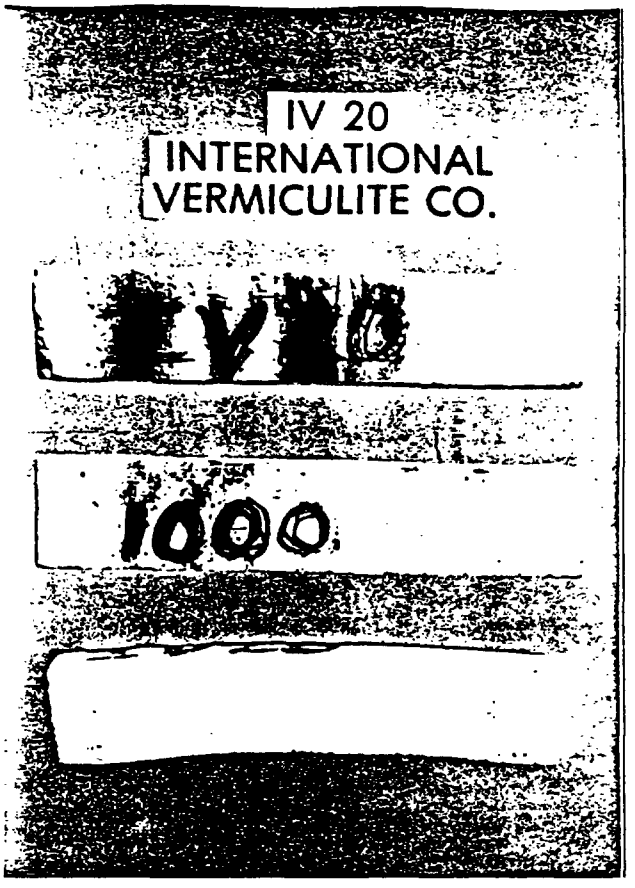

IV 20
INTERNATIONAL
VERMICULITE CO.
1000

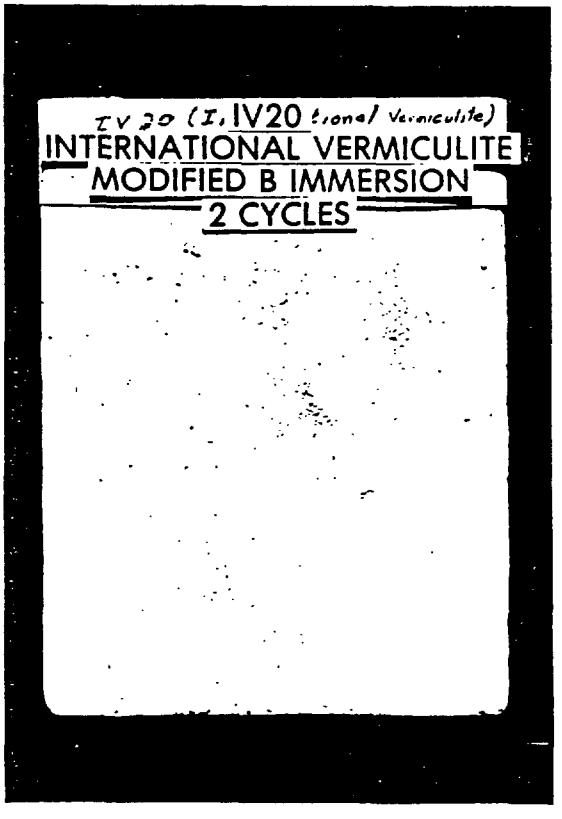
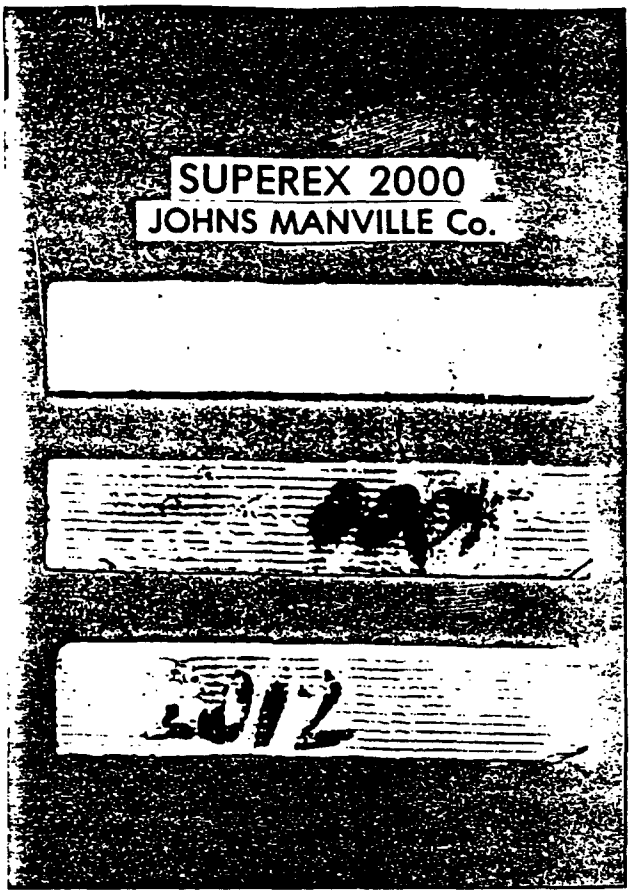

IV 20 (I. IV20 tional Vermiculite)
INTERNATIONAL VERMICULITE
MODIFIED B IMMERSION
2 CYCLES

FIGURE 6


SUPEREX 2000
JOHNS MANVILLE Co.

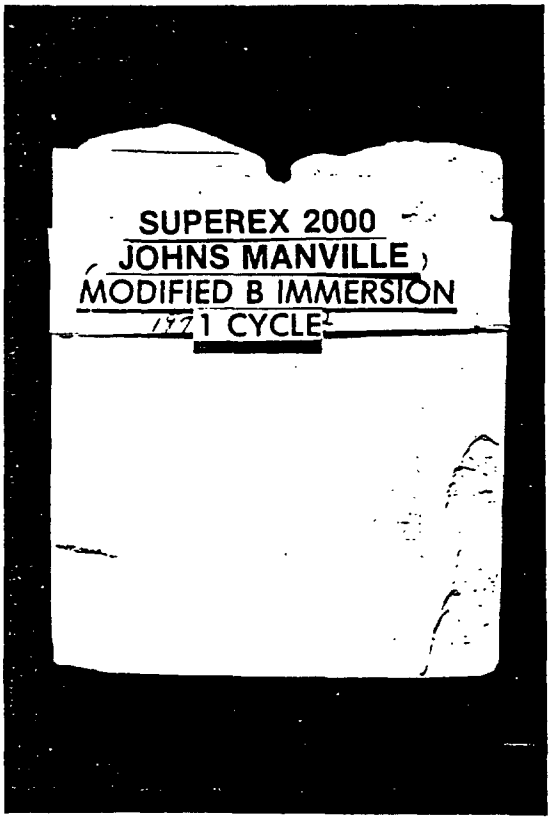

SUPEREX 2000
JOHNS MANVILLE
MODIFIED B IMMERSION
1 CYCLE

FIGURE 7

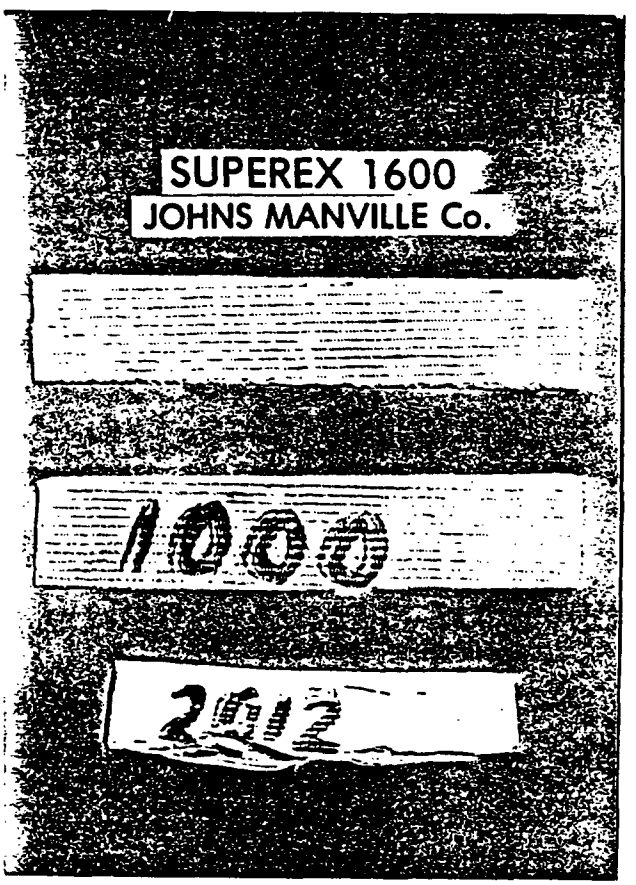
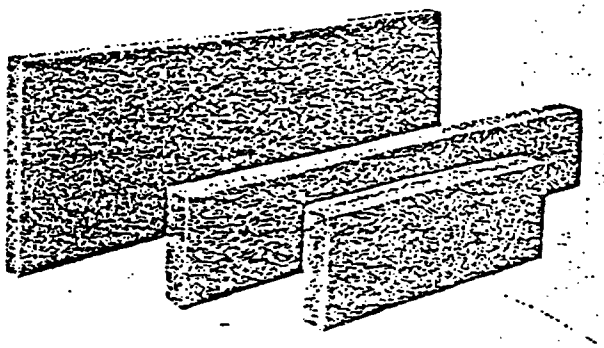


FIGURE 8

TYPE: Block
TEMPERATURE: to 1900°F

EAGLE-PICHER

"PV" SUPERTEMP BLOCK



Description:

Eagle-Picher "PV" Supertemp Block is composed of high temperature mineral fibers bonded with specially prepared binders to form a block insulation having optimum properties during both installation and service. Fibers are oriented to insure maximum strength and thermal efficiency. The blocks are "wet-sawed" by a patented process to provide precise dimensional tolerances and freedom from dust.

Uses:

Recommended for direct application or refractory back-up insulation in petroleum and process units, power generation equipment, ovens, furnaces, kilns and other related equipment requiring an insulation that is economical, efficient and dimensionally stable.

Advantages:

Durability: Strong yet resilient, processed to maintain structural integrity during field application.

Absorption: Allows placement of castable refractories in direct contact with the block without degradation.

Installation: Can be impaled on pins without predrilling. Easily field fabricated with knife or saw. Standard sizes up to 24" x 36" permit rapid installation.

Physical Properties:

Service Temperature	to 1900°F.
Density	16 - 18 lbs./cu. ft.
Moisture Absorption	Nil
Fire Resistance	Incombustible
Corrosion	Does not cause or accelerate

Physical Properties (cont'd):

Linear Shrinkage	
at 1600°F.	2.0%
1800°F.	2.2%
Modulus of Rupture	40.0 lbs./sq. in.
Compressive Strength at 10% Deformation	2,600 lbs./sq. ft.

Thermal Conductivity:

Mean Temperature °F.	"K" (Btu-in./hr./sq. ft./°F.)
200	0.28
400	0.38
600	0.49
800	0.59
1000	0.69

EAGLE-PICHER *Superwool®* INSULATION

APC 003912

EAGLE-PICHER

"PV" SUPERTEMP BLOCK

Applicable Specifications:

Commercial Standard CS-117
ASTM C612-67T, Class D

Federal HH-I-558, Form A, Class 5

Packaging:

Board Feet per Carton

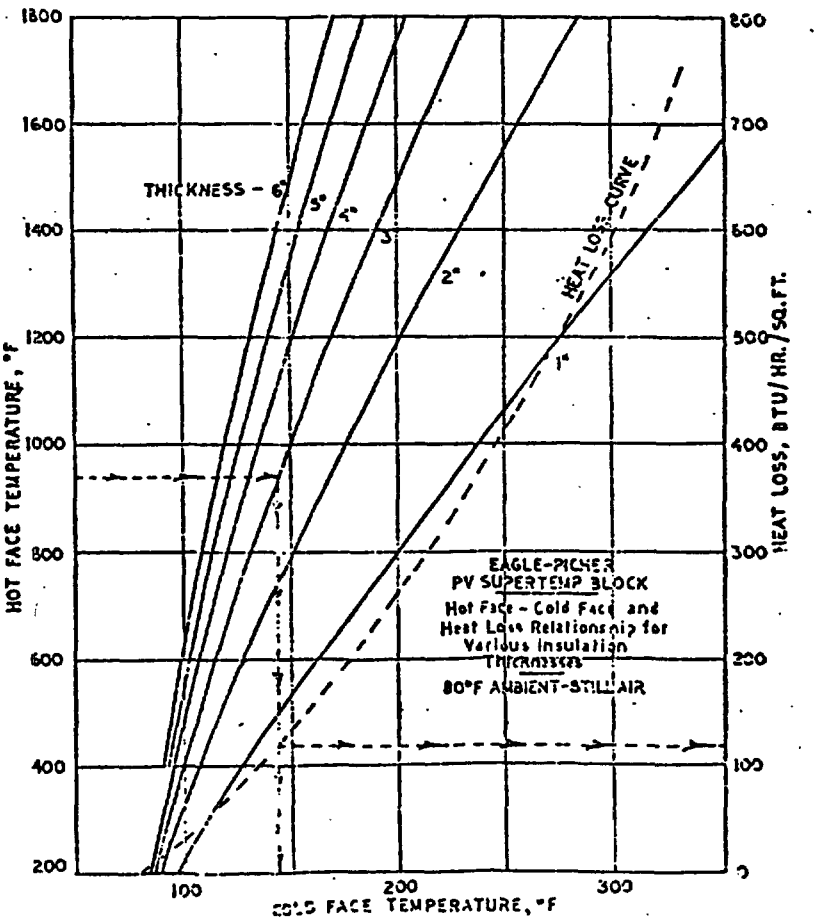
	1"	1½"	2"	2½"	3"	3½"	4"	4½"
6 x 18	48	45	48	45	45	42	48	40.5
12 x 18	48	45	48	45	45	42	48	40.5
6 x 36	48	45	48	45	45	42	48	40.5
12 x 36	48	45	48	45	45	42	48	40.5
18 x 36	54	54	54	45	54	47.25	54	40.5
24 x 36	48	54	48	45	54	42	48	54

Standard Sizes:

Thickness: 1" to 4½" in ½" increments
Width: 6", 12", 18" and 24"
Length: 18" and 36"

Special sizes and shapes are available and are quoted on request.

Heat Loss Chart:



KEENE

MONO-BLOCK

Mineral Wool Insulation – For Service to 1900 F – Asbestos Free

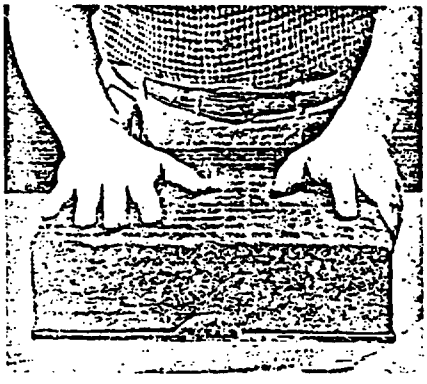
DESCRIPTION:

MONO-BLOCK is composed of spun mineral fibers and inorganic binders especially formulated for resistance to high temperatures. A patented process interlocks the long mineral fibers to form a lightweight and rigid, yet resilient block which is shaped and fitted.

TYPICAL USES:

- Heat Treating Ovens
- Boilers
- Incinerators
- Chemical Treating Tanks
- Refinery Equipment
- Ducts and Breechings
- Feed Water Heaters
- Wind Tunnels'
- Jet Silencers'
- Fan Housings'

'Acoustical Applications



FEATURES:

- *Easy to Apply* — Easily cut with a knife. Conforms to slight curvatures or projections such as rivet heads, providing a snug fit without cracking or breaking. Can be impaled over welded studs without predrilling holes.
- *High Strength* — Strong because of long mineral fibers and unique manufacturing process which uses inorganic binders. This extra strength guards against breakage loss.
- *Low Chloride/Moisture Resistant* — Acceptable for use on austenitic stainless steel.
- *Effective Acoustical Properties* — High sound absorption efficiency makes this product applicable where acoustical treatment is required at elevated temperatures.

KEENE
CORPORATION
INSULATION
1013 FULFORD STREET, KALAMAZOO, MICHIGAN 49001
TELEPHONE (616) 343-1220 TELEX 810-277-1003

PHYSICAL PROPERTIES:

Density — 12 lbs./cu. ft. minimum
Compressive Strength — 10 lbs./sq. in. @ 10% deformation
Flexural Strength — 40 lbs./sq. in.
Linear Shrinkage after heating 24 hrs. at 1900°F
Soaking Heat — Less than 5%
Single Face — Less than 5%

THERMAL CONDUCTIVITY:

Mean Temp. °F	200	400	600	800	1000	1200
K	.36	.42	.51	.62	.75	.90

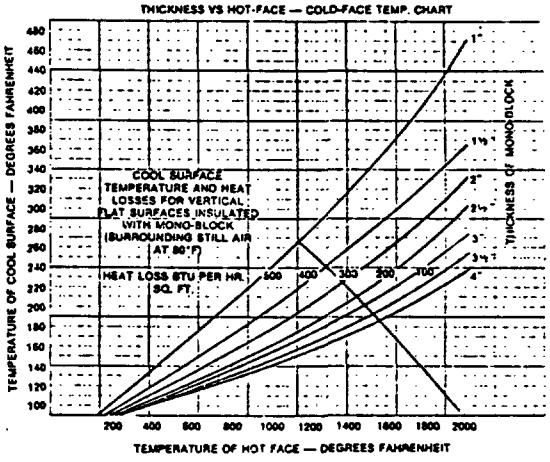
STANDARD SIZES AVAILABLE:

Length — 18, 36 inches
Width — 6, 12, 24 inches
Thickness — 1-4 inches in ½ inch increments

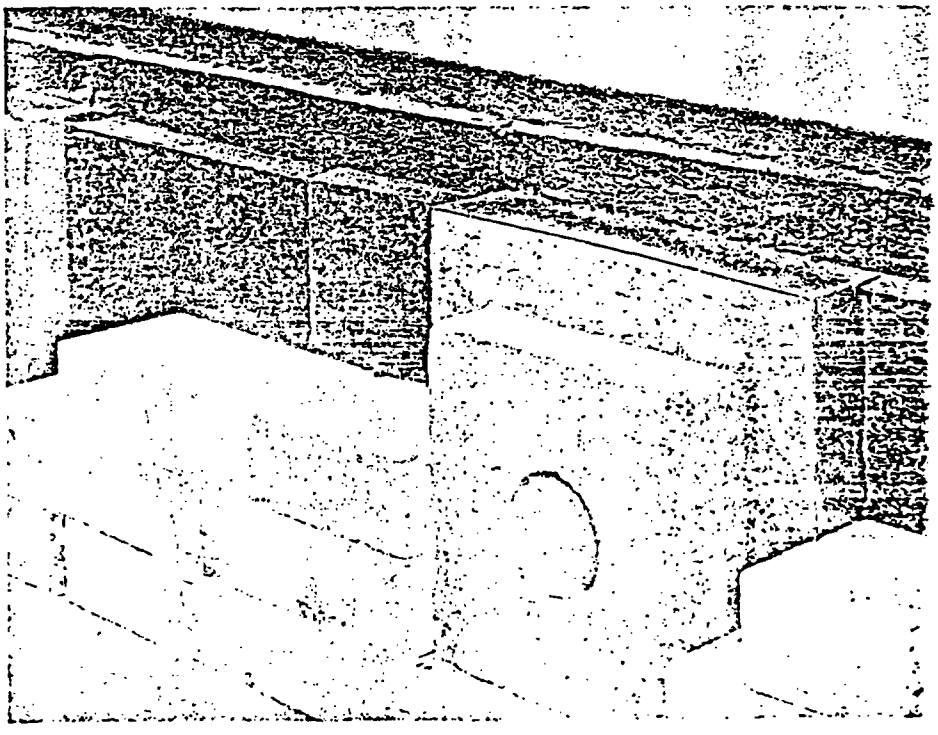
SPECIFICATION COMPLIANCE:

Military: MIL-I-24244A*
Federal: HH-I-558B Form A Class 5
ASTM: C612-70 Class 5

*Indicate on order when specification compliance is required.



1979



APC 003914

APC 003915

Delta-T specifications

Description	felted, spun ceramic fiber with inorganic binders
Color	off-white
Use Limits, F (C)	
Continuous	2300° (1275°)
Intermittent	2400° (1333°)
Melting Point	3200° (1775°)
Density, lb./cu. ft.	18
Modulus of Rupture, psi.	65
Compressive Strength	
@ 5% deformation, psi.	20.0
@ 5% deformation, psi. 400° F	26.2
@ 5% deformation, psi. 2300° F	45.7
Resiliency, % (to 1400° F)	99
Linear Shrinkage, % (max.)	
@ 1600° F	0.0
@ 2000° F	1.15
@ 2300° F	4.0

Anchor Materials	S.S. studs
Specific Heat, B.T.U./lb. °F (2000° F)	.24
Loss on Ignition, % (max.)	1.6
Chemical Analysis, %	
Alumina ..... Al_2O_3	44.5
Silica ..... SiO_2	51.4
Calcium oxide ..... CaO	1.3
Ferric oxide ..... Fe_2O_3	1.2
Titanium oxide ..... TiO_2	1.2
Magnesium oxide ..... MgO	.4
Atmospheres	resists oxidation and reduction
Standard sizes available	
Thickness (½" increments)	½"-4"
Length	36"
Width	24"
Tolerances	±1/16"
Custom sizes available	

Thermal Conductivity	Mean Temp. °F	200	400	600	800	1000	1200	1400	1600
	K	.43	.52	.60	.74	.84	.98	1.15	1.30

KENE CORPORATION
Building Products Division
1503 Fullerton Street, Kalamazoo, Michigan 49003

Hi-ALUMINA

CERAMIC FIBER INSULATION

Contains No Asbestos

Type AH-50 For 1500°C (2732°F)

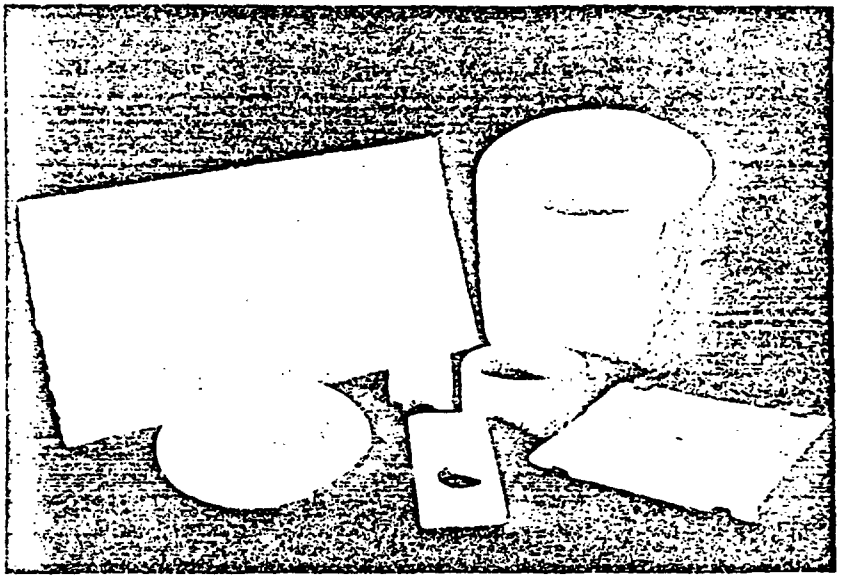
Type AH-30 For 1400°C (2552°F)

Type 410 For 1300°C (2372°F)

Hi-ALUMINA ceramic fiber products are made by bonding alumina-silica fibers with high purity alumina. No starch, silica, clays or asbestos are used. As a result, low density insulating products are obtained with high alumina contents. These Hi-ALUMINA products outperform conventional silica-bonded products.

Three products are offerred for three temperature ranges with three markedly different costs. In this way, users are able to obtain the most economical insulation for any particular temperature range.

Also available for the 3000°F range are our ALL-ALUMINA products described in a separate bulletin (AA-320).



PRODUCTS AVAILABLE

Type AH-50 77% Al_2O_3 For 1500°C (2732°F)

Type AH-30 61% Al_2O_3 For 1400°C (2552°F)

Type 410 54% Al_2O_3 For 1300°C (2372°F)

All of the above products are available in the form of boards, tubes, cylinders or special shapes. The products can be varied in size, thickness, degree of hardness and surface finish.

APPLICATIONS

The principal use for these products is as a rigid form of a low density, high temperature insulation. The alumina-insulation requires 50% less insulation than conventional brick insulation. Fast heat-up, fast cool down and low heat storage make this insulation ideal because of today's energy shortage.

Among the insulation uses are furnace linings, back-up insulation, heat shielding, induction coil liners, combustion chambers, stack insulation and high temperature pipe insulation.

The non-wetting characteristics of alumina binder and alumina-silica fibers to molten metal makes these products desirable for many molten metal applications. Among these are riser sleeves, hot top linings, trough linings and tap out cones.

The low sodium content and high surface area of the alumina binder makes these products ideal catalyt supports for the flameless heater.

The low sodium content makes these products ideal for electrical heating element holders and radiant heater pads.

Other uses include burner blocks, expansion joints, kiln furniture, gaskets, peep hole plugs and seals.

rim products corporation

1605 east ayre street
newport, delaware 19804
phone (302) 995-7194

APC 003916

PROPERTIES	AH-50	AH-30	410
Chemical Composition			
Al_2O_3 (%)	77	61	54
SiO_2 (%)	23	39	46
Density (lbs./cu. ft.)	11 – 12	14 – 16	16 – 18
Modulus of rupture (psi)	60	75	80
Loss on Ignition (%) (Absorbed Water)	2.3	2.3	2.3
Linear shrinkage (%)*			
1300°C (2372°F)	1.2	2.6	3.6
1400°C (2552°F)	2.0	3.1	–
1500°C (2732°F)	2.5	–	–
Thermal Conductivity (BTU-in./sq. ft. hr. °F)			
1300°C (2372°F)	1.5	1.4	1.4
1400°C (2552°F)	1.7	1.6	–
1500°C (2732°F)	1.8	–	–
Melting Point			
Fibers	Above 3200°F	Above 3200°F	3200°F
Binder	3700°F	3700°F	3700°F
Recommended upper use temperature	1500°C 2732°F	1400°C 2552°F	1300°C 2372°F
Thermal shock resistance	Excellent	Excellent	Excellent

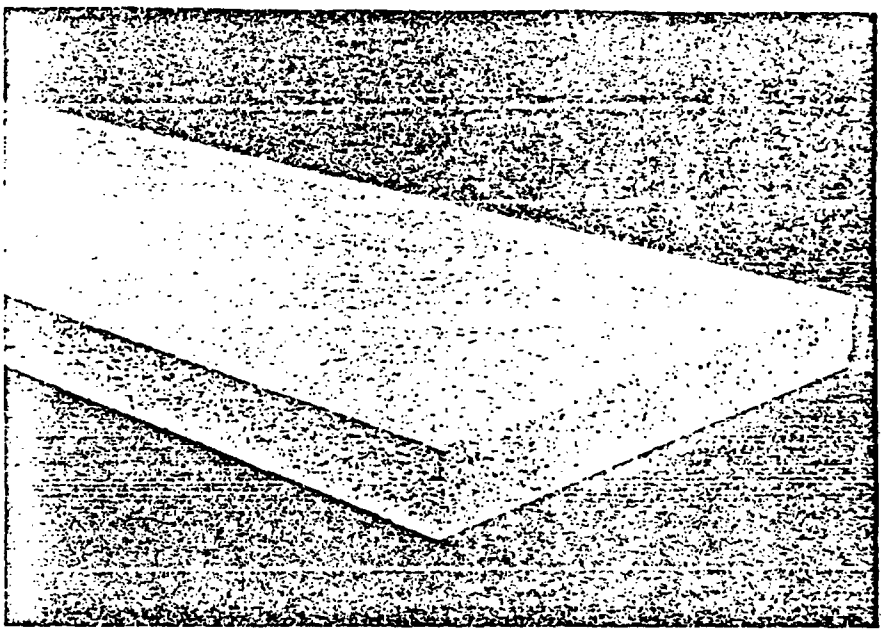
*Two-hour soak

The above information is intended for use by persons having technical skill, at their own discretion and risk. It should not be taken as a warranty nor as a license to operate under, or recommendation to infringe any patent. Some of the above values are averages obtained on developmental material and are subject to change. They should not be used for specification purposes.

APC 003917

IV 19
Block Insulation

Product Data Sheet



IV-19 Block Insulation is an asbestos-free insulation, manufactured from vermiculite granules and high temperature bonding materials. It is a versatile product available in a wide range of sizes.

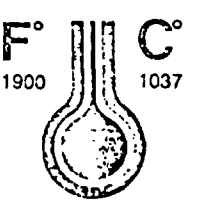
Because of its low conductivity, IV-19 is an economical, energy saving insulation. It exhibits minimal shrinkage at top temperature limits, and will not decompose even when exposed directly to flame at or beyond maximum service temperature.

IV-19 is an excellent back-up insulation as well as a highly efficient hot-face insulation for temperatures at or below 1900° F (1037° C). It's unique composition and hard surface helps insure strong adhesion of cement finishes, and provides superior handling qualities.

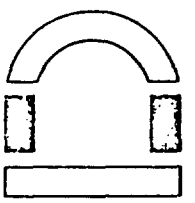
IV-19 can be manufactured with either straight or beveled edges to meet customer specifications. Standard sizes and weights are listed on the price sheet. Prices for custom size blocks will be quoted upon request.



Asbestos-free



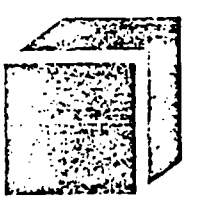
Temperature



Area



Method



Shipping

APC 003918

Product Data Sheet

IV 19
Block Insulation

Physical Properties:



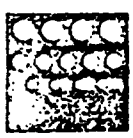
Temperature

1900° F
1037° C



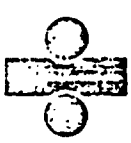
Conductivity

0.56 "k" at 200° F
(.0808 W/m•K at 93° C)
0.64 "k" at 400° F
(.0923 W/m•K at 204° C)
0.72 "k" at 600°F
(.1038 W/m•K at 315.6° C)
0.80 "k" at 800° F
(.1154 W/m•K at 425.7° C)
0.88 "k" at 1000° F
(.1269 W/m•K at 537.8° C)



Density

Cold: 20.5 lb/ft³
(328.4 kg/m³)
At 1900° F/1037° C:
19 lb/ft³ (304.4 kg/m³)



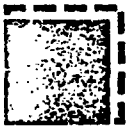
Crushing Strength

Cold: 125 PSI
(.0878 kg/mm²)
At 1900° F (1037° C):
51 PSI (.0359 kg/mm²)



Modulus of Rupture

Cold: 73.5 PSI
(.0517 kg/mm²)
At 1900° F (1037° C):
51.5 PSI (.0362 kg/mm²)



Linear Shrinkage

At 1900° F (1037° C):
2.25%

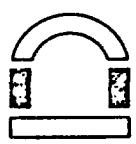


Chemical Analysis

Vermiculite, the basic component of IV-19, is a magnesium, aluminum, iron silicae. It contains no free oxides.

Al_2O_3	9.19	CaO	11.51
SiO_2	54.38	K_2O	3.72
As Silicate		Cr_2O_3, TiO_2	
Fe_2O_3	5.35	Na_2O, Mn_3O_4	0.86
MgO	13.16	Combined H_2O	1.84

Area of Application:



End/Sidewalls

IV-19 has a wide variety of uses in high temperature industrial furnaces including end and side walls of various heating furnaces . . . soaking pits, reheat furnaces, carbonizing furnaces and other annealing furnaces. IV-19 is applied as backup insulation as well as hot face material at temperatures of 1900° F (1037° C) and below, for example IV-19 could be used in duct or flue linings and cyclones.

Method of Application:



Block Construction

Install, using standard procedures for block construction.

Shipping:



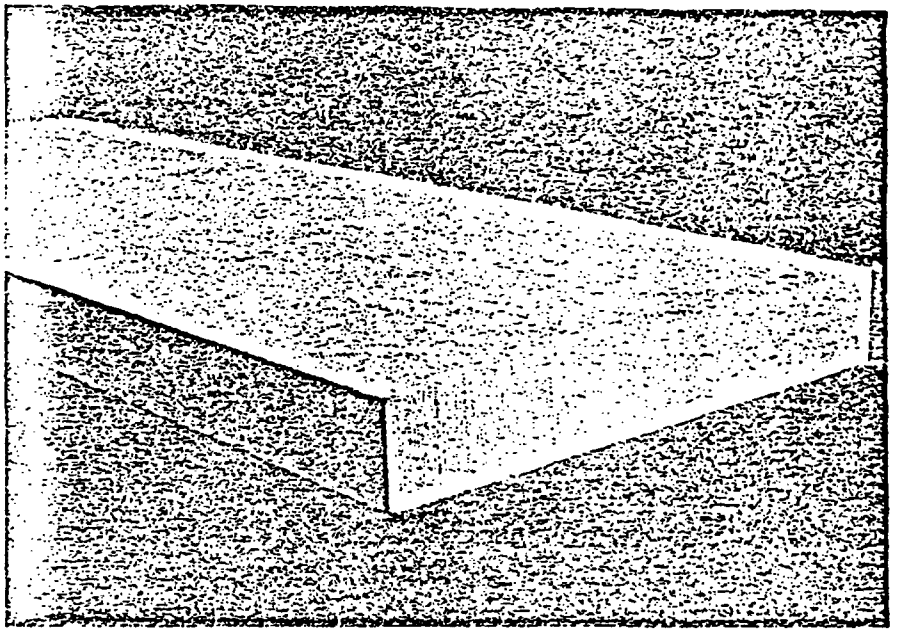
Carton

IV-19 is available in standard block thicknesses of 1" to 6" in ½" increments with the other dimensions measuring 6" x 18", 6" x 36", 12" x 18" or 12" x 36". Special sizes available on request.

APC 003919

IV-20
Block Insulation

Product Data Sheet

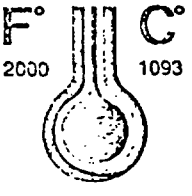


IV-20 Block Insulation, made from diatomaceous silica with a hydraulic binder, is a superior high temperature insulation for service to 2000° F (1093° C). According to ASTM testing procedures, IV-20 exhibits extremely high resistance to breakage at 2000° F (1093° C). Long maintenance-free service and maximum operating efficiency is assured by IV-20's unique combination of low conductivity and high stability. IV-20 is also very low in sulfur and iron, making it highly resistant to attack from atmospheric conditions and greatly reducing the possibility of product contamination.

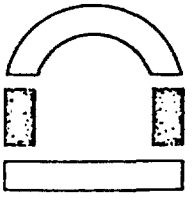
Like other International Vermiculite products, IV-20 is produced in a wide range of standard block sizes, available with either beveled or straight edges. This product can also be manufactured in special shapes to fit customer specifications, saving money on both installation and energy costs.



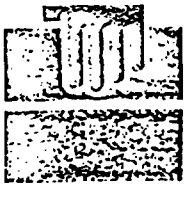
Asbestos-free



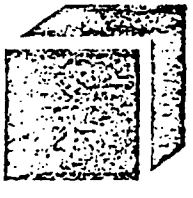
Temperature



Area



Method



Shipping

Product Data Sheet

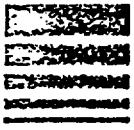
IV-20
Block Insulation

Physical Properties:



Temperature

2000° F
1093° C



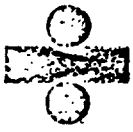
Conductivity

.65 "k" at 400°F
(.0938 W/m•K at 204.4°C)
.70 "k" at 600°F
(.1009 W/m•K at 315.6°C)
.77 "k" at 800°F
(.1111 W/m•K at 426.7°C)
.89 "k" at 1000°F
(.1284 W/m•K at 537.8°C)



Density

Cold: 24.5 lb/ft³
(392.2 kg/m³)
At 2000° F (1093° C):
23.5 lb/ft³ (376.4 kg/m³)



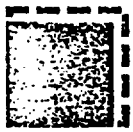
Crushing Strength

Cold: 176 PSI
(.1237 kg/mm²)
At 2000° F (1093° C):
150 PSI (.1055 kg/mm²)



Modulus of Rupture

Cold: 55 PSI
(.03867 kg/mm²)
At 2000° F (1093° C):
90 PSI (.0633 kg/mm²)



Linear Shrinkage

at 2000° F
(1093° C): 2.8%



Chemical Analysis

IV-20 is made from diatomaceous silica with hydraulic binder.

SiO_2	79.0%	MgO	3.8%
Al_2O_3	3.9%	Fe_2O_3	1.3%
Ca O	6.8%	Ignition loss	5.1%

Area of Application:



End or Side Walls

IV-20 is primarily a side wall and end wall insulating material. Whether it's used as a hot face or a backup depends upon customer requirements and the IV-20's 2000° F (1093° C) service range. The wide range of uses includes such diverse applications as, soaking pits, reheat and pusher furnaces, copper reverbatory furnaces, petroleum reactor vessels and oil fired water tube boilers.

Method of Application:



Block Construction

Install using standard procedures for block construction.

Shipping:



Carton

IV-20 is available in standard block thicknesses of 1" to 6" in ½" increments with the other dimensions measuring 6" x 18", 6" x 36", 12" x 18" and 12" x 36". Special sizes available on request.

APC 003921

Johns-Manville Refractory Products

Superex™ Block Insulation

Type: Block
Temp. Limit: 2000°F

Description

Superex block insulation products are manufactured from carefully selected combinations of silica, lime, clays, and fibers for reinforcement purposes. These products are characterized by high strength, both cold and at elevated temperatures, and high refractoriness. They can be used right up to their temperature use limits — and in some conditions even beyond — should upset conditions occur. They uniquely combine low thermal conductivity and high stability at elevated temperatures to provide efficiency of construction and thermal performance, and long maintenance-free service. Superex Block products contain no asbestos fibers and are not soluble in water. Repeated wettings have no effect on this insulation.

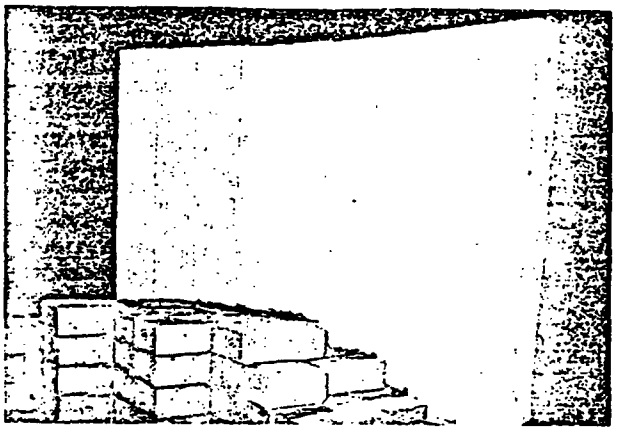
Superex products are not recommended as a furnace lining material exposed to combustion conditions unless a great deal of past experience shows the product to be satisfactory in a particular application.

Typical Applications

Superex block is designed as a backup insulation for all refractory constructions; i.e., insulating firebrick, dense fireclay brick, castables, plastic refractories and also ceramic fiber felts and blankets. All Superex block performs well at high temperatures and efficient designing of a refractory system with Superex as the backup insulation will reduce the amount of hot face refractories required.

The most thermally efficient and cost effective system is obtained when the lowest thermal conductivity materials are placed in the hottest possible location. The excellent heat resistance of Superex block allows this. The most thermally efficient systems utilize Superex 1600 as backup to Superex 2000.

Superex block is good insurance, too. Any refractory construction can be expected to crack in service and allow full furnace temperatures into the back-up insulation. Its high refractoriness will help to prevent catastrophic failure of important equipment and allow operation until a more convenient rebuild or repair time is reached.



Uses

Ovens	Reheat Furnaces
Soaking Pits	Annealing Furnaces
High Temperature Mains and Flues	Heat Treating Furnaces
	Combustion Air Piping
Industrial Boilers	Bustle Pipes
Marine Boilers	Blast Furnace Stoves
Regenerators	Glass Lehrs
Kilns	Car Tops
Roasters	Forge Furnaces
Reverberatory Furnaces	Laboratory Furnaces
	Cooking Equipment

Advantages

Exceptional Heat Resistance. Superex Block can be used to its full temperature use limit. Its high refractoriness also offers some insurance against immediate failure should these temperatures be exceeded.

Excellent Strength. Easy to install; resists damage both in installation and in operation.

Lightweight. Reduces structural steel requirements; ideal for insulating movable equipment.

Special Shapes. Good strength properties make Superex block ideal for cutting and grinding special shapes. J-M can supply these to your specific requirements.

Sect. 140 Part 10
Date: 4-78 Cancels: 10-77

APC 003922

Specification Data

Available Forms

Superex 2000 — A high-density, low-calcium oxide content block, designed for low shrinkage and top performance at temperatures up to 2000°F.

Superex 1600 — Has a higher calcium oxide content and lower density than Superex 2000. This formulation gives better strength and insulating properties for use in situations where temperature will not exceed 1600°F.

Superex 2000 SG — Composite insulation block made up of Superex and a layer of spun-attenuated glass fiber, bonded together at the factory. The fiber glass layer, consisting of 1000 Series Spin Glas[4], increase the insulation effectiveness of the Superex block and also serves as a mechanical "cushion" between the block and the steel shell of a furnace

Properties

		Superex 2000	Superex 1600
Normal Service Temperature, °F, (oxidizing atmosphere)		2000	16000
Marking		None	Green strip on end
Density, lbs/cu ft		24	14
Modulus of Rupture, lbs/sq in		45	65
Compressive Strength lbs/sq in to produce 5% deformation (2" thickness)		130	165
Linear shrinkage, % after 24 hours soaking heat		2.7 @ 2000°F	1.4 @ 1600°F
Chemical composition, %			
Silica,	SiO_2	74.8	49.6
Alumina,	Al_2O_3	4.3	1.2
Calcium Oxide	CaO	6.0	37.6
Ferric Oxide,	Fe_2O_3	2.0	0.3
Titania,	TiO_2	0.3	Trace
Magnesia,	MgO	0.8	0.2
Alkalies, as	Na_2O & K_2O	2.7	0.0
Sulphur Trioxide,	So_3	0.0	Trace
Others		—	0.2
Loss on Ignition		9.1	10.9

Superex Block Insulation

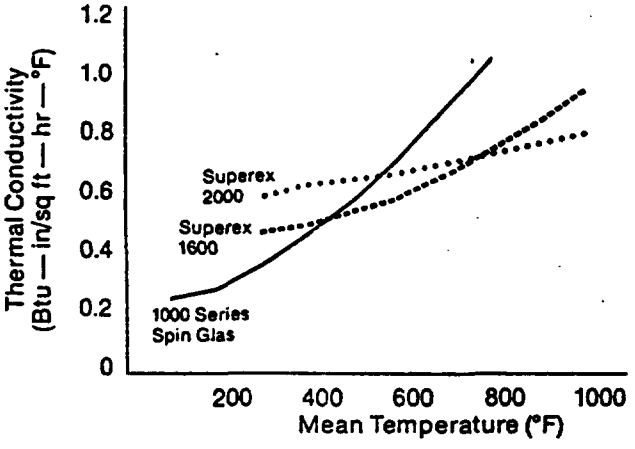
Compressive Data on Superex 2000 SG
(2¼" Superex 2000 plus ¾" 1000 Series Spin-Glas)

Compressive Strength of 3" Superex 2000 SG

Compressed Thickness (in.)	As Received	Load to Compress, psi Hot Face of Superex (24-hr test) 1600°F	1800°F	1900°F
3.00	0	0	0	0
2.90	1.4	0.6	0.4	0.4
2.75	3.5	2.4	1.5	1.6
2.50	22.6	21.1	12.5	13.5
2.25	66.0	29.0	70.0	73.0

Recovery of 3" Superex 2000 SG After Compression

Compressed Thickness	Thickness of Superex 2000 SG after release (Percent of original thickness)		Hot Face of Superex (24 hour test)		
Inch	%	As Received	1600°F	1800°F	1900°F
2.90	97	99	99	99	99
2.75	92	99	97	97	97
2.50	83	95	93	93	93



Standard Sizes
All dimensions in inches

Thicknesses in ½ inch increments	Superex 2000 1 to 5	Superex 1600 1 to 4
	Superex 2000 SG 1½ to 6	
Widths and Lengths	12 x 36	18 x 36
	6 x 36	12 x 36
	12 x 18	6 x 36
		18 x 18

Beveled blocks are tapered to specific requirements. Outside diameter of circle is to be specified on order.

Johns-Manville
Ken-Caryl Ranch
Denver, Colorado 80217

For information on other J-M Thermal Insulations and Systems, write the Johns-Manville Insulation Center, Drawer 17L, Denver, Colorado 80217 or call (303) 979-1000.

The physical properties of Johns-Manville Superex block insulation represent typical, average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. Check the Johns-Manville district office to assure current information.

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APC 003923

Litho in USA

SKAMOLEX PM-10

Asbestosfree Calcium Silicate Slab Insulation

PHYSICAL AND THERMAL PROPERTIES

Bulk density (dry)	250 kg/m³
Porosity	89%
Cold crushing strength	2.0 MN/m² (20 kp/cm²)
Compressive strength at 5% deformation	1.7 MN/m² (17 kp/cm²)
Modulus of rupture	0.6 MN/m² (6 kp/cm²)
Recommended service temperature (back-up)	1000°C
Linear reheat shrinkage DIN 51066 BL.2 (12 h 950°C)	<1.5%
Specific heat	0.75 kJ/kg K (0.18 kcal./kg°C)

Thermal conductivity at mean temp.

	W/m K	Kcal./m.h.°C
10°C	0.054	0.046
200°C	0.065	0.056
400°C	0.087	0.075
600°C	0.109	0.094
800°C	0.132	0.114

Pyrometric cone equivalent	1400°C
Thermal expansion coefficient 20-730°C	0.74×10⁻⁶/K

The above properties represent average test values. They are given in good faith but no guarantee is implied.

CHEMICAL ANALYSIS

SiO_2	41 %
CaO	42 %
Fe_2O_3	0.5 %
Al_2O_3	1.2 %
Ignition loss (mainly H_2O and CO_2)	13 %

SHAPES & SIZES

Skamolex PM-10 is available as flat boards of standard size 1000 x 610 mm with thicknesses of 25-30-40-50-60-75-100 mm. Other sizes or shapes, e.g. with bevelled edges, can be supplied to suit specific design requirements.

For agglutination of slabs, or for adhering Skamolex PM-10 to refractory and metallic surfaces, we recommend the use of SKAMOL FL-06 Mortar. This adhesive is supplied as a dry mix in 25 kg bags, ready for use after addition of water. Adhesive thickness should not exceed 5 mm.

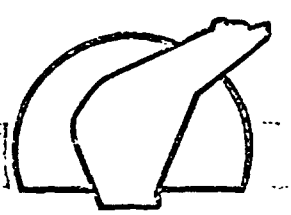
PACKAGING

Skamolex PM-10 in standard size 1000 x 610 mm is offered in shrink film wrapped packs holding between 1.83 and 6.10 m² of board depending on thickness. Packs are palletised for shipment on non-returnable pallets, secured with nylon strapping. One pallet unit comprises 2.25 m³ shipping volume.

PACKING SPECIFICATION

Thickness mm	Content per pack slabs	Content per pack m²	Content per pallet packs	Content per pallet m²
25	10	6.10	14	85.4
30	10	6.10	12	73.2
40	5	3.05	18	54.9
50	5	3.05	14	42.7
60	5	3.05	12	36.6
75	3	1.83	16	29.3
100	3	1.83	12	22.0

Packing in wooden crates or cases quoted upon request.



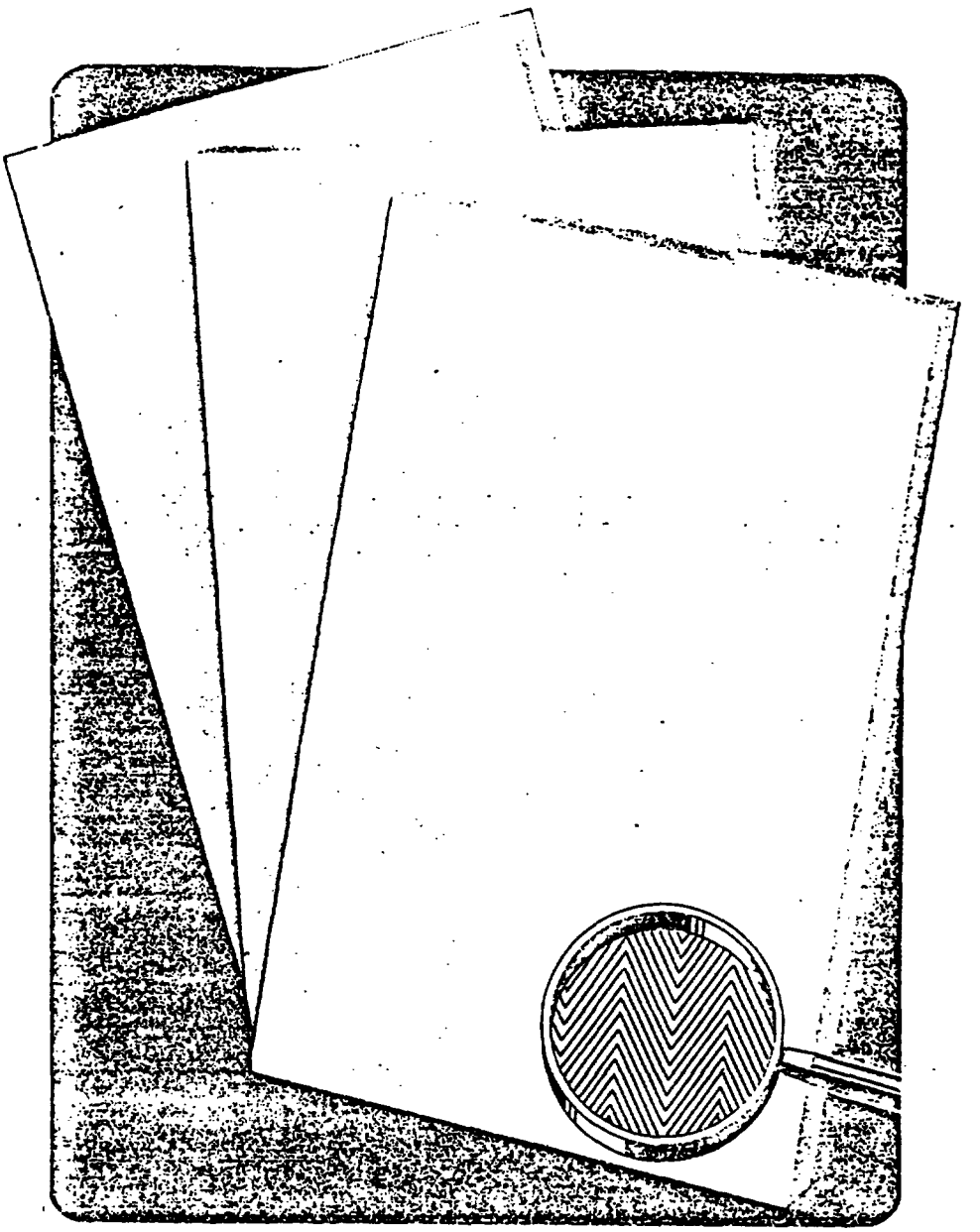
skamol

SKARREHAGE MOLERVÆRK A/S

APC 003924

DK-7900 NYKØBING MORS . DENMARK . TEL. INTERN. 45-7-72 15 33 . TELEX 66680

skamol



SKAMOLEX PM–10

APC 003925

Asbestosfree Calcium Silicate Slab Insulation.

An extremely lightweight calcium silicate slab, fibre reinforced but completely free of any asbestos and crystalline silica. It is designed as a final »back-up« insulation between refractory linings and furnace casing for interface temperatures up to 1000°C. A low density product – 250 kg/m³ – of good strength and low thermal conductivity throughout its temperature range of service. Excellent resistance to carbon monoxide and a number of other gases, and good performance in contact with molten aluminium. The large sized slabs – standard size 1000 x 610 mm – of accurate shape and clean edges speed construction and improve insulation efficiency. The slabs are easy and clean to handle because of a negligible dust emission.

Due to their porous structure the slabs are easily shaped on site by ordinary woodworking tools – fixing can be made with nails or screws. A specially developed adhesive is also available.

FROM HAIG G. SAKOIAN

PITTSBURGH OFFICE - 7

TO MEMORANDUM

URGENT!-URGENT!

1979 July 03

RE: "SUPEREX 2000" POT LINING INSULATION

Johns-Manville Corporation's "Superex 2000" pot lining insulation has been found to contain relatively high concentrations of free silica and cristobalite. The allowable TLV for exposure by inhalation to this material is greatly reduced because the calculation of the TLV is based on the amount of free silica or cristobalite, i.e.,
TLV = $\frac{10\ mg/M^3}{\%\ Free\ Silica\ +2}$ for respirable dust -- or $\frac{30\ mg/M^3}{\%\ Free\ Silica\ +3}$
for total dust.

Sampling performed at several locations which use "Superex 2000" for pot lining indicate possible silica exposures above recommended limits even when employees are working with the material for only brief periods.

Mr. D. D. McGregor, Pittsburgh Office, has alerted all smelting Production Managers of this problem and recommended they minimize cutting and handling of this material. If it has not been done so already, it is recommended that sampling be performed for respirable dust, with analyses for percent of quartz and cristobalite, to assess employee exposures.

In the interim, based on sampling results from several locations, it is recommended that respiratory protection be afforded employees working with this material. Any respirator approved for pneumoconiosis and fibrosis-producing dusts would be acceptable. These include the 3M-8710; AO R2090 MSA Comfo II with Type F filters; and others.

If air sampling indicates airborne concentrations in excess of the protection factors afforded by these respirators (5 times the TLV for quarter-mask; 10 times the TLV for the half-mask), then more adequate respiratory protection... or better control... must be implemented.

Conversely, if sampling indicates no problem at your location, the requirement for respirators may be lifted. If control measures are implemented, follow-up sampling should be performed to test their effectiveness.

It is understood that some locations are already working towards a solution to this problem. Any information gained through such efforts which may be useful to other locations would be appreciated.

HAIG G. SAKOIAN

HGS/eds
Distribution: See Page 2

APC 003926

ALCOA

SF-4563

Distribution:
E. M. Morgan - Badin Works
L. A. Hartley - Badin Works
G. D. Hicks - Massena Operations
B. M. Triko - Massena Operations
A. G. Clayton - Rockdale Works
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J. R. Haaland - Warrick Operations
M. R. Borjas - Veracruz, Mexico
J. L. Fox - Veracruz, Mexico
E. E. Rumberger/T. B. Bonney - Pittsburgh 7
D. D. McGregor - Pittsburgh 23
G. T. Holmes/J. A. Lang/R. J. Hosfeld - Pittsburgh 23
R. S. Danchik/D. R. Balya - ATC
M. J. Caprio - Pittsburgh 19

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