

IN-465

Final Draft, as filed on 10/7/71

DA'Ding draft dated 7/14/70

CALCIUM SILICATE THERMAL INSULATION REINFORCED WITH
CELLULOSIC FIBERS

Note

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to hydrous calcium silicate insulation for high temperature use. The insulation of this invention is free from asbestos or other inorganic fibers such as glass.

2. Discussion of Prior Art

The preparation and use of calcium silicate thermal insulation materials is well-known and described in detail in a number of prior art patents such as U.S. 2,699,097, 2,716,070 and 3,501,334. The process involves the reaction of lime and siliceous material and the use of reinforcing fibers to minimize cracking and fracture during manufacture, shipping and use. For the preparation of insulation suitable for high temperature the prior art describes inorganic fibers, such as asbestos and glass fibers which become air-borne during fabrication, installation and use of the insulation. U.S. 3,472,668 describes a similar calcium silicate product except that the reinforcing means consist of inorganic glass fibers coated with various resins.

Such insulation is produced commercially today in large quantities and used for thermal insulation of pipes, tanks, boilers and the like. The commercially available product generally contains 8-15% asbestos fiber and has a density of about 12-15 lbs. per cubic ft. The asbestos fiber is generally amosite, however chrysotile can be used alone, or in combination.

Although these prior art products have served well as insulation materials, unfortunately in recent years much concern has developed on the part of medical researchers over the part that inorganic fibers, such as asbestos and glass, may play in the development of lung cancer and asbestosis. As a result of developing concern over inorganic fibers as a potential health hazard, legislation has been introduced in a number of

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which seek to limit the use of materials containing inorganic fibers in certain applications. It is an object of this invention to provide a new class of high temperature insulating materials which eliminate the health hazards created by the use of inorganic fibers.

SUMMARY OF THE INVENTION

In accordance with this invention there is provided a calcium silicate insulation for high temperature use, where the surface temperatures of the insulation are maintained at about 100-200°F, wherein all the inorganic fibers such as asbestos and glass are replaced by cellulosic fibers as defined more fully hereinafter. The product of this invention therefore eliminates all questions regarding health hazards due to inorganic fibers since the resulting product is completely free of such fibers. Also the use of cellulosic fiber in place of inorganic fibers as reinforcing media reduces the wear on processing equipment as well as cutting and fabricating tools employed by applicators.

It is believed that this is the first time that such cellulosic reinforcing materials have been used in a high temperature calcium silicate insulating material. By high temperature, as used in this invention, is meant insulating products suitable for uses wherein the surface temperatures range from about 350° up to 1250°F and therefore are designed to meet the upper limit.

DETAILED DESCRIPTION OF THE INVENTION

The novel calcium silicate insulating materials of this invention are prepared by mixing lime, silica and the cellulosic fibers in an aqueous medium to provide an aqueous lime-silica slurry which reacts to form a gel. Filter pressing, removes excess water and forces the material into its desired shape. This wet product is then autoclaved to produce a desired crystalline end product suitable for use in high temperature insulating applications upon drying.

The reaction of silica and lime to form a hydrated calcium silicate is well-known and therefore the general reaction conditions and

reactant concentrations described in the prior art can be utilized. See for example U.S. 2,716,070 and/or U.S. 2,699,097. The preparation of the novel high temperature insulation of this invention requires certain reaction conditions and proportions to obtain optimum results in preparing an end product suitable for high temperature insulating application. These reaction conditions and proportions constitute preferred embodiments of the subject invention.

Therefore, although the molar ratio of lime to silica can generally fall within a range of from about 1.0:1.0 to about 1.0:1.5, it has been found desirable in carrying out the preparation of thermal insulating materials utilizing the novel cellulosic reinforcing fibers of this invention to employ a molar ratio of lime to silica of about 1.0:1.25.

The amount of water employed in preparing the lime-silica slurry has been found to fall within a water to solids ratio of about 10:1 to about 20:1. Optimum results have been obtained with a water to solids ratio of about 18:1.

In subjecting the lime-silica fiber slurries of this invention to a predetermined insulating temperature and pressure to achieve complete reaction to the desired crystalline hydrous calcium silicate end product, it is preferred that the autoclave pressures range from about 125 psig to about 175 psig and that pressure of about 150 psig be employed.

The following examples more fully demonstrate the subject invention. In these examples all parts and percentages shown are by weight.

EXAMPLE 1

An aqueous mixture of 177 parts bleached sulfate wood pulp (Mayofate J" cellulosic pulp) and 1049 parts diatomaceous earth (Greco Dicalite 677-1*) is prepared. This mixture, preheated to about 200°F, and an aqueous mixture containing 699 parts of calcium hydroxide at a temperature of about 150°F is added to a blending tank containing sufficient water, preheated to about 200°F, to result in a water to solids ratio of about 18:1 upon completion of said addition. The

resulting slurry is maintained at a temperature of about 190-200°F for about one hour under continuous slow agitation at about 4 RPM. Upon completion of this cycle, gelation has occurred. The gelled slurry is then dewatered by use of a filter press to provide 12x36x1½ block and 3x1 pipe covering molded. These shaped pieces are then indurated in a high pressure steam autoclave at 150 psig for about five hours. Thereafter the autoclaved products are dried in a forced-draft hot air dryer, after which the products are trimmed and ready for packaging.

* "Rayofate J" is a chemical wood pulp prepared by digestion of wood using the sulfate pulping process.

** Mined and refined by the General Refractories Co. (Grafco).

EXAMPLE 2

The procedure of Example 1 is repeated in every respect with the exception that 177 parts of amosite asbestos (M grade) are utilized in place of the bleached sulfate cellulosic pulp of Example 1.

The following table demonstrates the results obtained with the two formulations and the relationship of each to current Federal Specifications MH-1-523 (relating to the physical and strength characteristics limits for high temperature insulation materials).

Table I (12" x 1 1/2" x 36" Block)

	Example I	Example II	MH-1-523
Density - lbs./ft. ³	12.7	12.9	13 max.
Modulus - lbs./in. ²	168	140	35 min.
Impact - ft.lbs.	17	14	---
Compressive - (5% deformation) lbs./in. ²	238	186	---
1250°F. Soaking Heat			
Linear Shrinkage %	1.3	1.5	2.0
Weight Loss %	16.1	9.5	12.0
K-Factor @ 500°F mean	0.54	0.50	0.60

It can be seen from Table I that the test material (Example I)

comparative favorably with the standard commercial product. The test material meets the requirements of EH-1-523 in all respects except for loss in weight after soaking heat at 1250°F, which is to be expected since the organic cellulosic fiber has less temperature resistance than asbestos fiber. This high loss in weight is not deemed significant considering the good K-factor values obtained. The important shrinkage characteristic is not affected by the use of cellulosic fiber. It is also obvious from examination of the modulus, compressive and impact data that the test material has excellent, and more than adequate, strength characteristics for shipping and installation requirements, based on extensive field experience with the standard product.

In order to evaluate in-service performance, a comparison of properties was made after soaking heat conditioning in a furnace at 500, 750, 1000 and 1250°F for six hours. This data is presented in Table II.

Table II

		<u>Example I</u>	<u>Example II</u>
	<u>500°F.</u>		
	Modulus - lbs./in. ²	2	72
20	5% Compressive - lbs./in. ²	229	238
	<u>750°F.</u>		
	Modulus	3	45
	Compressive	218	190
	<u>1000°F.</u>		
25	Modulus	5	46
	Compressive	202	236
	<u>1250°F.</u>		
	Modulus	6	28
	Compressive	200	194

The results indicate a substantial drop-off in modulus, but the compressive strength at 5% deformation is essentially unchanged, and equal,

throughout the temperature usage range. The insulation products of this invention in all cases have a compressive strength at 5% deformation of at least 175 psi after soaking heat conditioning at 1250°F for six hours.

Based on industry experience, strength requirements, as measured by modulus, are much greater during shipping and installation than after installation. In any event, it is common practice to apply enough thickness of insulation to provide an outer insulation surface temperature not exceeding 150°F, so that heat loss is minimized and personnel are protected from severe burns. This practice will always result in the outer portion of the insulation maintaining its initial strength characteristics since it is subjected to temperatures of 350-375°F during the autoclaving and drying operations in manufacture.

To further establish performance, 12" x 2 1/2" pipe covering made with cellulosic fiber in accordance with Example 1 was applied to a section of 12" pipe operating at a temperature of 615°F in a power house. Periodic inspection of this installation indicates satisfactory performance. Surface temperature of the insulation is approximately 125°F. Similar results have been obtained with pipes operating at 1000°F and 1200°F.

In preparing the novel reinforced cellulosic fiber insulating materials of this invention, it has been found that cellulosic fibers which are free from impurities that interfere with the gelation reaction of the lime and silica must be employed. It is preferred that the cellulosic fibers have been refined to result in substantial freedom from lignins, wood sugars and other impurities that interfere with the formation of hydrous calcium silicate. Examples of these cellulosic materials are chemical wood pulps such as bleached or unbleached sulfate or sulfite pulps.

It is preferred that the cellulosic fibrous materials be present in an amount ranging from about 5 to 30% of the total weight of the solids content. Optimum results have been obtained in the area of about 10-15% cellulosic content, which results in an end product having a density (pcf) of about 12.5 and a compressive strength of about 230 (psi) at 5% deformation.

CLAIMS:

1. A thermal insulation suitable for use at temperatures up to 1250°F comprising a body element essentially consisting of the reaction products of calcium hydroxide and siliceous material together with reinforcing cellulose fibers, the cellulosic fiber content of said
5 body being from about 5% to about 30% by weight of the total weight thereof.
2. The composition of claim 1 wherein said fiber content is 10% to 15% and the compressive strength at 5% deformation of said element is at
10 least 175 psi after soaking heat conditioning at 1250°F for six hours.
3. The composition of claim 2 wherein said siliceous material is diatomaceous earth with an SiO₂ content of at least 84%.
4. The product of claim 3 having a temperature resistance such that a
15 thickness of insulation 2 1/2 inches thick applied to a surface heated to approximately 615°F results in a surface temperature not exceeding 150°F with no appreciable cracking of the outer surface of said insulation.