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METHOD FOR PREHEATING CEMENTITIOUS INSULATING MATERIAL
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Fig. 1

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This invention relates to the preparation of cementitious insulating material which is preheated before it is prepared in a mold, and more particularly to an apparatus and method for preheating cementitious insulating material in a container which is self-cleaning.

Relatively light weight porous cementitious insulating materials are well known. For example, light weight so-called magnesia insulation with fibrous reinforcing agents have been extensively employed as insulating materials. Another type insulating material particularly adapted for high temperature insulation, but still relatively light weight, compared to Portland cement, may be formed from lime and silicious material reactive with the lime. Such calcarcous-silicious materials also generally contain reinforcing fibers, and may contain argillaceous materials such as bentonite or clay.

It is well known that slurries of these light-weight cementitious insulating materials are advantageously preheated before the slurries are cast in a mold. When preheated slurries are introduced into the mold, such slurries will set in a relatively short time to a firm self-supporting mass with substantially no shrinkage, and the preset mass can be removed from the mold without employing a supporting form. Such procedure is disclosed in Patent No. 2,432,981, among others.

In order to obtain all of the advantages of preheating and provide a product that is uniform throughout, the slurry should be heated evenly and rapidly. Also, partially thickened material remaining in the reaction vessel from prior batches should not be in contact with the slurry during preheating since local seeding of the slurry by such thickened material tends to produce a non-uniform product. Furthermore, if the prior batch was composed of a different type of insulating material, it may contaminate a subsequent batch of a different insulating product.

Previously, in commercial practice the preheating had been conducted in metallic vessels that were rotated about an axis during preheating. However, the cementitious material tends to adhere to the metal and it contaminates or seeds subsequent batches. Furthermore, if the entire mass of the slurry is vigorously agitated by a rotary or oscillatory movement of the vessel, there is a tendency to break up any bonding growth which incipiently forms in the slurry with resultant impairment of the cohesive strength and insulating properties of the final product. Also, metal containers are good conductors of heat and thus tend to produce non-uniform heating of the slurry. Another problem encountered with apparatus previously employed for preheating is the heat loss from the preheated slurry during transfer of slurry from the preheater to the mold.

In accordance with this invention and as a brief summary thereof, an aqueous slurry of a lightweight porous cementitious insulating material, such as magnesia or lime bonded insulation, is preheated substantially to the point of incipient thickening in a resiliently supported container, preferably composed of rubber or similar flexible material, before the insulating material is introduced into the mold. The preheating container is resiliently supported adjacent its top portion, and steam introduced directly into the slurry causes the container to vibrate gently while the mass of the slurry remains relatively stationary. Also, a preheating container, such as rubber, is utilized that has an inner wall that serves as a release surface to which the cementitious material does not tend to adhere. The container is provided with an opening in its lower portion that is closed or opened by a freely suspended clamping valve so that the preheated slurry can be permitted to flow directly from the preheater to the mold by opening the valve.

This arrangement produces a uniform product since the gentle vibration of the resiliently mounted preheating container and the release nature of the container prevent thickened material from becoming attached to the preheating container. Consequently, contamination and local seeding due to the presence of material from previous batches is avoided. In addition the use of steam introduced directly into the slurry provides uniform heating, and shortens the time required for preheating. Unlike the prior rotating containers which were only partially filled in order to avoid loss of slurry during rotation, the resiliently mounted container maintains the mass of slurry in a relatively stationary position and thus it can be almost completely filled without loss of slurry. Consequently, the preheating container hereof has a larger capacity for its size even when it is about the same dimensions as previous preheaters.

Also, a rubber preheating container is a poor conductor of heat and prevents any of the heat lost that occurs with a metallic container. As a result of eliminating the seedling problem and providing uniform heating of the slurry, the time required to reach the desired point of preheating is relatively constant for a given composition and volume of slurry, and relatively uniform results are obtained with the same degree of preheating. An important reduction in heat loss is obtained by the quick transfer of slurry directly from the bottom of the-container into the mold by gravity flow. The clamping valve adjacent the bottom of the container is readily opened to permit flow of slurry into the mold, and the valve is freely suspended so that it does not interfere with the vibration of the preheater during introduction of steam.

In the drawings, with reference to which this invention is described in greater detail, Fig. 1 is a more or less schematic view of an apparatus system employed for preparing lightweight cementitious insulating material.

Fig. 2 is an enlarged vertical section through the line 2—2 in Fig. 1 illustrating the resiliently mounted preheater.

Fig. 3 is an enlarged fragmentary vertical section taken through the line 3—3 in Fig. 2 showing the nozzle employed for introducing steam into the preheating container.

Fig. 4 is a horizontal section through the line 4—4 in Fig. 2 illustrating the valve for the preheating container.

With the reference to Fig. 1, the materials employed for making the porous lightweight cementitious insulation are placed in vessels 2 and 3. Any required number of vessels may be utilized, or non-reactive components of the reaction mixture may be premixed and placed in vessels 2 and 3. For example, in the preparation of calcarcous-silicious insulating material, a premix of diaminoencarose earth, lime and water, is advantageously placed in vessel 2, and a premix of asbestos fibers, caustic and water deposited in vessel 3.

The contents of the vessels 2 and 3 are intermixed by opening valves 4 and 6 respectively adjacent the bottom portions of the vessels to enable the reactants to flow
through conduits 7 and 8 into mixer 9, which may be of any conventional design. During the mixing operation, no heat is applied to the reactants, and thus substantially no reaction takes place.

After the products have been intimately mixed to form an unslurred slurry, the resultant slurry is deposited in a travelling scale 11, which in turn deposits the desired amount of slurry into preheating container 12. The preheating container is resiliently mounted, as described hereafter in greater detail, so that it will be gently agitated when steam is introduced into the container through steam line 13. As previously mentioned the preheater is most advantageously composed of rubber or similar flexible material, and it is clamped adjacent its upper portion by means of clamps 14 to a supporting frame structure 16.

The supporting structure 16 is most conveniently of the same shape and somewhat larger than the adjacent portion of the preheating container, and it is secured to a base 17. The lower portion 18 of the preheating container 12 desirably in the form of a cone extension, depends freely from the clamped upper portion of the preheating container 12.

Steam is introduced into the slurry within the preheating container 12 until the temperature is raised to a predetermined desired level, and then thermo-couple 19 actuates a switch, not shown, which automatically shuts off the steam. Valve 21 is then opened either by a timed clock arrangement or by manual actuation, to allow the preheated slurry to flow through residual conduit 22 into hopper 23, which previously has been positioned over the mold cavities 24 that lie within mold 26. This direct gravity flow results in a substantial reduction of heat loss compared to previous systems, since the slurry need not be transferred into other containers or poured into the conduit leading to the mold. As a result, the temperature of the slurry remains relatively constant during the transfer and a more uniform product is obtained. Furthermore, when the slurry reaches the mold at substantially preheating temperature, less time is required for the slurry to set in the mold than when the slurry temperature has become substantially reduced.

The preheated slurry flows into the mold cavities 24 when pistons 27, shaped to conform to the dimensions of the mold cavity, are lowered within the cavities. Reciprocating fingers 28 follow the descending pistons 27 with a limited but rapid back-and-forth movement, orienting the fibers and crystals within the slurry to provide a much stronger final product. Shortly after the mold is completely filled with slurry the fingers 28 are moved out of the mold and the slurry is permitted to preset to a self-sustaining mass. Hot water inlet pipes 29 and water outlet pipes 31 provide means of heating the molds so that the slurry will set within a relatively brief period.

After the slurry has been preset within the mold, the self-sustaining mass of insulating material is ejected from the mold by upward movement of pistons 27, and then further handled in accordance with conventional practice.

As illustrated in Fig. 2, the preheating container 12 is resiliently supported adjacent its upper portion by means of clamps 14 which are formed in the same shape as the upper portion of the preheating container 12. The clamps 14 are secured to rigid supporting frame structure 16, which is advantageously made of metal, by means of bolts 32 so that the upper portion of the rubber preheating container 12 is securely but resiliently clamped while the remainder of the preheater hangs freely from the clamps, or in other words has a floating support. Bolts 33 secure supporting structure 16 to a base or floor 17. Steam is introduced into slurry 34 through pipe 13 and distributed uniformly throughout the slurry 34 by means of a conically shaped nozzle 36, which is disposed in the lower portion of preheating container 12. As a result, the resiliently supported preheater construction embodies a release coating to which the cementitious material does not adhere, and provides an enclosed zone that is vibrated gently when steam is introduced directly into the slurry of cementitious material. Consequently, the final product is uniform because local seeding is minimized and the slurry is evenly heated.

Nozzle 36 is best illustrated in Fig. 3. Disposed within the nozzle is cone 37 secured to the inner side of the nozzle 36 by supporting fins 38. The inner cone 37 causes an increased velocity of the steam flow and therefore increases the velocity of the slurry 34, and the angle at its apex is more acute than the angle formed by continuing the outer portion of the nozzle 36. Accordingly, steam exit chamber 39 is larger adjacent the end of the nozzle 36 than at the point at which the steam enters the nozzle. By this arrangement the steam tends to dislodge any reactant that might accidentally become preset and harden within steam exit chamber 39.

After the slurry 34 has reached the desired temperature, thermo-couple 19 automatically shuts off the steam entering preheating container 12 through steam pipe 13. In the meantime, hopper 23 is raised to a position above the mold 26, and valve 21 is opened to cause the slurry to run through conduit 22 into the hopper and thence into the mold cavity 24.

The construction of valve 21 is extremely advantageous, since it obviates a plugging when the slurry is discharged from the preheating container 12, and it is best shown in Figs. 2 and 4. The entire valve structure is freely suspended on wires 41 so that it will permit unrestricted vibration of the preheating container 12 during introduction of steam into the slurry 34. Valve 21 is closed during preheating of the mold, and the slurry 34 in preheating container 12. The closed position of valve 21 occurs when piston actuated clamping rod 42 is urged by any conventional means, not shown, against stationary clamping member 43. In the closed position of valve 21, the resilient conduit 22, which is desirably of rubber or of a suitable fabric such as commonly employed for hoses, is clamped between clamping rod 42 and the clamping member 43 thereby preventing passage of the slurry through the conduit. Stationary guides 44 provide a track along which clamping rod 42 slides for opening or closing valve 21. The slurry 34 is transferred from the preheater 12 merely by withdrawing clamping rod 42 by any conventional means so that the slurry can pass along the flexible conduit 22 into hopper 23. This construction renders the valve 21 virtually self-cleaning.

Any of the lightweight cementitious porous heat insulating materials that are set in a mold by the use of heat may advantageously be preheated by the apparatus and method hereof. For example, magnesia insulation made from calcined self-set normal magnesium carbonate trihydrate crystals according to the procedure disclosed in assignee's Patent No. 2,209,754, dated July 30, 1940 is advantageously preheated in a resiliently supported container, such as the rubber container 12. In the preparation of such insulating material, a precipitate of normal magnesium carbonate is prepared in the form of needle-like crystals having self-setting properties by the action of carbon dioxide gas on a solution of magnesium hydroxide, a slurry containing such precipitate is treated with alkali to neutralize any magnesium carbonate that may be present and to consume carbon dioxide which is evolved in the setting, fibers are mixed in the slurry, the mass is preheated to the desired point, then set in a mold and finally heated. The resultant insulating material has an average weight between about 10 and 12 pounds per cubic foot, and it contains about 85% by weight basic magnesium carbonate and 15% by weight of a fiber, such as asbestos fiber.

Another type of lightweight porous cementitious heat
insulating material adapted to withstand higher temperatures than the above described magnesium insulation can be formed by a well known method from an aqueous slurry containing siliceous material, and lime as the bonding agent. Such materials may be prepared in accordance with assignee's Patent No. 2,432,981, dated December 23, 1947. A slurry of diatomaceous earth, quicklime, reinforcing fiber, colloidal earth, and accelerator such as sodium hydroxide are preheated substantially to the point of incipient reaction, preset in a mold, and finally set in an indurator. The product usually varies in weight from about 12 to 17 pounds per cubic foot.

The following are specific examples of the preparation of porous lightweight cementitious insulating material in accordance with this invention.

Example I

Fine needle-like self-setting crystals of normal magnesium carbonate trihydrate are prepared by passing flue gas containing 10% by volume carbon dioxide into an aqueous suspension of about 800 pounds of Mg(OH)₂ in 2500 gallons of water. Approximately 5 hours are required for complete conversion of the Mg(OH)₂ into normal magnesium carbonate trihydrate.

Next 185 pounds of chrysolite fiber averaging ½ inch in filament length is thoroughly mixed into the slurry by any suitable mixing means. Then the slurry is filtered in any conventional filter, and the cake washed with fresh water.

In order to produce a final product having a density of about 11 pounds per cubic foot, the filter cake is diluted and mixed with about 310 gallons of water. A more dense product can be made by adding less water, or a lighter product may be prepared by adding more water.

The diluted slurry is then preheated with live steam in the rubber preheating container 12 illustrated in the drawings. During introduction of steam, the rubber container 12 is vibrated. When the temperature of the slurry reaches about 150° F., the slurry has reached the desired point at which thickening is about to occur. Thermo-couple 19 then automatically actuates a switch that shuts off the steam, and valve 21 is opened to cause the slurry to flow into hopper 23 and thence into mold cavity 24. Substantially all of the slurry flows out of container 12 without adhering to the sides of the container.

While the preheated slurry is in the mold, it is heated with hot water until it has set to a firm self-supporting mass. About 9 minutes at a mold temperature of about 190° F. is sufficient to preset the product. Finally the solid product is dried to constant weight at a temperature of about 400° F., although any elevated temperature may be employed. The resultant porous cementitious insulating material is strong and uniform, and it weighs about 11 pounds per cubic foot.

Example II

A slurry is formed by mixing the following ingredients:

- Calcium oxide: 300 lbs.
- Diatomaceous earth: 400 lbs.
- Asbestos fiber: 150 lbs.
- Sodium hydroxide (accelerator): 53 lbs.
- Water: 400 gallons

The dry ingredients, except the sodium hydroxide, are first intimately dry mixed; while the sodium hydroxide is dissolved in the water to which the other dry ingredients are added. The resultant slurry is preheated in the preheating container 12 by introducing steam until the temperature reaches about 200° F. This temperature is obtained in about 120 seconds. During the introduction of steam, the rubber preheater vibrates slightly while the mass of the slurry remains relatively fixed.

After the desired temperature has been reached, the thermo-couple actuates a switch that shuts off the steam. Valve 21 is then opened, and the preheated slurry flows into hopper 23 and thence into mold cavity 24. The slurry is then preset in the mold at about 200° F. until it forms a firm self-supporting mass. Finally, the preset product is ejected from the mold and then cured in an autoclave under about one hundred and twenty-five pounds steam pressure. The resultant product has a density of about 14 pounds per cubic foot, and it is strong and uniform throughout.

From the preceding it can be seen that the preheating container is virtually self-cleaning. This feature is of great value in a plant that makes a variety of different types of insulating material, since the same apparatus may be utilized for successively preheating the different slurries. Consequently, one apparatus system of the present invention can replace several preheating containers of the type that accumulate thickened material on their sides, and this results in substantial saving in equipment costs and plant space.

We claim:

1. In the preparation of a lightweight mass of porous cementitious heat insulating material wherein an aqueous slurry of said material is preheated and then preset in a mold until it forms a firm self-supporting mass, the method of preheating such slurry which comprises providing a resilient container with an opening in its upper portion, introducing the slurry into said container through said opening, resiliently supporting said container while maintaining the mass of the slurry in a relatively stationary position, introducing steam into said slurry to effect preheating of the slurry and simultaneously vibrate said resiliently supported container, and removing the preheated slurry from said container.

2. In the preparation of a lightweight mass of porous cementitious heat insulating material wherein an aqueous slurry of said material is preheated and then preset in a mold until it forms a firm self-supporting mass, the method of preheating such slurry which comprises providing a resilient container with an opening in its upper portion, introducing the slurry into said container through said opening, resiliently supporting said container while maintaining the mass of the slurry in a relatively stationary position, introducing steam into said slurry to effect preheating of the slurry and simultaneously vibrate said resiliently supported container, and transferring the preheated slurry from said resilient container to said mold by gravity flow through a resilient self-cleaning conduit.

3. In the preparation of a lightweight mass of porous cementitious heat insulating material wherein an aqueous slurry of said material is preheated and then preset in a mold until it forms a firm self-supporting mass, the method of preheating such slurry which comprises providing a resilient container, introducing the slurry into said container, resiliently supporting said container while maintaining the mass of the slurry in a relatively stationary position, introducing steam into said slurry to effect preheating of the slurry and simultaneously vibrate said resiliently supported container, and removing the preheated slurry from said container.

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