

Insulation Material

Technical Field

The invention relates to insulation material particularly suitable for insulating molten metals in ladles and tundishes.

Background Art

5 Rice hull ash has been used widely in steel mills as an insulating cover on tundishes and ladles containing molten steel. The rice hull ash is a good insulator because it is inexpensive, it flows over and covers the steel surface well and does not crust or cause metals sculls during use. Rice hull ash is
10 produced in various combustion processes around the world. The most desirable rice hull ash contains silica which is substantially amorphous.

 The major problem with rice hull ash is that, because of its low bulk density and small particle size, some of the ash becomes airborne when it comes in contact with hot metal. The resulting dust can cause eye injuries as
15 well as being a general nuisance in the immediate work place. Silica/carbon dust also causes electrical hazards in overhead crane switchgear and air conditioning filter systems.

 Previous attempts to improve the properties of rice hull ash for molten steel insulation have met with limited success. Attempts have been made to
20 produce agglomerated rice hull ash insulation products in the form of pellets, briquettes or simply agglomerated with a variety of binders. Binders that have been proposed in the past include bentonite clay and starch, starch, cement dust with starch, lime and molasses, rice flour and rice bran, sodium silicate, wood or paper pulp, and lignosulphonates. Examples of several types of rice
25 hull ash insulation materials that have been produced can be found in US 4440575 and US 5073281.

 Unfortunately, a number of problems were exhibited in the prior art products due to the binders used. These problems include lower melting points causing crusting from the use of sodium silicate. The insulation
30 material does not break down during use which inhibits spread and reduces the insulation effectiveness. Some binders cause excessive smoke or even flame during use which is particularly undesirable. Other binders introduce undesirable elements into the steel including elements such as sulphur. Many of the insulating products are of low density which may be ideal for insulation
35 but result in increase in weight over neat rice hull ash causing higher transport costs.

The present inventors have recognised that there is a need for an improved thermal insulating material which addresses many of the disadvantages of the prior art rice hull ash insulation materials.

Disclosure of Invention

5 In a first aspect, the present invention consists in a granular thermal insulating material comprising rice hull ash, ceramic clay binder, bran (preferably rice bran), and an exfoliating agent.

10 The present invention further consists in a granular thermal insulating material comprising rice hull ash, ceramic clay binder, bran (preferably rice bran), and an exfoliating agent, such that when the insulating material is exposed to a temperature of 1000⁰C or more the material exfoliates to form an expanded particulate material.

15 The thermal insulating material is in the form of granules of a size and shape that allows convenient packaging and transport of the material. Furthermore, the granules are so formed such that in use there is little or no airborne dispersion of the material prior to expansion. Preferably the granules are in the form of pellets or disks.

20 The invention further consists in a granular thermal insulating material comprising 70 to 95%, preferably 85 to 95% by dry weight rice hull ash, 2 to 20%, preferably 5 to 15% by dry weight ceramic clay binder, 1 to 10%, preferably 2 to 7% by weight of bran (preferably rice bran), 0.1 to 10%, preferably 0.2 to 5% by dry weight exfoliating agent, and 1 to 10%, preferably 1 to 5% by weight water.

25 Ceramic clay binders suitable for the present invention fall within the definition of "refractory clays" having appropriate ranges of the following elements:

$\text{SiO}_2 < 55\%$, $\text{Al}_2\text{O}_3 > 20\%$, $\text{K}_2\text{O} < 1\%$, $\text{Na}_2\text{O} < 0.5\%$

30 A suitable ceramic clay is Bentonite. An other ceramic clay suitable for the present invention is Clay CeramTM made by Commercial Minerals Limited. Typical formula of this ceramic clay is set out in Table 1.

Table 1. Typical Chemical and Physical Properties of Clay CeramTM

Component	Formula	Content
Silica	SiO ₂	52.6%
Magnesia	MgO	0.4%
Alumina	Al ₂ O ₃	32.3%
Ferric Oxide	Fe ₂ O ₃	0.7%
Lime	CaO	0.1%
Potash	K ₂ O	0.5%
Soda	Na ₂ O	0.2%
Titanium Dioxide	TiO ₂	1.0%
Loss on ignition	(1000°C)	12.0%

5 Bran is generally defined as the outer coating of a cereal grain. Rice bran is particularly suitable for the present invention and is the brown layer removed from a rice grain to produce white rice. Although rice bran is preferably used for the present invention, it will be appreciated that bran derived from other cereals would also be suitable.

10 It will be appreciated that any exfoliating agent that will cause the granular thermal insulating material to exfoliate (expand or breakdown) in the presence of temperatures of 1000°C or more and form a finer particulate material would be suitable. Examples of such exfoliating agents include graphite, vermiculite and perlite. The preferred material, however, is
 15 exfoliating graphite. When vermiculite or perlite is used in the present invention, approximately five times more vermiculite or perlite is required than graphite as their exfoliating activity is not as great as graphite.

In a more preferred form the granular thermal insulating material comprises about 85% by dry weight rice hull ash, about 5% by dry weight
 20 ceramic clay binder, 5% rice bran, about 0.35% by dry weight exfoliating graphite, and about 4% by weight water.

In a second aspect, the present invention consists in a method for the production of a granular thermal insulating material comprising the steps of:-
 (a) admixing rice hull ash, ceramic clay binder, bran (preferably rice bran)
 25 and exfoliating agent;
 (b) adding water to the mixture to form a slurry;

- (c) forming the slurry mixture into granules; and
- (d) substantially drying the material.

In a preferred embodiment of the second aspect of the present invention, in step (b) water is added between 25 and 50% by weight of the mixture. More preferably water is added at 30 to 35% weight of the final mixture prior to granulating. Steps (a) and (b) are preferably carried out in the same apparatus but can be carried out in any manner known to the art. A particularly suitable apparatus for the mixing the components and forming the slurry is a slow ribbon blender.

The granulation step (c) can be carried out in any known system for this process. Examples include briquetters, disk pelleters and extrusion pellet presses.

Preferably the granules are pellets of a cylindrical nature with approximate diameters of 4 mm to 12 mm. The more preferred pellet diameter is 8 mm with a length of 4 mm to 20 mm. It will be appreciated that the granules can be of any size suitable for packaging and use in overlaying molten metals.

The drying step (d) can be carried out in any known drying system. In order to reduce the incidence of generation of fines, however, it is preferred that the drying process is gentle. In this regard, temperatures of 100°C to 130°C have been found to be suitable. Preferably the drying results in a granular thermal insulating material having less than about 5% by weight as retained water.

In a third aspect, the present invention consists in a method of insulating molten steel or metal comprising adding to the molten steel or metal a granular thermal insulating material according to the first aspect of the present invention such that the insulating material is caused to exfoliate (expand or breakdown) on exposure to a temperature of 1000°C or more from the molten steel or metal thereby forming a thermal insulating layer over the molten steel or metal.

The present invention further consists in use of a granular thermal insulating material according to the first aspect of the present invention for insulating molten steel or metal.

The insulation material is useful in steel industry application including tundishes, ladles, runners, torpedo ladles and ingot tops. In the

foundry industry, the insulation material is suitable for use on moulds and runners and in various other metalliferous industries such as copper smelting.

In order that the present invention may be more clearly understood, preferred forms will be described with reference to the following Examples.

5 Modes of Carrying out the Invention

The addition of a ceramic clay binder, rice bran and an exfoliating agent to rice hull ash prior to pelletising creates a high density granule or pellet which upon heating exfoliates (expands or breaks down) to form an excellent insulating material with none of the drawbacks of prior art insulating materials.

When preparing the insulating material adequate mixing of the ingredients is important. Due to the extremely abrasive nature of the rice hull ash all mixing should preferably be as slow as possible to limit wear and tear on the machinery.

15 In the Examples described below the mixing is carried out in two steps.

Stage 1 is a thorough dry mixing in a slow ribbon blender but preferably in a long (5 to 10 minute residence time) screw conveyor having overlapping segmented crescent shaped flights.

20 Approximately two thirds of the screw conveyor is dedicated to dry mixing. The final one third of the conveyor is for wet mixing, a metered amount of water is added in stages to permit even mixing. Water addition is at 20% to 50% by weight and preferably 30% to 35% by weight of the final mixture prior to pelleting is water.

25 In stage 2 the mixed product is fed to the desired agglomeration process such as Robinson Briquetter, a disk pelletiser or preferably a standard extrusion pellet press (produced by many manufacturers). With the correct amount of water, precise temperature control and the correct die hole shape such a pellet press can operate successfully without steam injection. This produces pellets of a cylindrical nature with approximate diameters of 4 mm to 30 12 mm the preferred diameter is 8 mm with a length of 4 mm to 20 mm and of a high density.

35 In stage 3 the pellets are then dried in any number of proprietary driers at a temperature of 100°C to 130°C. The main emphasis in this stage is that the drying process should be gentle to reduce the incidence of generation of fines. Pellets are then sieved to remove fines to achieve a product containing less than 5% by weight fines passing a 1 mm sieve. The fines are recycled, the

pellets are then filled into suitable packs according to customers' requirements.

This invention is further described in the following Examples.

Example 1

5 Rice hull ash is produced on a continuous basis from a suitable furnace (in this instance a K C Reactor) at a rate of 500 Kg/hr. The ceramic clay binder used was Clay CeramTM (Table 1) produced by Commercial Minerals Ltd is metered into the mixing screw conveyor via a calibrated feed screw. Exfoliating graphite is metered into the mixing screw conveyor via a calibrated
10 vibratory feeder. Approximately two thirds along this mixing screw conveyor water is added via a calibrated dosing pump. Sufficient mixing occurs by careful design of the crescent flight mixing conveyor which is run at low speeds to obviate excessive wear.

 The mixed product is then fed to a standard California Pellet Mill
15 (CPM) extrusion type pellet press (although many other extrusion devices would be suitable) in which further mixing occurs prior to being compacted and extruded through the die. Cylindrical pellets with approximate diameters of 4 mm to 12 mm can be produced, the preferred diameter is 8 mm as the best compromise between drying efficiency, production efficiency and customer
20 preference.

 The formulation is 1000 g Rice Hull Ash, 50 g Clay CeramTM, 50 g rice bran, 350 g water and 4 g exfoliating graphite. The amount of Clay CeramTM can vary from 25 g to 200 g or more and the graphite from 1 g to 10 g or more depending on the final characteristics required by the customer which related
25 to coverage, heat retention ability and end use.

Example 2

 The process largely as described in Example 1 is followed, in this Example the mixed product is fed to a Robinson Briquetting Press producing a preferred size of "Pillow" shaped briquette measuring approx 20 mm x 15 mm x
30 10 mm. The performance of these briquettes on molten steel is indistinguishable from that of the pellets in Example 1.

Example 3

 The process largely as described in Example 1 is followed, in this Example the mixed product is fed to a standard "Disc Pelletiser" where a disc
35 rotates slowly, the disc being inclined at approx 30° to the horizontal.

The pellets from this process become essentially spherical. When a mean diameter of 5 mm has been achieved, the pellets are continuously removed and replaced with fresh pre-mixed ash.

5 These pellets do not achieve the high density as in the previous two Examples and usually only require the following preferred mix of products:-

1000 g rice hull ash

50 g Clay CeramTM

50 g rice bran

300 g water

10 1 g exfoliating graphite

The final performance of these pellets in use in the production of hot metal, however, is extremely satisfactory. In essence the "disc" pelletising process is usually less capital intensive and therefore better suited where there is shorter transport to customers and lower costs are required.

15 **Example 4**

Further testing has indicated that unexpanded vermiculite (hydrated sheet silicates) can be used to substitute exfoliating graphite in Examples 1 to 3 at a rate of 5 to 1 vermiculite to graphite.

20 Performance at high temperatures, > 1500°C is somewhat retarded. This product, however, is totally satisfactory for use in iron foundries and other metalliferous industries operating at less than 1500°C.

Example 5

25 The process as described in Examples 1 to 4 can incorporate any type of rice hull ash high carbon, 40% by mass, down to less than 1% by mass carbon.

In this Example a preferred rice hull ash is 35 to 40% carbon containing ash, the resultant tundish insulation material is highly exothermic contributing approximately 6 MJ/Kg of finished pelleted product to the insulation capability of the product.

30 Where the end use is sensitive to carbon, a low carbon rice hull ash may be substituted.

Example 6

The process described in Examples 1 to 5 are largely followed in this Example the Clay CeramTM is substituted by clay plas.

Example 7

The process described in Examples 1 to 5 are largely followed in this Example the Clay CeramTM is substituted by bentonite (sodium modified) to less than 0.5%.

5 The results of various insulating materials tested are shown in Table 2.

Table 2. Comparative results of various insulating materials.
Tested by Refractories Centre Australia and Tested to AS 1774.10

Sample	Ceramic Binder Type	Inclusion rate %	Rice Bran %	Fusion Temp Degrees C
1	Bentonite (1)	10	0	1540
2	Bentonite (1)	7.5	2.5	1555
3	Bentonite (1)	5	5	1575
4	Bentonite (1)	2.5	7.5	1580
5	Bentonite (1)	0	10	1600
6	Clay Ceram TM	5	0	1565
7	Clay Ceram TM	7.5	0	1555
8	Clay Ceram TM	10	0	1550
9	Clay Plas	5	0	1500
10	Clay Plas	7.5	0	1500
11	Clay Plas	10	0	1500

Note: - Bentonite (1) is Sodium Modified Na < 0.5%

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A higher fusion temperature is desired together with a product that does not substantially form dust in use. The preferred product made according to the present invention contained Bentonite and rice bran. Sample 5 had a high fusion temperature but tended to form dust in use and therefore was not ideal.

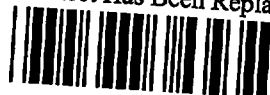
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It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

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Claims

1. A granular thermal insulating material comprising rice hull ash, ceramic clay binder, rice bran, and an exfoliating agent.
2. A granular thermal insulating material comprising rice hull ash, rice
5 bran, ceramic clay binder and an exfoliating agent, such that when the insulating material is exposed to a temperature of 1000°C or more the material exfoliates to form an expanded particulate material.
3. The insulating material according to claim 1 or 2 wherein the granules are in the form of pellets, disks, spheres or granules.
- 10 4. The insulating material according to any one of claims 1 to 3 comprising 70 to 95% by dry weight rice hull ash, 2 to 20% by dry weight ceramic clay binder, 0.1 to 10% by dry weight rice bran, 0.1 to 10% by dry weight exfoliating agent, and 1 to 10% by weight water.
- 15 5. The insulating material according to claim 4 comprising 85 to 95% by dry weight rice hull ash, 5 to 15% by dry weight ceramic clay binder, 2 to 5% by weight rice bran, 0.2 to 5% by dry weight exfoliating agent, and 1 to 5% by weight water.
- 20 6. The insulating material according to claim 5 comprising about 85% by dry weight rice hull ash, about 5% by dry weight ceramic clay binder, about 5% by weight rice bran, about 0.35% by dry weight exfoliating agent, and about 4% by total weight water.
7. The insulating material according to any one of claims 1 to 6 wherein the ceramic clay binder is a refractory clay having including ranges of the following elements:
25 $\text{SiO}_2 < 55\%$, $\text{Al}_2\text{O}_3 > 20\%$, $\text{K}_2\text{O} < 1\%$, $\text{Na}_2\text{O} < 0.5\%$.
8. The insulating material according to any one of claims 1 to 7 wherein the exfoliating agent is selected from the group consisting of graphite, vermiculite and perlite.
9. The insulating material according to claim 8 wherein the exfoliating
30 agent is exfoliating graphite.
10. The insulating material according to any one of claims 1 to 9 comprising about 85% by dry weight rice hull ash, about 5% by dry weight ceramic clay binder, 5% by dry weight rice bran, and about 0.35% by dry weight exfoliating graphite, and about 4% by total weight water.





11. A method for the production of a granular thermal insulating material comprising the steps of:-
- (a) admixing rice hull ash, ceramic clay binder, rice bran, and exfoliating agent;
- 5 (b) adding water to the mixture to form a slurry;
- (c) forming the slurry mixture into granules; and
- (d) substantially drying the material.
12. The method according to claim 11 such that in step (b) water is added at 20 to 50% by weight of the mixture.
- 10 13. The method according to claim 12 such that in step (b) water is added at 30 to 35% by weight of the mixture.
14. The method according to any one of claims 11 to 13 wherein steps (a) and (b) are carried out in the same apparatus.
- 15 15. The method according to claim 14 wherein the apparatus for the mixing the components and forming the slurry is a slow ribbon blender.
16. The method according to any one of claims 11 to 15 wherein the granulation step (c) is carried out in a briquetter, a disk pelleter or an extrusion pellet press.
17. The method according to any one of claims 11 to 16 wherein the
- 20 granules are substantially cylindrical pellets with diameters of 4 mm to 12 mm.
18. The method according to claim 17 wherein the pellets have a diameter of 8 mm with a length of 4 to 20 mm.
19. The method according to any one of claims 11 to 18 wherein the drying
- 25 step (d) is carried out at temperatures of 100°C to 130°C.
20. A method of insulating molten steel or metal comprising adding to the molten steel or metal a granular thermal insulating material according to any one of claims 1 to 10 such that the insulating material is caused to exfoliate on exposure to a temperature of 1000°C or more from the molten steel or metal
- 30 thereby forming a thermal insulating layer over the molten steel or metal.
21. Use of a granular thermal insulating material according to according to any one of claims 1 to 10 for insulating molten steel or metal.

