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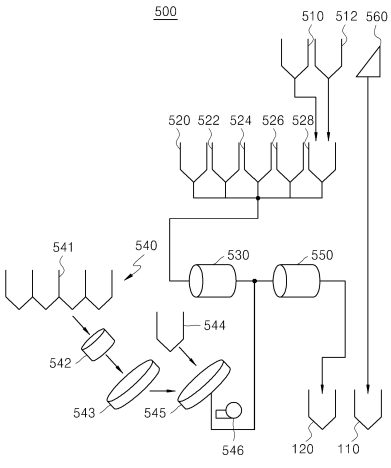
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(54) APPARATUS FOR PROCESSING RAW MATERIAL, METHOD OF PROCESSING RAW MATERIAL, AND GRANULES MANUFACTURED USING SAME

(57) The present invention relates to a raw material processing apparatus, a raw material processing method, and a granule produced using the same. A raw material processing method for producing sintered ore includes preparing an iron-containing ultra-fine powder raw material and a binder, mixing the iron-containing ultra-fine powder raw material and the binder in a mixing device, producing a primary granule by introducing the iron-containing ultra-fine powder raw material and the binder into a primary granulator, producing a secondary granule by introducing the primary granule and at least one of calcium oxide (CaO) or calcium hydroxide ($Ca(OH)_2$) into a secondary granulator, and curing the secondary granule with CO_2. The present invention is capable of producing a granule having excellent strength using an ultra-fine powder raw material such as ultra-fine powder iron ore.

FIG2



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Description

TECHNICAL FIELD

[0001] The present invention relates to a raw material processing apparatus, a raw material processing method, and a granule produced using the same, and more particularly, to a raw material processing apparatus, a raw material processing method, and a granule produced using the same, capable of producing a granule having excellent strength using an ultra-fine powder raw material such as an ultra-fine powder iron ore.

BACKGROUND ART

[0002] In a producing process of sintered ore, fine-grained powder iron ore is sintered to be produced to have a size suitable for use in a blast furnace. In such sintering process, powder iron ore, supplementary raw materials, fuel (powder coke, anthracite), and the like are put into a drum mixer to be mixed and humidified (a raw material weight ratio of about 7 to 8%), so that a blended raw material for sintering is pseudo-granulated and charged to a predetermined height in a sintering cart. After a surface of the blended raw material for sintering is ignited by an ignition furnace, air is forcibly sucked from below to perform firing of the blended raw material to produce sintered ore. The produced sintered ore passes through a crusher of a sintering machine to be cooled in a cooler, and classified to have a particle size of 5 to 50 mm, which is a size suitable for being charged and reacted in a blast furnace, and is transferred to the blast furnace. A preparing process of a blended raw material for sintering for producing sintered ore typically includes mixing iron ore which is a main raw material, limestone, calcium oxide, and silica which are supplementary raw materials, and coke serving as fuel during sintering, and granulating the mixture in which the main raw material, the supplementary raw materials, and the coke are mixed. Then, a granule produced in the above-described process is charged into a sintering device and sintered. That is, when air is sucked by sucking a lower portion of the sintering device, the coke included in the granule comes into contact with oxygen in the air to generate flame. As the flame advances, the blended raw material for sintering charged into the sintering machine is sintered.

[0003] In the meantime, methods for reducing production costs using a low-priced iron source instead of iron ore, which is a main raw material for a blended raw material for sintering, are being studied. Among such low-priced iron sources, pellet feed is an ultra-fine powder iron ore having a particle size of 0.15 mm or less containing an iron (T.Fe) component of close to 70%. However, when pellet feed is used in a large amount as a blended raw material for sintering, and when a granule for a blended raw material for sintering is produced by being applied to a typical granulating process without a process of selectively granulating the pellet feed, an expensive binder such as calcium oxide is used in a large amount in order to secure assemblability and strength. Therefore, production costs are increased, making the use of pellet feed which is relatively low-priced meaningless. In addition, when a granule is produced by using pellet feed, at least 10 granulators are required in order for the granule to have a desired size and strength. Therefore, there is also a limitation in that space and cost for constructing facilities are enormous.

DISCLOSURE OF THE INVENTION

TECHNICAL PROBLEM

[0004] The present invention provides a raw material processing apparatus, a raw material processing method, and a granule produced using the same, capable of improving the strength of a granule produced from an ultra-fine powdered raw material.

[0005] The present invention provides a raw material processing apparatus, a raw material processing method, and a granule produced using the same, capable of improving operation efficiency using a granule by improving the strength of the granule.

TECHNICAL SOLUTION

[0006] A raw material processing apparatus according to an embodiment of the present invention is a raw material processing apparatus for producing sintered ore, and may include a primary granulator for producing a primary granule by granulating an iron-containing ultra-fine powder raw material and a binder; a secondary granulator for producing a secondary granule by forming a coating layer containing at least one of calcium oxide or calcium hydroxide on a surface of the primary granule; and a curing device for curing the secondary granule.

[0007] A raw material processing apparatus according to an embodiment of the present invention may include a mixing device for mixing the iron-containing ultra-fine powder raw material and the binder.

[0008] The primary granulator and the secondary granulator may respectively include a moisture supply device for

supplying moisture.

[0009] The curing device may include a transfer path for transferring the secondary granule produced in the secondary granulator, and an exhaust gas supply device for supplying exhaust gas to the transfer path.

[0010] The exhaust gas supply device may supply exhaust gas generated in a lime firing process.

[0011] A raw material processing method according to an embodiment of the present invention is a raw material processing method for producing sintered ore, and may include preparing an iron-containing ultra-fine powder raw material and a binder; mixing the iron-containing ultra-fine powder raw material and the binder in a mixing device; producing a primary granule by introducing the iron-containing ultra-fine powder raw material and the binder into a primary granulator; producing a secondary granule by introducing the primary granule and at least one of calcium oxide (CaO) or calcium hydroxide ($Ca(OH)_2$) into a secondary granulator; and curing the secondary granule with CO_2.

[0012] The iron-containing ultra-fine powder raw material may have a particle size greater than 0 mm to 4 mm.

[0013] The iron-containing ultra-fine powder raw material may include at least one of iron ore, pellet feed, or a steel-making by-product.

[0014] The binder may include at least one of molasses, ultra-fine powder limestone, bentonite, ladle slag, fly ash, or a polymeric organic binder.

[0015] The binder may be used in an amount of 0.1 to 5 wt% based on the weight of the iron-containing ultra-fine powder raw material.

[0016] Moisture may be supplied in the producing of the primary granule and the secondary granule.

[0017] The secondary granule may be produced to have a size of 10 mm or less in the producing of the secondary granule.

Exhaust gas containing CO_2 may be supplied to the secondary granule in the curing.

[0018] The exhaust gas may be exhaust gas generated in a lime firing process.

[0019] The exhaust gas may have a CO_2 concentration of 3 to 7%.

[0020] The exhaust gas may contain moisture of 3 to 10%.

[0021] Exhaust gas of 50 to 100°C may be supplied to the secondary granule in the curing.

[0022] The curing may be performed during a process of transferring the secondary granule to a storage device for storing the secondary granule.

[0023] A coating layer containing calcium carbonate may be formed on a surface of the primary granule in the curing.

[0024] A granule according to an embodiment of the present invention may be produced by the raw material processing method described above, and may be formed to have a diameter of 10 mm or less.

[0025] A coating layer having a thickness of 0.25 to 1 mm may be formed on a surface of the granule, and the coating layer may contain calcium carbonate ($CaCO_3$).

ADVANTAGEOUS EFFECTS

[0026] According to embodiments of the present invention, the strength of a granule produced using an ultra-fine powder raw material such as powder iron ore and pellet feed may be improved. A primary granule is produced using an ultra-fine powdered raw material, and then... The granule thus produced is capable of securing excellent strength and productivity even when a small amount of expensive binder is used.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

FIG. 1 is a view showing a facility for producing sintered ore.

FIG. 2 is a conceptual view of a raw material processing apparatus according to an embodiment of the present invention.

FIG. 3 is a flow chart for explaining a raw material processing method according to an embodiment of the present invention.

FIG. 4 is a conceptual view of a granule produced by a raw material processing method according to an embodiment of the present invention.

MODE FOR CARRYING OUT THE INVENTION

[0028] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings. However, it should be understood that the present invention is not limited to the embodiments disclosed below, but may be embodied in many different forms. These embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

[0029] In an embodiment of the present invention, an ultra-fine powder raw material having a particle size of greater than 0 mm to 4 mm may be made as a granule, and the granule may be used as a raw material for producing sintered ore. To achieve this, a granule is made using an ultra-fine powder raw material, for example, an iron-containing ultra-fine powder raw material, and then cured using CO_2 to form a coating layer on a surface of the granule, so that the strength of the granule may be increased.

[0030] FIG. 1 is a view showing a facility for producing sintered ore. FIG. 2 is a conceptual view of a raw material processing apparatus according to an embodiment of the present invention. FIG. 3 is a flow chart for explaining a raw material processing method according to an embodiment of the present invention. FIG. 4 is a conceptual view of a granule produced by a raw material processing method according to an embodiment of the present invention.

[0031] First, referring to FIG. 1, a facility for producing sintered ore includes a movement path (not shown) forming a closed loop, a sintering cart 300 moving in an infinite orbit manner along the movement path, a raw material supply part 100 disposed on the movement path to charge a raw material for sintering in the moving sintering cart 300, an ignition furnace 200 for performing ignition by spraying flame on a surface layer of the raw material in the sintering cart 300, and a plurality of windboxes 400 for sucking the inside of the sintering cart 300.

[0032] When upper ore and a blended raw material for sintering are charged by the raw material supply part 100 into the sintering cart 300 moving along the movement path, the ignition furnace 200 which is located at one side of the raw material supply part 100, that is, in front with respect to the moving direction of the sintering cart 300, ignites a surface layer portion of the blended raw material for sintering. After the ignition, the sintering cart 300 moves along the movement path, and the inside of the sintering cart 300 is sucked by the windboxes 300 below the movement path, so that sintering of the blended raw material for sintering is achieved and sintered ore is produced.

[0033] Meanwhile, upper ore and a blended raw material for sintering may be used as a raw material for sintered ore. The upper ore is generated after the producing of the sintered ore, and refers to sintered ore having a certain size selected by a selector 560, for example, a size of 10 to 15 mm. The upper ore is stored in an upper ore hopper 110 at one side of a surge hopper 120 for storing a blended raw material for sintering, and charged on the bottom of the sintering cart 300 before the blended raw material for sintering is charged into the sintering cart 300. The blended raw material for sintering includes iron ore, calcium oxide, limestone, silica, coke, coal, and the like, and refers to a mixture thereof being uniformly mixed. At this time, cokes and coal may be used as fuel. Such blended raw material for sintering is charged in an upper portion of the upper ore in the sintering cart 300 by a charging device 130, and each raw material constituting the blended raw material for sintering has a predetermined size, for example, a particle diameter of 10 mm or less. However, as described in the background art, an ultra-fine powder raw material having a very small particle diameter, for example, greater than 0 to 4 mm, deteriorates air permeability in the sintering cart 300 during sintering, and therefore, may be used as a blended raw material for sintering after going through a separate processing process, that is, a granule process. However, in a typical granulating process, an ultra-fine powder raw material is granulated in a granulator and used as it is, so that the strength of a granule is not so good. Therefore, in the present invention, a granule is produced using an ultra-fine powder raw material, and then cured to form a coating layer on a surface of the granule, so that the strength of the granule may be improved.

[0034] Hereinafter, a raw material processing apparatus for preparing a blended raw material for sintering may be constructed as follows.

[0035] Referring to FIG. 2, a raw material processing apparatus 500 may include raw material reservoirs 520, 522, 524, 526, and 528, a primary mixing device 530 for mixing raw materials supplied from the raw material reservoirs 520, 522, 524, 526, and 528, a granule part 540 for producing a granule by granulating an ultra-fine powder raw material, and a secondary granulator 550 for mixing the raw materials mixed in the primary mixing device 530 and the granule.

[0036] The raw material reservoirs 520, 522, 524, 526, and 528 may include an iron ore storage hopper 520 for storing iron ore, a limestone hopper 522 for storing limestone, a silica hopper 524 for storing silica, a fuel hopper 526 for storing fuel such as coke and coal, and a return ore hopper 528 for storing return ore. At this time, the return ore hopper 528 is supplied with the return ore from storage hoppers 510 and 512 for storing blast furnace return or, return ore of its own generated after the producing of sintered ore.

[0037] The primary mixing device 530 serves to uniformly mix respective raw materials discharged from respective hoppers of the raw material reservoirs 520, 522, 524, 526, and 528.

[0038] The secondary mixing device 550 uniformly mixes a mixture discharged from the primary mixing device 530 and the granule produced in the granule part 540 to prepare a blended raw material for sintering. The prepared blended raw material for sintering is stored in the surge hopper 120 of the raw material supply part 100 of the facility for producing sintered ore.

[0039] The granule part 540 may include a first hopper 541 for storing the ultra-fine powder raw material and the binder, a mixing device 542 for uniformly mixing the ultra-fine powder raw material and the binder discharged from the first hopper 541, a primary granulator 543 for producing a primary granule by granulating a mixture of the ultra-fine powder raw material and the binder, a second hopper 544 for storing calcium oxide and calcium hydroxide, a secondary granulator 545 for producing a secondary granule using the primary granule produced in the primary granulator 543 and

at least one of calcium oxide or calcium hydroxide, and a curing device 546 for curing the secondary granule.

[0040] The first hopper 541 may be formed in plurality in order to store the ultra-fine powder raw material and the binder, respectively, and may discharge the ultra-fine powder raw material and binder to the mixing device 542 by a predetermined amount. At this time, the ultra-fine powder raw material may be an iron-containing ultra-fine powder raw material containing iron, and may have a particle size of greater than 0 mm to 4 mm. The iron-containing ultra-fine powder raw material may include iron ore, pellet feed, a steel-making by-product, and the like, and the steel-making by-product may include dust or sludge.

[0041] The binder may include at least one of molasses, ultra-fine powder limestone, bentonite, ladle slag, fly ash, or a polymeric organic binder, and may be used in a solid or a liquid state.

[0042] The mixing device 542 may be a 'high-speed stirring mixing device' which stirs the iron-containing ultra-fine powder raw material and the binder supplied from the first hopper 541 at high speed. The mixing device 542 uniformly mixes the iron-containing ultra-fine powder raw material and the binder supplied from the first hopper 541 by stirring the same at high speed. The mixing device 542 has a cylindrical shape having an internal space, and may be provided with a stirring means, for example, a blade (not shown), for mixing introduced raw materials. At this time, the mixing device 542 may be provided with a nozzle for spraying water on the mixture of the iron-containing ultra-fine powder raw material and the binder.

[0043] The primary granulator 543 is a pelletizer used in a typical selective granulating facility, and has an internal space into which the mixture is charged, and a rotating fan (not shown) installed therein. The mixture of the iron-containing ultra-fine powder raw material and the binder mixed in the mixing device 542 flows over the rotating fan to allow particles to gradually grow and be granulated such that the primary granule is produced. At this time, the primary granulator 543 may be provided with a moisture supply device for supplying moisture into the primary granulator 543 so that the iron-containing ultra-fine powder raw material and the binder may be easily combined.

[0044] The secondary granulator 545 may be formed to have substantially the same configuration as the primary granulator 543.

[0045] The secondary granulator 545 produces the secondary granule by using the primary granule produced in the primary granulator 543 and at least one of calcium oxide or calcium hydroxide supplied from the second hopper 544. The secondary granule may be formed by using the primary granule which has a relatively large particle size as a nucleus and attaching calcium oxide or calcium hydroxide which has a relatively small particle size on a surface of the primary granule.

[0046] At this time, the secondary granulator 545 may be provided with a moisture supply device for supplying moisture into the secondary granulator 545 such that calcium oxide or calcium hydroxide may be easily attached.

[0047] The curing device 546 may include a transfer path for transferring the secondary granule produced in the secondary granulator 545, and an exhaust gas supply device for supplying exhaust gas which contains at least one of carbon or oxygen, for example, exhaust gas containing CO_2, to the secondary granule being transferred along the transfer path. At this time, the transfer path may be a conveyor belt and the like, and the exhaust gas supply device may be formed to spray exhaust gas on the transfer path.

[0048] The exhaust gas supply device may supply various exhaust gas generated in a steel-making process, and in an embodiment of the present invention, exhaust gas generated in the lime firing process may be supplied.

[0049] Hereinafter, a raw material processing method using the raw material processing apparatus described above will be described.

[0050] Referring to FIG. 3, a raw material processing method according to an embodiment of the present invention may include a process S100 of preparing main raw materials, a primary mixing process S110 of mixing the raw materials, a process S120 of producing a granule by granulating an ultra-fine powder raw material, and a secondary mixing process S130 of preparing a blended raw material for sintering by mixing the main materials and the granule, and a process S140 of storing the blended raw material for sintering in a reservoir, that is, the surge hopper 120.

[0051] Here, the remaining processes other than the process of producing the granule are almost the same in a typical process for preparing a blended raw material for sintering.

[0052] However, when the granule is produced, at least one of calcium oxide or calcium hydroxide is used other than the iron-containing ultra-fine powder raw material. Therefore, when main raw materials are provided, calcium oxide or calcium hydroxide may not be separately prepared, or may be prepared in an amount less than an amount prepared in a typical preparation of a blended raw material for sintering.

[0053] The process of producing a granule is as follows.

[0054] The process S120 of producing a granule includes a process S121 of preparing an iron-containing ultra-fine powder raw material, a binder, calcium oxide, and calcium hydroxide, a process S122 of mixing the iron-containing ultra-fine powder raw material and the binder, a process S123 of producing a primary granule by using the mixture of the iron-containing ultra-fine powder raw material and the binder, a process S124 of producing a secondary granule by forming a coating layer including at least one of calcium oxide or calcium hydroxide on a surface of the primary granule using the primary granule and at least one of calcium oxide (CaO) or calcium hydroxide ($Ca(OH)_2$); and a process S125

of curing the secondary granule with CO_2.

[0055] The iron-containing ultra-fine powder raw material may include iron ore, pellet feed, and a steel-making by-product, having a particle size of greater than 0 to 4 mm. At this time, the steel-making by-product may be dust or sludge containing an iron component.

[0056] When iron ore and a steel-making by-product are used as the iron-containing ultra-fine powder raw material, iron ore may be included in an amount of 50 to 90 wt% based on the total weight of the iron-containing ultra-fine powder raw material. When the content of the iron ore is less than the suggested range, the content of iron in sintered ore decreases. When greater than the suggested range, the strength of the granule is lowered.

[0057] As the binder, at least one of molasses, ultra-fine powder limestone, bentonite, ladle slag, fly ash, or a polymeric organic binder may be used. In this case, the binder may be used in a solid state or in a liquid state. The binder may be used in an amount of 0.1 to 5 wt% based on the weight of the iron-containing ultra-fine powder raw material. At this time, when the binder is in a liquid state, it is preferable to use the binder in a range of 0.1 to 1 wt%. When in a solid state, it is preferable to use the binder in a range of 5 wt% or less. When the binder is in a liquid state and used less or more than the suggested range, the assemblability of the granule may be lowered in a subsequent granulating process. In addition, when the binder is in a solid state and used less than the suggested range, the assemblability of the granule may be lowered. When the binder is used more than the suggested range, the assemblability of the granule may be improved. However, the strength of the granule may be lowered since the binder is removed in a high-temperature process which may be subsequently performed. When sintered ore produced using the granule is used in a steel-making process, there is a problem in that a large amount of steel-making slag may be generated.

[0058] Calcium oxide and calcium hydroxide are materials for forming a coating layer on a surface of a granule when producing the granule. Calcium oxide and calcium hydroxide may have a particle size of greater than 0 to 0.25 mm. When the particle size of the calcium oxide and the calcium hydroxide is greater than the suggested range, it is difficult to form a coating layer having a uniform thickness, and the reaction time with CO_2 is delayed in the curing process, so that there is a problem in that it is difficult to effectively increase the strength of the granule.

[0059] When the raw materials for producing the granule are prepared as described above, the iron-containing ultra-fine powder raw material and the binder are supplied to the mixing device 542 to be uniformly mixed.

[0060] Thereafter, the mixture of the iron-containing ultra-fine powder raw material and the binder is charged into the primary granulator 543 to produce the primary granule composed of the iron-containing ultra-fine powder raw material and the binder.

[0061] When the primary granule is produced, the primary granule is charged into the secondary granulator 545, and at least one of calcium oxide or calcium hydroxide is charged thereinto to produce the secondary granule. The secondary granule is to form a coating layer containing at least one of calcium oxide or calcium hydroxide on a surface of the primary granule, and the secondary granulator 545 may be provided with moisture such that calcium oxide or calcium hydroxide may be easily attached to the surface of the primary granule.

[0062] The secondary granule may be formed to have a particle size of 10 mm or less. Preferably, the ratio of the secondary granule having a particle size of about 1 to 8 mm may be made to be about 70 to 90% of the total secondary granule. When the ratio of the secondary granule having a particle size of about 1 to 8 mm is smaller than the suggested range, the content of fine powder in the blended raw material for sintering may become excessively large so that the air permeability in the sintering cart 300 may be deteriorated. In addition, it is preferable that the ratio of the secondary granule having a particle size of about 1 to 8 mm is greater than the suggested range. However, it is not possible due to the capability of the facility itself.

[0063] In addition, the coating layer formed on the surface of the primary granule in the secondary granule producing process may be formed to have a thickness of 0.25 to 1 mm. When the thickness of the coating layer is smaller than the suggested range, the coating layer is partially formed on the surface of the primary granule so that the strength of the granule finally produced may not be improved as desired. When greater than the suggested range, the strength of the granule may be improved, but the effect is insignificant. Furthermore, there is a problem in that the production costs are increased due to an increase in the amount of calcium oxide and calcium hydroxide to be used.

[0064] When the secondary granule is thus produced, the secondary granule is transferred to the secondary mixing device 550 so as to be uniformly mixed with the main raw materials.

[0065] In the process of transferring the secondary granule to the secondary mixing device 550, exhaust gas containing CO_2 is supplied to the transfer path through which the secondary granule is transferred, and the secondary granule is cured. At this time, the exhaust gas supplied to the secondary granule may be exhaust gas generated in various processes. In this embodiment, exhaust gas generated in a lime firing process for producing calcium oxide may be used.

[0066] The exhaust gas generated in the lime firing process is typically at a high temperature of about 300°C. Therefore, when such exhaust gas is directly supplied to the secondary granule, there is a problem in that the transfer path through which the secondary granule is transferred may be damaged. In addition, the secondary granule contains a predetermined amount of moisture. Therefore, when the exhaust gas at a high temperature is supplied, the moisture in the secondary granule is rapidly evaporated so that there is a problem in that the secondary granule may be differentiated.

[0067] Therefore, in the present invention, air is mixed with the exhaust gas of about 300°C generated in the lime firing process, and then the mixture is cooled to 100°C or lower, for example, about 50 to 100°C to be supplied to the secondary granule, so that the differentiation of the secondary granule may be suppressed or prevented.

[0068] The exhaust gas generated in the lime firing process contains 20% of CO_2 and 15% of moisture. When air is mixed with the exhaust gas, the concentration of CO_2 and the content of moisture in the exhaust gas may be reduced to some extent. Thus, in the curing process, exhaust gas having a CO_2 concentration of 10% or less, preferably 3 to 7%, and a moisture content of 10% or less, preferably 3 to 10%, may be supplied to the secondary granule.

[0069] The coating layer formed on the surface of the secondary granule, that is, the surface of the primary granule in such curing process reacts with CO_2 in accordance with the following formulas 1 and 2 to form calcium carbonate ($CaCO_3$) and be hardened. Thus, the strength of the secondary granule may be improved.

Formula 1) $CaO + CO_2 \rightarrow CaCO_3$

Formula 2) $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

[0070] The granule product thus produced is supplied to the secondary mixing device 550 to be mixed with the main raw materials mixed in the primary mixing device 530 and is prepared as a blended raw material for sintering and charged into the surge hopper 120.

[0071] Hereinafter, experimental examples for verifying the strength improvement of a granule produced by the raw material processing method according to the present invention will be described.

[0072] First, a primary granule was produced using iron ore, dust, and sludge mixed to have a composition ratio of 2: 1: 1 as an iron-containing ultra-fine powder raw material, and using molasses as a binder.

[0073] Next, a secondary granule was produced by forming a coating layer on a surface of the primary granule using calcium oxide having a particle size of 0.25 mm or less. At this time, the secondary granule was produced by varying the thickness of the coating layer.

[0074] Thereafter, air was mixed with exhaust gas generated in a lime firing process, and then the mixture was cooled to about 100°C and supplied to the secondary granule so as to perform a curing process.

[0075] At this time, the curing process was performed by supplying the exhaust gas to the secondary granule while changing a CO_2 concentration and a moisture content of the exhaust gas.

[Thickness change of a coating layer]

[0076] A secondary granule was prepared while changing the thickness of a coating layer to 0.25 mm, 0.5 mm, 1.0 mm and 1.5 mm.

[0077] The secondary granule thus produced was cured under the same conditions and the strength thereof was measured. At this time, the strength refers to a ratio of a granule having a particle size of 4 mm or greater in the total granules after dropping 300 g of a granule having a particle size of 4 to 6.3 mm at a height of 2 m five times.

[Table 1]

	Experimental Example 1	Experimental Example 2	Experimental Example 3	Experimental Example 4
Thickness of coating layer (mm)	0.25	0.5	1.0	1.5
Strength (%)	80.9	83.7	85.3	85.5

[0078] Referring to Table 1 above, it can be seen that as the thickness of the coating layer increases, the strength of the granule increases. However, in the cases of Experimental Example 3 in which the thickness of the coating layer was 1.0 mm, and Experimental Example 4 in which the thickness of the coating layer was 1.5 mm, the strength of the granule was increased to a degree of 0.2%. It can be seen that the degree of strength improvement is insignificant when compared with the change in strength with respect to the amount of change in thickness according to Experimental Example 2 and Experimental Example 3. Therefore, considering that the strength of a granule not subjected to a curing process is typically about 75%, it is preferable that the coating layer is formed to have a thickness of 1 mm or less, preferably 0.25 to 1 mm, in order to improve the strength of the granule.

[CO_2 concentration change in exhaust gas]

[0079] A secondary granule having a coating layer of 1.0 mm formed on a surface of the primary granule was produced.

[0080] A curing process was performed by supplying exhaust gas to the secondary granule thus produced while changing a CO_2 concentration of the exhaust gas. Thereafter, the strength of the granule was measured, and the strength measurement was performed in the same manner as in Experimental Examples 1 to 4.

[Table 2]

	Experimental Example 5	Experimental Example 6	Experimental Example 7	Experimental Example 8
CO_2 concentration (%)	1	3	5	7
Strength (%)	76.5	84.3	85.5	85.1

[0081] Referring to Table 2 above, it can be seen that as the concentration of CO_2 in the exhaust gas increases, the strength of the granule increases. However, after the CO_2 concentration in the exhaust gas increased to some extent, the strength of the granule was reduced. That is, the strength of the granule increased up to 5% of CO_2 concentration in the exhaust gas. However, when the CO_2 concentration was 7%, the strength of the granule decreased. However, even when the CO_2 concentration was 7%, the strength of the granule was higher than that of a granule which has not gone through a curing process. Therefore, the curing process may be performed by controlling the CO_2 concentration in the exhaust gas to be about 3 to 7%.

[Moisture content change in exhaust gas]

[0082] A secondary granule having a coating layer of 1.0 mm formed on a surface of the primary granule was produced.

[0083] A curing process was performed by supplying exhaust gas to the secondary granule thus produced while changing a moisture content in the exhaust gas. Thereafter, the strength of the granule was measured, and the strength measurement was performed in the same manner as in Experimental Examples 1 to 8.

[Table 3]

	Experimental Example 9	Experimental Example 10	Experimental Example 11	Experimental Example 12
Moisture content (%)	3	5	10	15
Strength (%)	85.5	85.3	85.0	82.2

[0084] Referring to Table 3 above, it can be seen that as the content of moisture in the exhaust gas increases, the strength of the granule decreases. The exhaust gas contains moisture to some extent but there is a problem in that it is difficult to completely remove the moisture. Therefore, as shown in Table 3, even when the exhaust gas contains moisture to some extent, the strength of the granule is not greatly affected, so that the granule may be cured by adjusting the moisture content in the exhaust gas to a predetermined range, for example, about 3 to 10%. Such moisture content control in the exhaust gas may be performed by introducing air to cool the exhaust gas.

[0085] As such, the detailed description of the present invention has been described with respect to specific embodiments. However, it is obvious that various modifications can be made without departing from the scope of the present invention. Therefore, the scope of the present invention should not be limited to the embodiments described, but should be defined by the appended claims and equivalents thereof.

INDUSTRIAL APPLICABILITY

[0086] A raw material processing apparatus, a raw material processing method, and a granule produced using the same, according to the present invention, may be used as a raw material to be mixed when producing sintered ore.

Claims

1. A raw material processing apparatus for processing a raw material for producing sintered ore, comprising:

   a primary granulator for producing a primary granule by granulating an iron-containing ultra-fine powder raw material and a binder;
   a secondary granulator for producing a secondary granule by forming a coating layer containing at least one of calcium oxide or calcium hydroxide on a surface of the primary granule; and
   a curing device for curing the secondary granule.

2. The raw material processing apparatus of claim 1 comprising,
   a mixing device for mixing the iron-containing ultra-fine powder raw material and the binder.

3. The raw material processing apparatus of claim 2, wherein
   the primary granulator and the secondary granulator respectively comprise a moisture supply device for supplying moisture.

4. The raw material processing apparatus of claim 1 or claim 2, wherein
   the curing device comprises a transfer path for transferring the secondary granule produced in the secondary granulator, and an exhaust gas supply device for supplying exhaust gas to the transfer path.

5. The raw material processing apparatus of claim 4, wherein
   the exhaust gas supply device supplies exhaust gas generated in a lime firing process.

6. A raw material processing method for producing sintered ore, comprising:

   preparing an iron-containing ultra-fine powder raw material and a binder;
   mixing the iron-containing ultra-fine powder raw material and the binder in a mixing device;
   producing a primary granule by introducing the iron-containing ultra-fine powder raw material and the binder into a primary granulator;
   producing a secondary granule by introducing the primary granule and at least one of calcium oxide (CaO) or calcium hydroxide ($Ca(OH)_2$) into a secondary granulator; and
   curing the secondary granule with CO_2.

7. The raw material processing method of claim 6, wherein
   the iron-containing ultra-fine powder raw material has a particle size greater than 0 mm to 4 mm.

8. The raw material processing method of claim 7, wherein
   the iron-containing ultra-fine powder raw material is at least one of iron ore, pellet feed, or a steel-making by-product.

9. The raw material processing method of claim 8, wherein
   the binder is at least one of molasses, ultra-fine powder limestone, bentonite, ladle slag, fly ash, or a polymeric organic binder.

10. The raw material processing method of claim 9, wherein
    the binder is used in an amount of 0.1 to 5 wt% based on the weight of the iron-containing ultra-fine powder raw material.

11. The raw material processing method of claim 10, wherein
    moisture is supplied in the producing of the primary granule and the secondary granule.

12. The raw material processing method of claim 11, wherein
    the secondary granule is produced to have a size of 10 mm or less in the producing of the secondary granule.

13. The raw material processing method of claim 12, wherein
    exhaust gas containing CO_2 is supplied to the secondary granule in the curing.

14. The raw material processing method of claim 13, wherein

the exhaust gas is exhaust gas generated in a lime firing process.

15. The raw material processing method of claim 14, wherein
the exhaust gas has a CO_2 concentration of 3 to 7%.

16. The raw material processing method of claim 14, wherein
the exhaust gas contains moisture of 3 to 10%.

17. The raw material processing method of claim 14, wherein
exhaust gas of 50 to 100°C is supplied to the secondary granule in the curing.

18. The raw material processing method of claim 17, wherein
the curing is performed during a process of transferring the secondary granule to a storage device for storing the secondary granule.

19. The raw material processing method of claim 18, wherein
a coating layer containing calcium carbonate is formed on a surface of the primary granule in the curing.

20. A granule produced by the raw material processing method of any one of claims 6 to 19.

21. The granule of claim 20 being formed to have a diameter of 10 mm or less.

22. The granule of claim 21, wherein
a coating layer having a thickness of 0.25 to 1 mm is formed on a surface of the granule.

23. The granule of claim 22, wherein
the coating layer contains calcium carbonate ($CaCO_3$).

FIG.1

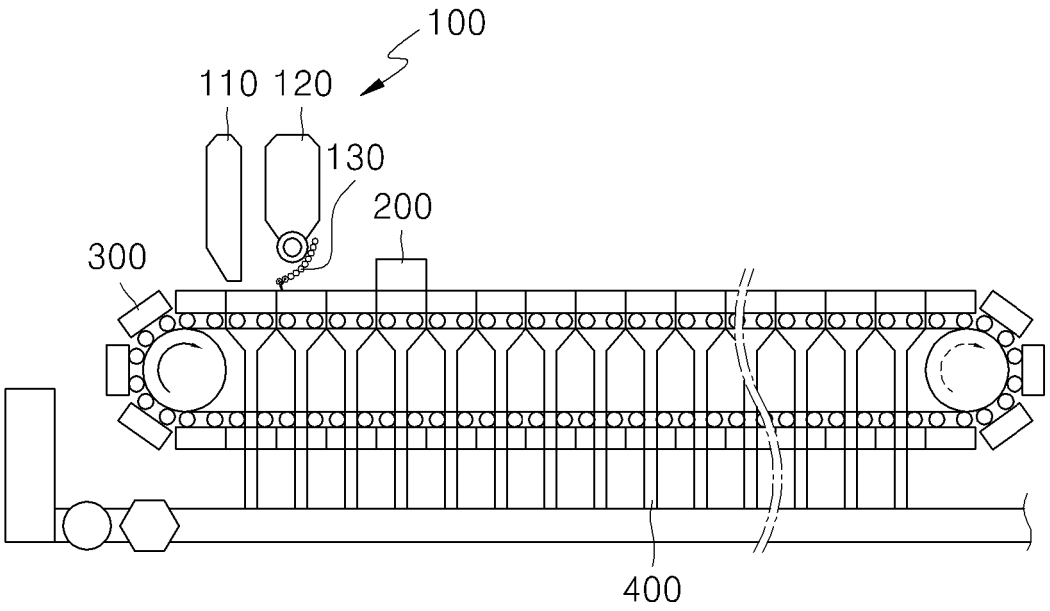


FIG.2

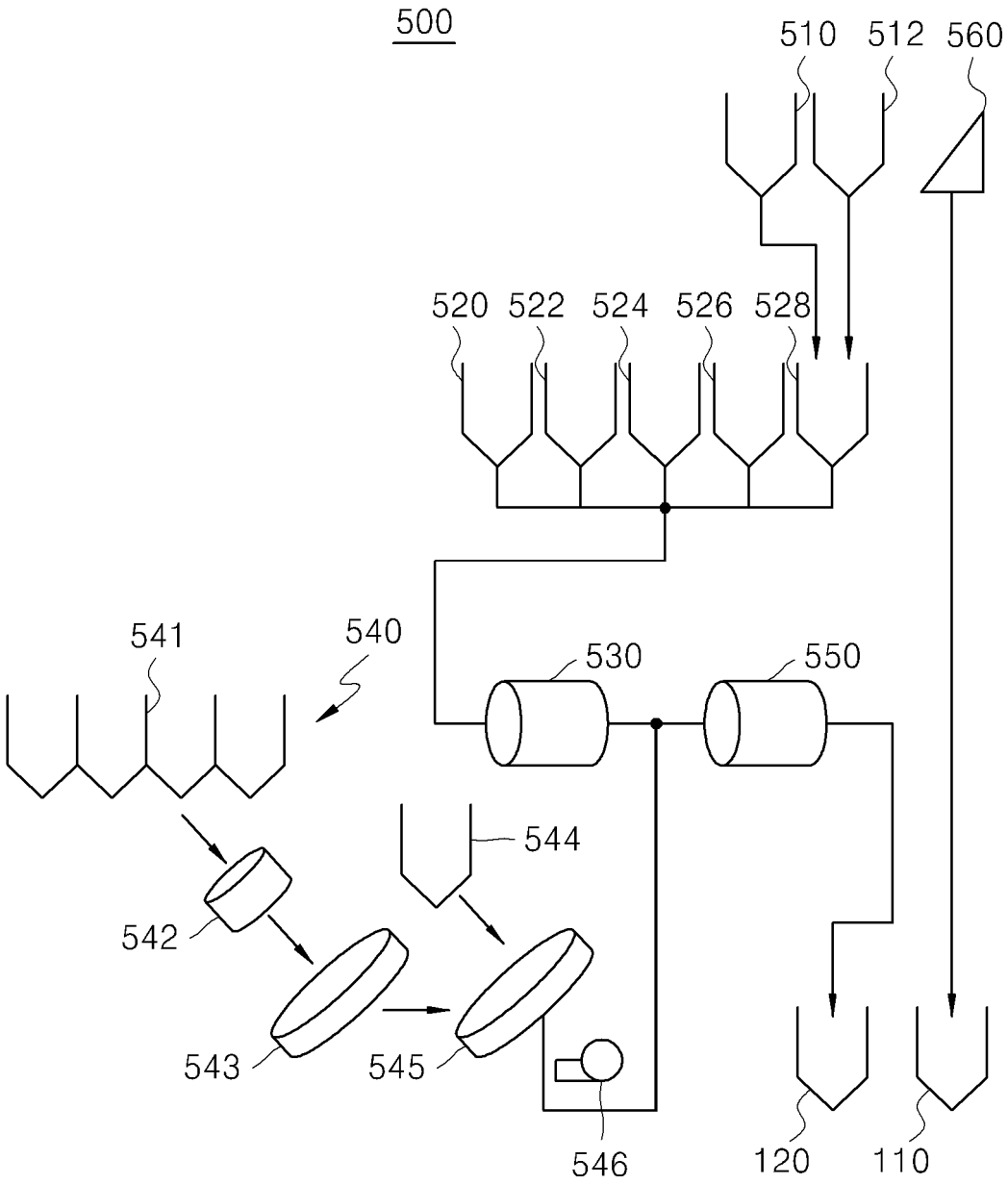

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FIG.3

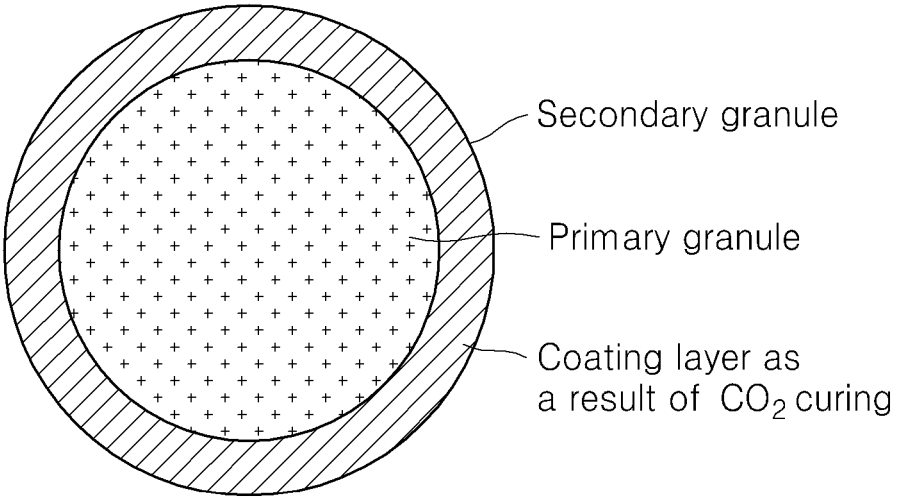
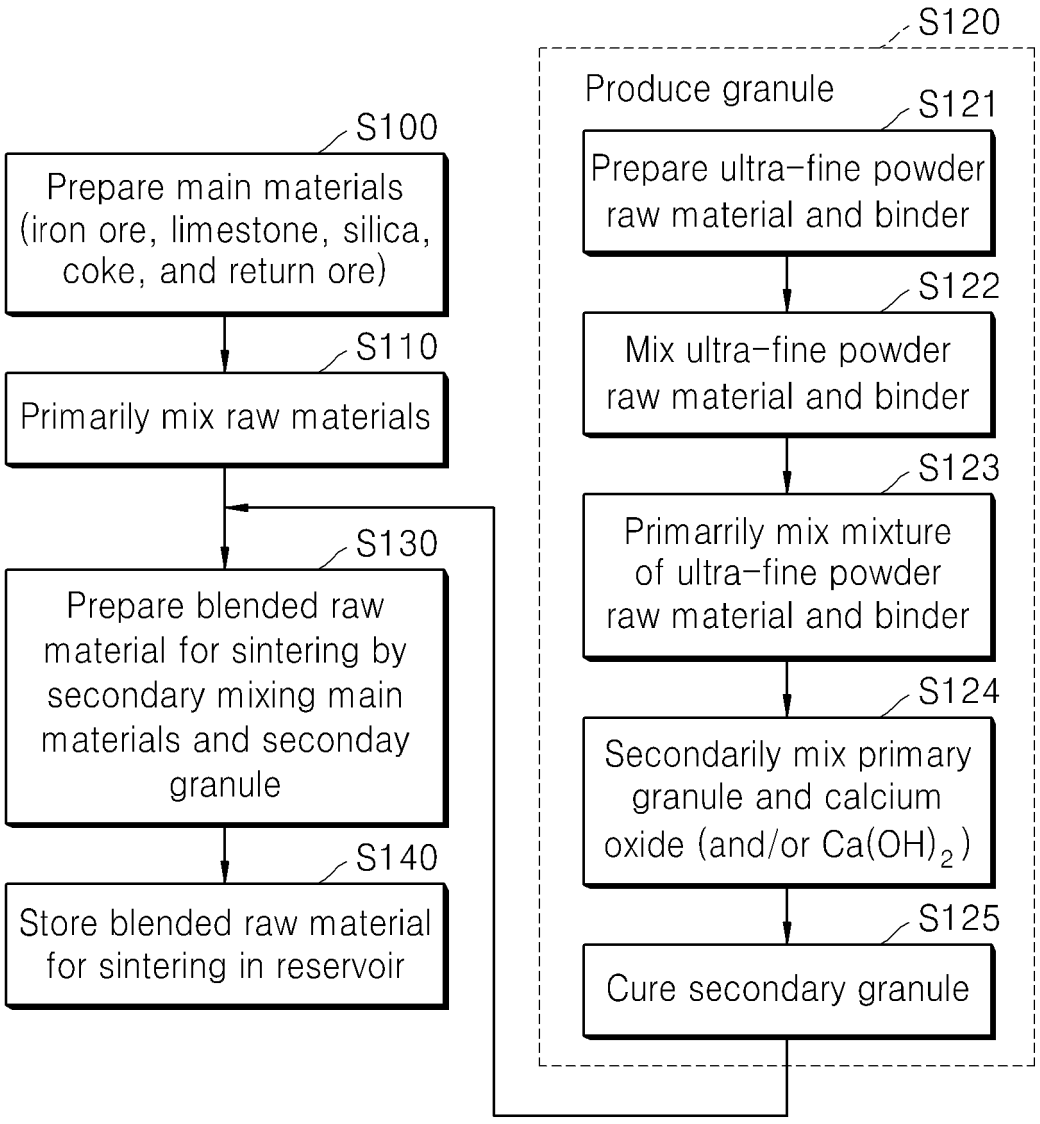

Secondary granule
Primary granule
Coating layer as a result of CO_2 curing

FIG.4


S100
Prepare main materials (iron ore, limestone, silica, coke, and return ore)
S110
Primarily mix raw materials
S130
Prepare blended raw material for sintering by secondary mixing main materials and seconday granule
S140
Store blended raw material for sintering in reservoir
S120
Produce granule
S121
Prepare ultra-fine powder raw material and binder
S122
Mix ultra-fine powder raw material and binder
S123
Primarrily mix mixture of ultra-fine powder raw material and binder
S124
Secondarily mix primary granule and calcium oxide (and/or Ca(OH)2)
S125
Cure secondary granule

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2016/011801

A. CLASSIFICATION OF SUBJECT MATTER

C22B 1/242(2006.01)i, C22B 1/243(2006.01)i, C22B 1/244(2006.01)i, C22B 1/248(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C22B 1/242; C22B 1/244; B28B 3/02; B28B 11/16; C22B 1/16; C22B 1/243; C22B 1/14; C22B 1/248

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: base material, treatment, sintered ore, iron-containing ultrafine powder, binding material, quick lime, slaked lime, coating layer, curing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-1990-0007450 B1 (POHANG IRON & STEEL CO. et al.) 10 October 1990 See pages 1-2; claim 1; and figure 1.	1-23
Y	JP 09-071824 A (NKK CORP. et al.) 18 March 1997 See paragraphs [0008], [0013]-[0015]; claim 1; and figure 1.	1-23
A	KR 10-2013-0070827 A (POSCO) 28 June 2013 See paragraphs [0019]-[0020], [0031]; and figure 4.	1-23
A	KR 10-2004-0050002 A (PAIK, Sang Jin et al.) 14 June 2004 See claims 1-5; and figure 1.	1-23
A	KR 10-2013-0102150 A (KIM, Jae Wook) 17 September 2013 See paragraphs [0026]-[0029]; and figures 4-5.	1-23

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 JANUARY 2017 (20.01.2017)	**23 JANUARY 2017 (23.01.2017)**

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Authorized officer

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2016/011801

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KR 10-2013-0102150 A	17/09/2013	NONE	

Form PCT/ISA/210 (patent family annex) (January 2015)