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(54) METHOD FOR MANUFACTURING SINTERED ORE

VERFAHREN ZUR HERSTELLUNG VON SINTERERZ

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Description

Technical Field

[0001] The present invention relates to a method for manufacturing sintered ore, and in particular, to a method for manufacturing sintered ore including measuring component concentrations in the sintered ore and adjusting the pallet speed in accordance with the measured component concentrations.

Background Art

[0002] In blast furnace ironmaking methods, iron-containing raw materials such as sintered ore, lump iron ore, and pellets are mainly used as iron sources for blast furnace feed materials. Here, sintered ore is a kind of agglomerated ore manufactured in such a manner that a sintering raw material, which is prepared by gathering iron ore having a particle size of 10 mm or less, miscellaneous iron sources, such as various kinds of dust generated in a steel plant, CaO-containing raw materials, such as limestone, quick lime, and steel-making slag, and bonding agents, such as coke breeze and anthracite, and by adding, as an optional blending material, MgO-containing raw materials, such as nickel refining slag, dolomite, and serpentinite, and SiO_2-containing raw materials, such as nickel refining slag and silica stone (silica sand), is stirred, mixed and granulated in a drum mixer with adding water, and then burned.

[0003] In recent years, the concentration of iron in iron ore contained in a sintering raw material, which is a raw material for sintered ore, has been decreasing, and, in contrast, the concentrations of gangue components, such as SiO_2 and Al_2O_3, have been increasing. In addition, the component concentrations in produced iron ore have become variable to such an extent that, even in the case of the same kind of iron ore, the component concentrations may vary from one shipment to another when the iron ore is imported.

[0004] There is a large variation in the amounts of the various kinds of dust generated in a steel plant and in the carbon concentration in the dust. In the case where there is a large variation in the amount of carbon contained in a sintering raw material, there is a variation in the sintering reaction temperature.

[0005] Since a variation in the sintering reaction temperature causes a variation in the quality of product sintered ore (hereinafter, also referred to as "sintered ore"), which is produced by performing sintering, the variation in the sintering reaction temperature has a significant influence on the quality of the sintered ore. For example, in the case where there is an excessive amount of heat, since there is an increase in the sintering reaction temperature, there is a deterioration in the quality of sintered ore, for example, due to a low-strength vitreous structure being formed in the sintered ore or due to a deterioration in reducibility as a result of an increase in the amount of magnetite structure. On the other hand, in the case where there is an insufficient amount of heat, since there is a decrease in the sintering reaction temperature, there may be a case where a sintering reaction does not occur, which results in sintered ore not being obtained. Therefore, adjusting the sintering reaction temperature is indispensable for achieving stable quality of sintered ore.

[0006] However, it is very difficult to continuously determine the sintering reaction temperature. Therefore, generally, by analyzing the composition of sintered ore, the amount of heat is adjusted in accordance with the sintering reaction temperature which is estimated on the basis of analysis results. Specifically, the FeO concentration and the retained C concentration in sintered ore are determined. In a sintering reaction, thermal dissociation, in which hematite in sintered ore transitions into magnetite, progresses with an increase in temperature. Although magnetite transitions back into hematite with a decrease in temperature after the reaction, since the magnetite, which has been formed by thermal dissociation, does not always transition back into hematite, a large amount of magnetite is retained in sintered ore in the case where the sintering reaction temperature is high. Since magnetite contains divalent iron, the FeO concentration in sintered ore provides an indication of the sintering reaction temperature. Since C retained in sintered ore indicates that such C has not been used as a heat resource for a sintering reaction, it is supposed that there is an insufficient amount of heat at the time of the sintering reaction in the case where the C concentration retained in sintered ore is high.

[0007] To date, determination of the components of sintered ore and adjustment of the amount of heat of the sintering reaction have been implemented. For example, Patent Literature 1 discloses a technique in which the FeO concentration in sintered ore is determined and in which the amounts of a bonding agent and granulation water and an air-discharging rate of the sintering raw material are adjusted in accordance with the FeO concentration of the sintered ore. In addition, Patent Literature 2 discloses a technique in which the FeO concentration in sintered ore is determined and in which the amount of city gas blown into a sintering machine is adjusted in accordance with the FeO concentration of the sintered ore.

[0008] In addition, Patent Literature 3 discloses a technique in which the component concentrations in sintered ore are estimated on the basis of the component concentrations in a surface layer of the burden layer of a sintering raw material, which has been charged onto a pallet, the component concentrations in the surface layer being determined by using a laser-type component measuring device disposed above a sintering machine, and in which the composition of a sintering raw material is adjusted in accordance with the estimation results. Futhermore, Patent Literature 4 and 5 disclose a method for manufacturing sintered ore, in which a sintering raw material containing an iron-containing raw material, a

CaO-containing raw material, and a bonding agent is mixed with water and granulated, and the granulated sintering raw material is sintered in a sintering machine to manufacture sintered ore, the method comprising a pallet speed-adjusting process.

Citation List

Patent Literature

[0009]

PTL 1: Japanese Unexamined Patent No. 1464203
PTL 2: Japanese Unexamined Patent No. 5544784
PTL 3: Japanese Unexamined Patent Application Publication No. 60-262926
PTL 4: US 2012/103136 A1
PTL 5: US 2005/050995 A1

Summary of Invention

Technical Problem

[0010] In the case of the techniques disclosed in Patent Literature 1 and Patent Literature 2, the FeO concentration in sintered ore is determined, and the amounts of bonding agents and granulation water, the air-discharging rate, and the amount of city gas blown are adjusted to achieve the target concentration of FeO. However, since it takes a long time to reflect the adjustment results in the component of the sintered ore, there may be equipment problems such as abnormal stoppage of a cooler and the breakdown of equipment located downstream of the cooler when there is an increase in the sintering reaction temperature.

[0011] In the case of the technique disclosed in Patent Literature 3, although the component concentrations in sintered ore are estimated on the basis of the component concentrations in the surface layer of a burden layer of a sintering raw material, there is a variation in the component concentrations in the surface layer of the burden layer of the sintering raw material due to segregation caused by a charging apparatus for the sintering raw material and the particle diameter of the sintering raw material. Therefore, there is no definite relationship between the component concentrations in the surface layer of the burden layer and the component concentrations in the sintered ore, which makes it difficult to practically estimate the component concentrations in the sintered ore on the basis of the component concentrations in the surface layer of the burden layer.

[0012] The present invention has been completed in view of the problems of the conventional techniques, and an object of the present invention is to provide a method for manufacturing sintered ore with which it is possible to inhibit equipment problems from occurring in equipment for manufacturing sintered ore, even when there is a variation in the sintering reaction temperature, by detecting such a variation.

Solution to Problem

[0013] The features of the present invention for solving the issues described above are as disclosed in appended claims 1-4.

Advantageous Effects of Invention

[0014] By implementing the method for manufacturing sintered ore according to the present invention, the component concentrations in sintered ore are continuously measured, and the pallet speed of a sintering machine is adjusted. With this, since it is possible to inhibit an increase in sintered ore temperature at the discharge part of a cooler, it is possible to inhibit equipment problems such as the equipment breakdown of the sintering machine.

Brief Description of Drawings

[0015]

[Fig. 1] Fig. 1 is a schematic diagram illustrating an example of sintered ore manufacturing equipment 10 with which the method for manufacturing sintered ore according to the present embodiment is implemented.
[Fig. 2] Fig. 2 includes graphs illustrating the variations of the FeO concentration in sintered ore, the pallet speed, the blending ratio of coke breeze, and a sintered ore temperature at the discharge part of a cooler with respect to time in the case of the example of the present invention.
[Fig. 3] Fig. 3 includes graphs illustrating the variations of the FeO concentration in sintered ore, the pallet speed, the blending ratio of coke breeze, and a sintered ore temperature at the discharge part of a cooler with respect to time in the case of the comparative example.

Description of Embodiments

[0016] Hereafter, the present invention will be described in accordance with the embodiments of the present invention. Fig. 1 is a schematic diagram illustrating an example of sintered ore manufacturing equipment 10 with which the method for manufacturing sintered ore according to the present embodiment is implemented. An iron-containing raw material 12 which is stored in a yard 11 is transported to a blending bin 22 via a transporting conveyer 14. The iron-containing raw material 12 contains various brands of iron ore and dust generated in a steel plant.

[0017] A raw material feeding section 20 has plural blending bins 22, 24, 25, 26, and 28. The blending bin 22 contains the iron-containing raw material 12. The blending bin 24 contains a CaO-containing raw material 16 including limestone, quicklime, and so forth. The blending bin 25 contains a MgO-containing raw material 17 including dolomite, nickel refining slag, and so forth. The blending bin 26 contains a bonding agent 18 including coke breeze, which is prepared by performing crushing in a rod mill so that the particle diameter is 1 mm or less, and anthracite. The blending bin 28 contains return fine 74 having a particle diameter of 5 mm or less, which is the portion of sintered ore passing through sieves for sintered ore (powder under the sieves for sintered ore). Predetermined amounts of the raw materials are discharged from each of the blending bins 22, 24, 25, 26, and 28 of the raw material feeding section 20 so as to be added, and a blend of the discharged raw materials is made into a sintering raw material on a transporting conveyer 30. The sintering raw material is transported to a drum mixer 36 via the transporting conveyer 30. A SiO_2-containing raw material may be blended in the sintering raw material. In this case, a predetermined amount of the SiO_2-containing raw material may be blended to the iron-containing raw material 12 stored in the yard 11, or another blending bin containing the SiO_2-containing raw material may be installed and a predetermined amount of the SiO_2-containing raw material may be discharged from the blending bin so as to be blended.

[0018] The sintering raw material, which has been transported to the drum mixer 36, is charged into the drum mixer 36 with an appropriate amount of water 34 being added and granulated to form quasiparticles having an average particle diameter of, for example, 3.0 mm to 6.0 mm. The granulated sintering raw material is transported to a sintering raw material charging device 42 of a sintering machine 40 via a transporting conveyer 38. Since the drum mixer 36 is an example of a granulating apparatus which is used to granulate the sintering raw material, plural drum mixers 36 may be used, and a pelletizer may be used as a granulating apparatus instead of the drum mixer 36. Both the drum mixer 36 and the pelletizer may be used, and a high-speed stirring apparatus may be placed upstream of the drum mixer 36 to stir the sintering raw material before the sintering raw material is charged into the drum mixer 36. In the present embodiment, the term "average particle diameter" denotes an arithmetic average particle diameter defined by the formula $\sum(Vi \times di)$, where Vi denotes the abundance ratio of particles having a particle diameter within the i-th range defined in terms of particle diameter and di denotes the representative particle diameter of the i-th range. In the sintering machine 40, the sintering raw material, which has been granulated in the drum mixer 36, is sintered. The sintering machine 40 is, for example, a downward suction-type Dwight-Lloyd sintering machine. The sintering machine 40 has the sintering raw material charging device 42, an endless mobile pallet 44 that circulates and moves, an ignition furnace 46, and wind boxes 48. The sintering raw material, which has been granulated, is charged into the pallet 44 through the sintering raw material charging device 42 to form a burden layer of the sintering raw material.

[0019] The burden layer is ignited by using the ignition furnace 46, and air in the burden layer is suctioned downward through the wind boxes 48 so that a combustion-melting zone in the burden layer moves toward the lower portion of the burden layer. With this, the burden layer is sintered to form a sintered cake. When air in the burden layer is suctioned downward through the wind boxes 48, at least one of a gas fuel and oxygen may be blown down from above the burden layer. The gas fuel is a combustible gas selected from among blast furnace gas, coke oven gas, converter gas, city gas, natural gas, methane gas, ethane gas, propane gas, and shale gas, and a mixture thereof.

[0020] The sintered cake is crushed by using a crushing machine 50 to form sintered ore. The sintered ore, which has been crushed by using the crushing machine 50, is cooled by using a cooler 60. The sintered ore, which has been cooled by using the cooler 60, is subjected to screening utilizing a sieving apparatus 70 having plural sieves to separate the sintered ore into product sintered ore 72 having a particle diameter of more than 5 mm and the return fine 74 having a particle diameter of 5 mm or less.

[0021] The product sintered ore 72 is transported to a blast furnace 82 via a transporting conveyer 76. In the transporting conveyer 76, via which the product sintered ore 72 is transported, an infrared analyzer 80 is installed. By using the infrared analyzer 80, a measuring process is performed. In the measuring process, the component concentration of at least one or more of FeO and C in the product sintered ore 72 is continuously measured by using the infrared analyzer 80.

[0022] The infrared analyzer 80 radiates infrared light having a wavelength of 0.5 μm to 50.0 μm and receives reflected light from the product sintered ore 72. Since the molecular vibration of FeO contained in the product sintered ore 72 absorbs specific-wavelength components of the radiated infrared light, FeO imparts specific-wavelength components to the reflected infrared light. Also, the crystal structure of a single-atom molecule, such as C, starts vibrating at the time of radiating the infrared light and thereby imparts the specific-wavelength components to the reflected infrared light. Therefore, it is possible to determine the component concentrations of FeO and C in the product sintered ore 72 by analyzing the radiated infrared light and the reflected infrared light.

[0023] The infrared analyzer 80 radiates infrared light having 20 or more wavelengths and receives reflected light reflected from the product sintered ore 72 at a frequency of, for example, 128 times per minute. Since it is possible to radiate and receive infrared light in such a short time by using the infrared analyzer 80, it is possible to continuously measure the component concentrations in the product sintered ore 72, which is transported on the transporting conveyer 76, online by using the infrared analyzer 80. Since the infrared analyzer 80 is an example of an analyzing device which is used to measure the component concentrations in the sintering raw material, a laser analyzer which radiates laser beams onto an object to be measured, a neutron analyzer which radiates neutrons onto an object to be measured, or a microwave analyzer which radiates microwaves onto an object to be measured may be used instead of the infrared analyzer 80.

[0024] The product sintered ore 72 having a particle diameter of more than 5 mm is transported to the blast furnace 82 via the transporting conveyer 76 and charged into a blast furnace as a blast furnace feed material. On the other hand, the return fine 74 having a particle diameter of 5 mm or less is transported to the blending bin 28 in the raw material feeding section 20 via a transporting conveyer 78.

[0025] Since the product sintered ore 72 is sintered ore which has been subjected to crushing by using the crushing machine 50 followed by cooling and screening, the product sintered ore 72, the sintered ore which has been crushed by using the crushing machine 50 and the return fine 74 have the same component concentrations. Therefore, the infrared analyzer 80 may be installed between the cooler 60 and the sieving apparatus 70 or on the transporting conveyer 78. In the case where the infrared analyzer 80 is installed between the cooler 60 and the sieving apparatus 70, the component concentrations in the sintered ore, which has been cooled, are measured in the measuring process. In the case where the infrared analyzer 80 is installed in the transporting conveyer 78, the component concentrations in the return fine 74 are measured in the measuring process.

[0026] In the present embodiment, the term "particle diameter of the product sintered ore 72 or the return fine 74" denotes a particle diameter determined by performing screening utilizing a sieve, and, for example, the expression "a particle diameter of more than 5 mm" denotes the particle diameter of particles which remain on a sieve having a sieve mesh of 5 mm, and the expression "a particle diameter of 5 mm or less" denotes the particle diameter of particles which pass through a sieve having a sieve mesh of 5 mm. The value expressing the particle diameter of the product sintered ore 72 or the return fine 74 is definitely used as an example, and the particle diameter of the product sintered ore 72 or the return fine 74 is not limited to this example.

[0027] The method for manufacturing sintered ore according to the present embodiment includes a pallet speed-adjusting process of adjusting the pallet speed. In the pallet speed-adjusting process, the pallet speed is adjusted in accordance with, for example, the FeO concentration in the product sintered ore 72 which is measured in the measuring process.

[0028] Since the fact that the FeO concentration in the product sintered ore 72 is high indicates that a large amount of magnetite is retained in the product sintered ore 72, it is inferred that there is an increase in the temperature of a sintered cake due to an increase in the sintering reaction temperature. Therefore, even if such a sintered cake is crushed and cooled by using the cooler 60, since it is not possible to cool the sintered ore to a temperature equal to or lower than the upper-temperature limit at the discharge part of the cooler 60, there may be equipment problems such as abnormal stoppage of the cooler 60 and the breakdown of equipment located downstream of the cooler 60.

[0029] Therefore, by checking the relationship between the FeO concentration in the sintered ore and a sintered ore temperature at the discharge part of the cooler 60 in accordance with the pallet speed in advance, the control value of the FeO concentration, which indicates that the sintered ore temperature at the discharge part of the cooler 60 exceeds the upper-temperature limit at the discharge part of the cooler 60, is determined in advance. In the pallet speed-adjusting process, in the case where the FeO concentration in the product sintered ore 72 is higher than the control value, that is, in the case where it is predicted that the sintered ore temperature at the discharge part of the cooler 60, which is calculated by using the relationship described above, will exceed the upper-temperature limit, the pallet speed is adjusted lower. In the case where there is a decrease in the pallet speed, since there is an increase in the time for which the sintered ore is cooled in the cooler 60, there is a decrease in sintered ore temperature at the discharge part of the cooler 60, which makes it possible to inhibit equipment problems such as abnormal stoppage of the cooler 60 and the breakdown of equipment located downstream of the cooler 60.

[0030] In the example described above, the FeO concentration in the product sintered ore 72 is continuously measured in the measuring process, and the pallet speed is adjusted in the case where the FeO concentration in the product sintered ore 72 is higher than the control value, that is, in the case where it is predicted that the sintered ore temperature at the discharge part of the cooler 60, which is calculated by using the relationship described above, will exceed the upper-temperature limit. However, in the measuring process, the C concentration in the product sintered ore 72 may be measured instead of the FeO concentration. By checking the relationship between the C concentration in the sintered ore and a sintered ore temperature at the discharge part of the cooler 60 in advance, the control value of the C concentration with which the sintered ore temperature at the discharge part of the cooler 60 exceeds the upper-temperature limit at the discharge part of the cooler 60 is determined in advance. Then, in the case where the C concentration is higher than the control value, the pallet speed is adjusted lower. In this case, an increase in C concentration indicates that there is an increase in C concentration due to C remaining uncombusted because of inhomogeneous temperature distribution in the width direction of the sintering machine, that is, unburned sintered ore is discharged. Therefore, by adjusting the pallet speed lower to completely combust C in the sintering machine, it is possible to inhibit abnormal stoppage of the cooler 60 due to C being combusted in the cooler 60 and equipment problems, for example, due to C being combusted in equipment located downstream of the cooler 60.

[0031] The method for manufacturing sintered ore according to the present embodiment may further include a blending amount-adjusting process of adjusting the amount of the bonding agent, of the sintering raw material, in accordance with the component concentration of at least one or more of FeO and C in the product sintered ore 72 that is measured in the measuring process. For example, even in the case where the FeO concentration in the product sintered ore 72 is higher than the control value, that is, even in the case where it is predicted that the sintering reaction temperature will be high, by decreasing the amount of the bonding agent in the blending amount-adjusting process, it is possible to decrease the sintering reaction temperature. After the sintering reaction temperature has been decreased, since it is possible to return the pallet speed, which has been decreased in the pallet speed-adjusting process, to the original value, it is possible to inhibit a decrease in the productivity of sintered ore due to a decrease in the pallet speed. By inhibiting a variation in the sintering reaction temperature by adjusting the amount of the bonding agent added, since it is possible to inhibit a variation in the FeO concentration in the sintered ore, there is an improvement in the quality of sintered ore.

[0032] The method for manufacturing sintered ore according to the present embodiment may further include a blowing amount-adjusting process of adjusting the amount of at least one of a gas fuel and oxygen blown in accordance with the concentration of at least one or more of FeO and C in the sintered ore that is measured in the measuring process. For example, even in the case where the FeO concentration in the sintered ore is higher than the control value, that is, even in the case where it is predicted that the sintering reaction temperature will be high, by decreasing the amount of at least one of the gas fuel and the oxygen blown in the blowing amount-adjusting process, it is possible to decrease the time for which the sintering reaction temperature is held at a higher level. After the time for which the sintering reaction temperature is held at a higher level has been decreased, since it is possible to return the pallet speed, which has been decreased in the pallet speed-adjusting process, to the original value, it is possible to inhibit a decrease in the productivity of sintered ore due to a decrease in the pallet speed. By inhibiting a variation in the sintering reaction temperature by adjusting the amount of at least one of the gas fuel and oxygen blown, since it is possible to inhibit a variation in the FeO concentration in the sintered ore, there is an improvement in the quality of sintered ore.

[0033] Although an example, in which raw materials are discharged from each of the blending bins 22, 24, 25, 26, and 28 in the raw material feeding section 20 to be blended, made into the sintering raw material in the transporting conveyer 30, and granulated in the drum mixer 36, is described in the present embodiment, the embodiment of the present invention is not limited to this example. For example, carbonaceous material-coated particles, which are manufactured by charging a sintering raw material containing the iron-containing raw material 12, the CaO-containing raw material 16, the MgO-containing raw material 17, and the return fine 74 to the drum mixer 36, by adding water to the sintering raw material to granulate the sintering raw material, and by charging the bonding agent 18 in the posterior part of the granulating time to coat the granulated particles with the bonding agent 18, may be used as a granulated sintering raw material.

[0034] Carbonaceous material-coated particles, which are manufactured by charging a sintering raw material containing the iron-containing raw material 12, the CaO-containing raw material 16, the MgO-containing raw material 17, the return fine 74, and part of the bonding agent 18 to the drum mixer 36, by adding water to the sintering raw material to granulate the sintering raw material, and by charging the remaining bonding agent 18 in the posterior part of the granulating time to coat the surface layer of the granulated sintering raw material with the bonding agent 18, may be used as a granulated sintering raw material. Examples of the bonding agent which is added in the posterior part of the granulating time after water has been added to the sintering raw material include coke breeze and anthracite.

[0035] In the case where plural drum mixers 36 are used and the surface layer of the carbonaceous material-coated particles which is coated with the bonding agent 18 are used, the carbonaceous material-coated particles, which are coated with the bonding agent 18, may be manufactured by charging all or part of the bonding agent 18 into the posterior part of the last drum mixer 36 and by charging the sintering raw material into the drum mixers 36 by using the method described above. Moreover, regarding water which is added to the sintering raw material in the case where plural drum mixers 36 are used, all of the water may be added in the first drum mixer 36, or part of the water may be added in the first drum mixer 36 with the remaining water being added in the other drum mixers 36.

[0036] Although an example, in which raw materials are discharged from each of the blending bins 22, 24, 25, 26, and 28 in the raw material feeding section 20 to be blended, made into the sintering raw material in the transporting conveyer 30, and granulated in the drum mixer 36, is described in the present embodiment, the embodiment of the present invention is not limited to this example. For example, granulated particles, which are manufactured by charging a sintering raw material containing the iron-containing raw material 12, the MgO-containing raw material 17, and the return fine 74 to the drum mixer 36, by adding water to the sintering raw material to granulate the sintering raw material, and by charging the CaO-containing raw material 16 and the bonding agent 18 in the posterior part of the granulating time to coat the surface layer of the granulated particles with the CaO-containing raw material 16 and the bonding agent 18, may be used as a granulated sintering raw material.

[0037] Granulated particles, which are manufactured by charging a sintering raw material containing part of the iron-containing raw material 12, MgO-containing raw material 17, the return fine 74, and the bonding agent 18 to the drum mixer 36, by adding water to the sintering raw material to granulate the sintering raw material, and by adding the remaining iron-containing raw material 12 and the CaO-containing raw material 16 in the posterior part of the granulating time to coat the surface layer of the granulated sintering raw material with the iron-containing raw material 12 and the CaO-containing raw material 16, may be used as a granulated sintering raw material.

[0038] Granulated particles, which are manufactured by charging a sintering raw material containing the iron-containing raw material 12, the return fine 74, MgO-containing raw material 17, and part of the CaO-containing raw material 16 to the drum mixer 36, by adding water to the sintering raw material to granulate the sintering raw material, and by adding the remaining CaO-containing raw material 16 and the bonding agent 18 in the posterior part of the granulating time to coat the surface layer of the granulated sintering raw material with the CaO-containing raw material 16 and the bonding agent 18, may be used as a granulated sintering raw material.

[0039] Granulated particles, which are manufactured by charging a sintering raw material containing the iron-containing raw material 12, the return fine 74, MgO-containing raw material 17, and part of the CaO-containing raw material 16 and part of the bonding agent 18 to the drum mixer 36, by adding water to the sintering raw material to granulate the sintering raw material, and by adding the remaining CaO-containing raw material 16 and the remaining bonding agent 18 in the posterior part of the granulating time to coat the surface layer of the granulated sintering raw material with the CaO-containing raw material 16 and the bonding agent 18, may be used as a granulated sintering raw material.

[0040] In the case where plural drum mixers 36 are used and the granulated particles which are coated with the CaO-containing raw material 16 or the CaO-containing raw material 16 and the bonding agent 18 are manufactured, the granulated particles, which are coated with the CaO-containing raw material 16 and the bonding agent 18, may be manufactured by charging all or part of the CaO-containing raw material 16 and the bonding agent 18 into the posterior part of the last drum mixer 36 and by charging the sintering raw material into the drum mixers 36 by using the method described above.

[0041] Although an example, in which raw materials are discharged from each of the blending bins 22, 24, 25, 26, and 28 in the raw material feeding section 20 to be blended and made into the sintering raw material in the transporting conveyer 30, is described in the present embodiment, the embodiment of the present invention is not limited to this example. For example, parts of the respective raw materials discharged from each of the blending bins 22, 24, 25, 26, and 28 in the raw material feeding section 20 are directly transported to the drum mixer 36 via the transporting conveyer 30, and the remaining parts of the respective raw materials are transported to a high-speed stirring apparatus via a transporting conveyer, which is different from the transporting conveyer 30, so as to be subjected to a stirring treatment. Subsequently, such remaining parts may be charged into the transporting conveyer 30 or the transporting conveyer 38 after having been subjected to granulation utilizing a granulating machine, such as a drum mixer 36 or a pelletizer, optionally followed by drying utilizing a drying machine as needed. Also, such remaining parts may be directly charged into the transporting conveyer 30 after having been subjected to a stirring treatment without being subjected to granulation utilizing the granulating machine, such as a drum mixer 36 or a pelletizer. Moreover, a crushing process and/or a sieving process may be performed before a stirring treatment is performed by using the high-speed stirring apparatus. In the case where plural drum mixers 36 are used, such remaining parts may be charged into any one of the transporting conveyers placed between the drum mixers.

[0042] Moreover, in the measuring process, not only one but plural infrared analyzers 80 may be installed. The component concentration of at least one or more of FeO and C in the sintered ore may be measured by using the plural infrared analyzers 80.

EXAMPLES

[0043] In the case of both the example of the present invention and the comparative example, sintered ore was manufactured by using the sintered ore manufacturing equipment 10 illustrated in Fig. 1. In the case of example of the present invention and the comparative example, the sintered ore was manufactured for 5 hours while the FeO concentration, as the component concentration in the sintered ore, was continuously measured at a frequency of 18 times per hour by using the infrared analyzer 80 installed in the transporting conveyer 76, and the blending ratio of the coke breeze, that is a bonding agent, was adjusted in accordance with the measured FeO concentrations so that the FeO concentration in the sintered ore was equal to the FeO control value. In the case of both the example of the present invention and the comparative example, after one hour had elapsed since the start of manufacturing, the raw material pile was changed to one containing dust having a high C concentration.

[0044] The example of the present invention was an example including the pallet speed-adjusting process of adjusting the pallet speed in the sintering machine, and the comparative example was an example not including the pallet speed-adjusting process. Therefore, when there was an increase in the FeO concentration in the sintered ore, while the pallet speed was decreased and the blending ratio of coke breeze was adjusted in the example of the present invention, the blending ratio of coke breeze was adjusted without adjusting the pallet speed in the comparative example.

[0045] Fig. 2 includes graphs illustrating the variations of the FeO concentration (mass%) in sintered ore, the pallet speed (m/min), the blending ratio (mass%) of coke breeze, and a sintered ore temperature (°C) at the discharge part of a cooler with respect to time in the case of the example of the present invention. Fig. 3 includes graphs illustrating the variations of the FeO concentration (mass%) in sintered ore, the pallet speed (m/min), the blending ratio (mass%) of coke breeze, and a sintered ore temperature (°C) at the discharge part of a cooler with respect to time in the case of the comparative example.

[0046] Since the measuring process of continuously measuring the FeO concentration in the sintered ore by using the infrared analyzer 80 was included, it was possible to promptly detect that the FeO concentration in the sintered ore was higher than the FeO control value after the raw material pile had been changed. Since it was possible to detect, on the basis of an increase in the FeO concentration, that the temperature of the sintered ore at the discharge part of the cooler would exceed the upper-temperature limit due to an increase in the sintering reaction temperature, the pallet speed in the sintering machine was decreased in the pallet speed-adjusting process and the blending ratio of coke breeze was adjusted in the example of the present invention. As a result, since it was possible to inhibit an increase in sintered ore temperature at the discharge part of the cooler, it was possible to perform the operation without the upper-temperature limit at the discharge part of the cooler being exceeded. After the FeO concentration had been returned to the control value by adjusting the blending ratio of coke breeze, the pallet speed was returned to the original value. With this, it was also possible to inhibit a decrease in the productivity of the sintered ore.

[0047] As described above, in the case of the method for manufacturing sintered ore according to the present embodiment, the FeO concentration in the sintered ore is continuously measured, and the pallet speed in the sintering machine is adjusted when an increase in the FeO concentration in the sintered ore is detected. With this, it is clarified that, since it is possible to inhibit an increase in sintered ore temperature at the discharge part of the cooler, it is possible to decrease a load on the cooler and equipment located downstream of the cooler, which makes it possible to avoid equipment problems such as equipment breakdown.

[0048] Also in the case of the comparative example, since it was possible to detect, on the basis of an increase in the FeO concentration in the sintered ore, that the temperature of the sintered ore at the discharge part of the cooler would exceed the upper-temperature limit, the blending ratio of coke breeze was adjusted. However, it was only after an elapsed time of about 30 minutes, which was the period of time from when the blending ratio of coke breeze was adjusted until the raw material already charged in the sintering machine was replaced by the adjusted raw material, that there was a decrease in sintered ore temperature at the discharge part of the cooler. During such an elapsed time, there was an increase in sintered ore temperature at the discharge part of the cooler to a level exceeding the upper-temperature limit at the discharge part of the cooler, which resulted in abnormal stoppage of the cooler. After the stoppage of the cooler and the pallet, since there was a decrease in the temperature of the sintering machine, the manufacture of sintered ore was restarted with the blending ratio of coke breeze in the sintering raw material being increased and with the pallet speed being decreased.

[0049] In the case of both the example of the present invention and the comparative example, when an increase in the FeO concentration in the sintered ore was detected and it was thereby possible to detect that the temperature of the sintered ore at the discharge part of the cooler would exceed the upper-temperature limit, the sintering raw material taken from the raw material pile containing dust having a high C concentration causing the sintering reaction temperature to increase had already been charged onto a pallet in the sintering machine. In the case of the comparative example, although the blending ratio of coke breeze was adjusted, such adjustment of the blending ratio was reflected in the sintering raw material which was prepared by using the raw materials discharged from the raw material feeding section to be added after such adjustment had been performed and not in the sintering raw material which had already been charged on the pallet. Therefore, in the case of the comparative example, since there was an increase in sintered ore temperature due to an increase in the sintering reaction temperature, the sintered ore temperature exceeded the upper-temperature limit at the discharge part of the cooler. As a result, an equipment problem, that is, abnormal stoppage of the cooler occurred.

[0050] In the case of the example of the present invention, when an increase in the FeO concentration in the sintered ore was detected and it was thereby possible to detect that the temperature of the sintered ore at the discharge part of the cooler would exceed the upper-temperature limit, the pallet speed was decreased in the pallet speed-adjusting process. With this, since it was possible to increase the time for which the sintering raw material which had already been charged onto a pallet was cooled in the cooler, it was possible to inhibit an increase in sintered ore temperature at the discharge part of the cooler, even if there was an increase in the sintering reaction temperature of such a sintering raw material, which made it possible to inhibit problems such as abnormal stoppage of the cooler and the equipment breakdown. Although the measurement utilizing the infrared analyzer 80 installed in the transporting conveyer 76 was performed at a measuring frequency of 18 times per hour in this example of the present invention, it is possible to realize the effects of the present invention caused by adjusting the pallet speed with a measuring frequency lower than this. It is sufficient that the measurement be performed once or more in a period of about 30 minutes, which is the time taken to replace the raw material already charged in the sintering machine.

[0051] As described above, in the case of the method for manufacturing sintered ore according to the present embodiment, an increase in the sintering reaction temperature is promptly detected by continuously measuring the FeO concentration in the sintered ore in the measuring process, and the pallet speed is decreased in the pallet speed-adjusting process. It is clarified that, with this, for example, even in the case where there is an increase in the sintering reaction temperature due to the raw material pile being changed to one containing dust having a high C concentration, since it is possible to inhibit an increase in the sintered ore temperature at the discharge part of the cooler, it is possible to inhibit equipment problems such as abnormal stoppage of the cooler and the equipment breakdown of the sintering machine.

Reference Signs List

[0052]

10	sintered ore manufacturing equipment
11	yard
12	iron-containing raw material
14	transporting conveyer
16	CaO-containing raw material
17	MgO-containing raw material
18	bonding agent
20	raw material feeding section
22	blending bin
24	blending bin
25	blending bin
26	blending bin
28	blending bin
30	transporting conveyer
34	water
36	drum mixer
38	transporting conveyer
40	sintering machine
42	sintering raw material charging device
44	pallet
46	ignition furnace
48	wind box
50	crushing machine
60	cooler
70	sieving apparatus
72	product sintered ore
74	return fine
76	transporting conveyer
78	transporting conveyer
80	infrared analyzer
82	blast furnace

Claims

1. A method for manufacturing sintered ore, in which a sintering raw material containing an iron-containing raw material, a CaO-containing raw material, and a bonding agent is mixed with water and granulated, and the granulated sintering raw material is sintered in a sintering machine to manufacture sintered ore, the method comprising:

a measuring process of continuously measuring component concentration (mass%) of at least one or more of FeO and C in the sintered ore, wherein the measurement is performed by use of any of an infrared analyzer, a laser analyzer, a neutron analyzer or a microwave analyzer; and
a pallet speed-adjusting process of adjusting a pallet speed in accordance with the component concentration of at least one or more of FeO and C in the sintered ore measured in the measuring process,
wherein, in the case that the component concentration is higher than a control value, the pallet speed is adjusted to be lower in the pallet speed-adjusting process.

2. The method for manufacturing sintered ore according to Claim 1, wherein the sintering raw material further contains at least one of a MgO-containing raw material and a SiO_2-containing raw material.

3. The method for manufacturing sintered ore according to Claim 1 or 2, the method further comprising
a blending amount-adjusting process of adjusting an amount of the bonding agent, of the sintering raw material, in accordance with the component concentration of at least one or more of FeO and C in the sintered ore.

4. The method for manufacturing sintered ore according to any one of Claims 1 to 3,

wherein at least one of a gas fuel and oxygen is blown into the sintering machine to sinter the sintering raw material, the method further comprising
a blowing amount-adjusting process of adjusting an amount of at least one of the gas fuel and the oxygen blown in accordance with the component concentration of at least one or more of FeO and C in the sintered ore.

Patentansprüche

1. Verfahren zur Herstellung von Sintererz, bei dem ein Sinterrohmaterial, das ein eisenhaltiges Rohmaterial, ein CaO-haltiges Rohmaterial und ein Bindemittel enthält, mit Wasser gemischt und granuliert wird, und das granulierte Sinterrohmaterial in einer Sintermaschine gesintert wird, um ein Sintererz herzustellen, wobei das Verfahren umfasst:

ein Messverfahren zur kontinuierlichen Messung der Konzentration von Komponenten (Masse-%) von mindestens einem Element oder mehr aus FeO und C im Sintererz,
wobei die Messung durch Verwendung eines Infrarot-Analysators, eines Laser-Analysators, eines Neutronen-Analysators oder eines Mikrowellen-Analysators ausgeführt wird; und
einen Paletten-Geschwindigkeitseinstellprozess zur Anpassung einer Palettengeschwindigkeit entsprechend der Komponentenkonzentration von mindestens einer Komponente aus FeO und C im Sintererz, die im Messprozess gemessen wird,
wobei für den Fall, dass die Komponentenkonzentration höher als ein Kontrollwert ist, die Palettengeschwindigkeit im Prozess zur Anpassung der Palettengeschwindigkeit auf einen niedrigeren Wert eingestellt wird.

2. Verfahren zur Herstellung von Sintererz nach Anspruch 1, wobei das Sinterrohmaterial ferner mindestens eine Komponente aus einem MgO-haltigen Rohmaterial und einem SiO_2-haltigen Rohmaterial enthält.

3. Verfahren zum Herstellen von Sintererz nach Anspruch 1 oder 2, wobei das Verfahren ferner umfasst:

einen Prozess zum Einstellen der Mischungsmenge, bei dem die Menge des Bindemittels, des Sinterrohmaterials, entsprechend der Komponentenkonzentration von mindestens einer Komponente aus FeO und C im Sintererz eingestellt wird.

4. Verfahren zum Herstellen von Sintererz nach einem der Ansprüche 1 bis 3,

wobei mindestens eines der Gase Brenngas und Sauerstoff in die Sintermaschine geblasen wird, um das Sinterrohmaterial zu sintern, wobei das Verfahren ferner umfasst
ein Verfahren zum Einstellen der Einblasmenge, bei dem die Menge von mindestens einem der Gase Brenngas und Sauerstoff entsprechend der Komponentenkonzentration von mindestens einer Komponente aus FeO und C im Sintererz eingestellt wird.

Revendications

1. Procédé de fabrication de minerai fritté, dans lequel un matériau brut de frittage contenant un matériau brut contenant du fer, un matériau brut contenant du CaO et un agent de liaison, est mélangé avec de l'eau et granulé, et le matériau de frittage granulé est fritté dans une machine de frittage pour fabriquer un minerai fritté, le procédé comprenant :

un procédé de mesure de manière continue d'une concentration de composant (% en masse) d'au moins un ou plusieurs parmi FeO et C dans le minerai fritté, dans lequel la mesure est effectuée en utilisant un quelconque parmi un analyseur infrarouge, un analyseur laser, un analyseur de neutrons ou un analyseur de micro-ondes ; et
un procédé de réglage de vitesse de palette pour ajuster une vitesse de palette en fonction de la concentration de composant d'au moins un ou plusieurs parmi FeO et C dans le minerai fritté mesurée dans le procédé de mesure,
dans lequel, dans le cas où la concentration de composant est supérieure à une valeur de commande, la vitesse de palette est ajustée pour être inférieure dans le processus d'ajustement de vitesse de palette.

2. Procédé de fabrication de minerai fritté selon la revendication 1, dans lequel le matériau brut de frittage contient en outre au moins un matériau brut parmi un matériau brut contenant du MgO et un matériau brut contenant du SiO_2.

3. Procédé de fabrication de minerai fritté selon la revendication 1 ou 2, le procédé comprenant en outre un processus d'ajustement de quantité de mélange pour ajuster une quantité de l'agent de liaison, du matériau brut de frittage, en fonction de la concentration de composant d'au moins un ou plusieurs parmi FeO et C dans le minerai fritté.

4. Procédé de fabrication de minerai fritté selon l'une quelconque des revendications 1 à 3,

dans lequel au moins un parmi un combustible gazeux et de l'oxygène est soufflé dans la machine de frittage pour fritter le matériau brut de frittage, le procédé comprenant en outre
un processus d'ajustement de quantité de soufflage pour ajuster une quantité d'au moins un parmi le combustible gazeux et l'oxygène soufflé en fonction de la concentration de composant d'au moins un ou plusieurs parmi FeO et C dans le minerai fritté.

FIG. 1

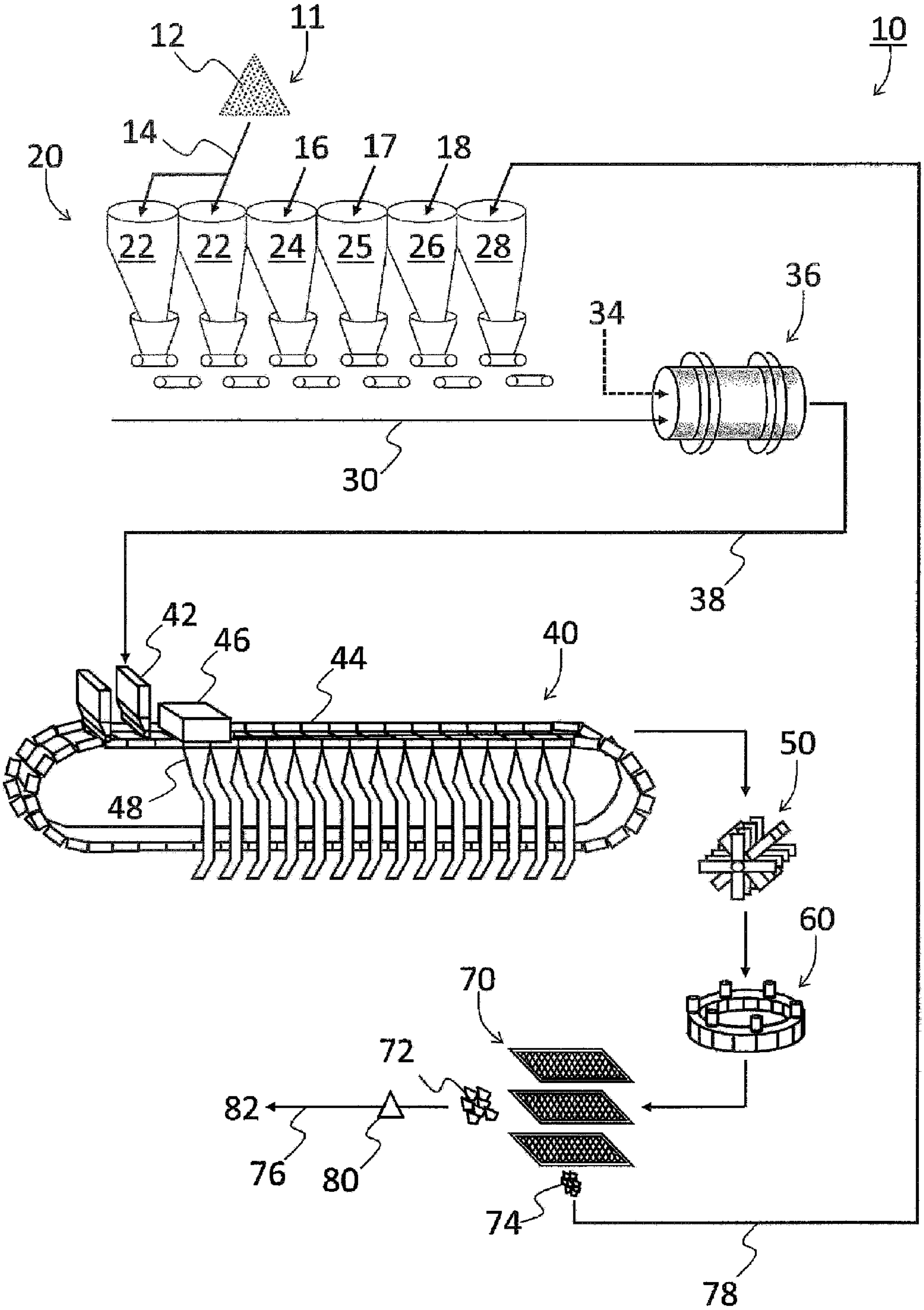

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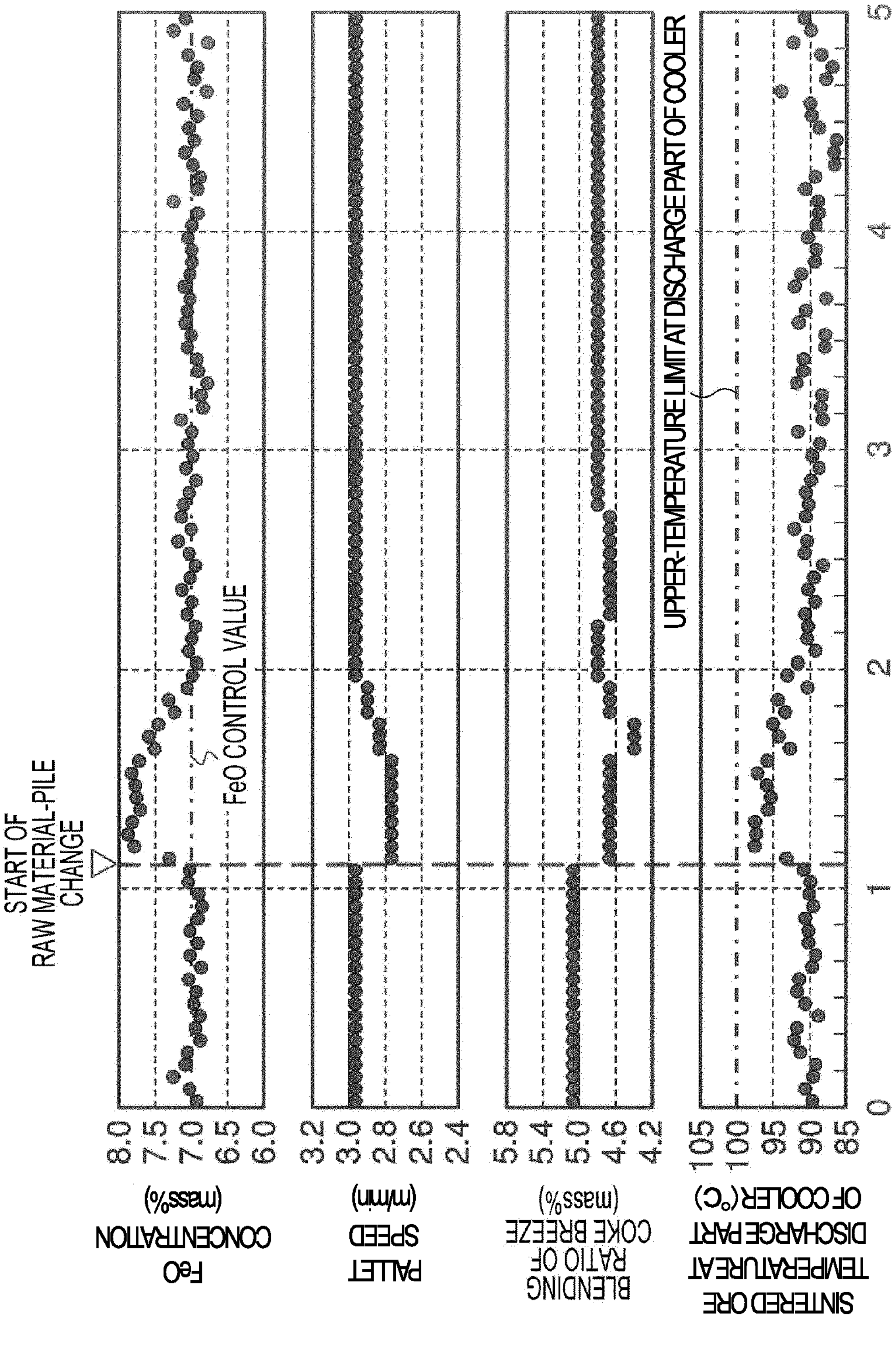
FIG. 2


START OF RAW MATERIAL-PILE CHANGE
FeO CONTROL VALUE
UPPER-TEMPERATURE LIMIT AT DISCHARGE PART OF COOLER
FeO CONCENTRATION (mass%)
PALLET SPEED (m/min)
BLENDING RATIO OF COKE BREEZE (mass%)
SINTERED ORE TEMPERATURE AT DISCHARGE PART OF COOLER (°C)
8.0
7.5
7.0
6.5
6.0
3.2
3.0
2.8
2.6
2.4
5.8
5.4
5.0
4.6
4.2
105
100
95
90
85
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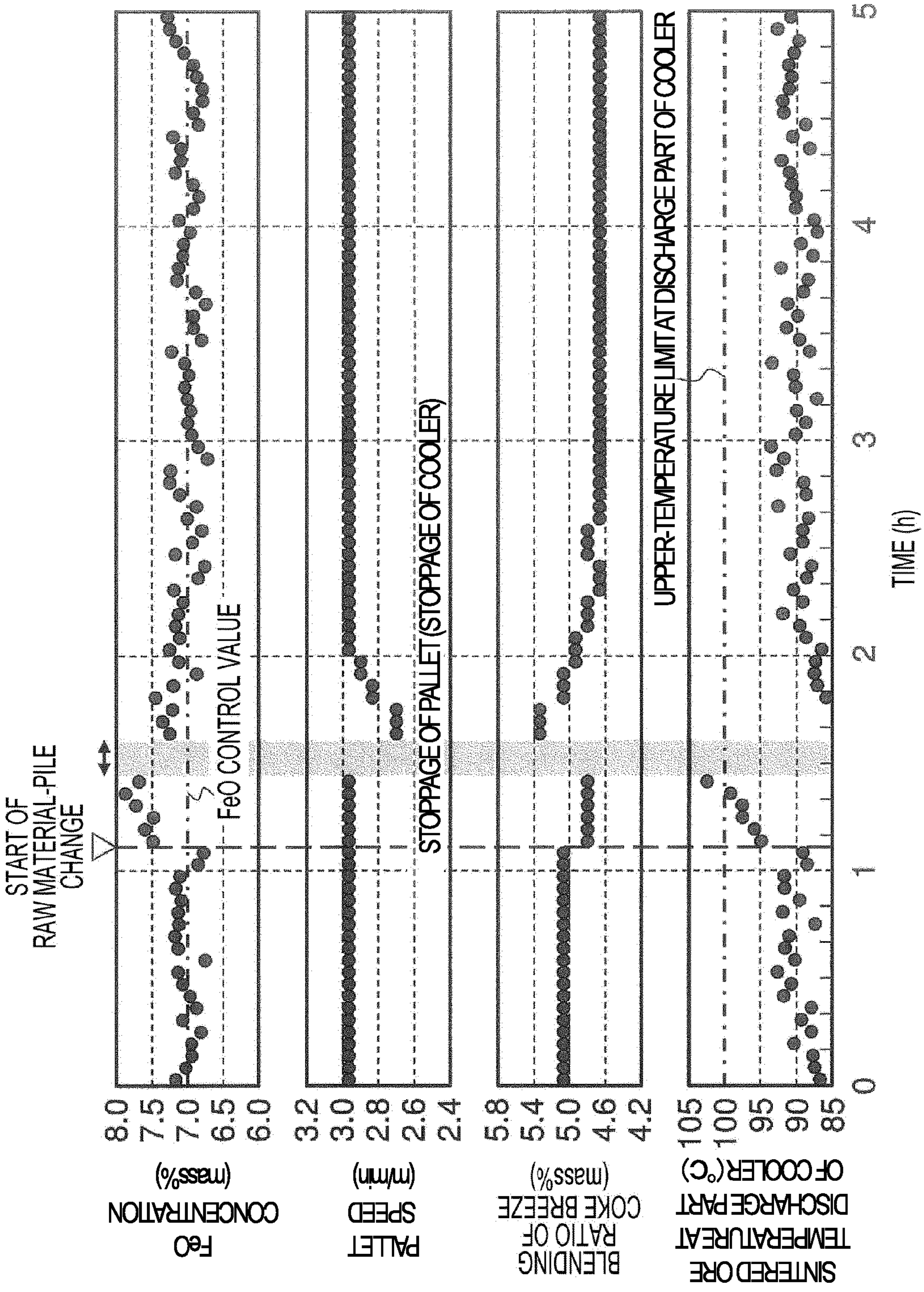
3
4
5
TIME (h)

FIG. 3


START OF RAW MATERIAL-PILE CHANGE
FeO CONTROL VALUE
STOPPAGE OF PALLET (STOPPAGE OF COOLER)
UPPER-TEMPERATURE LIMIT AT DISCHARGE PART OF COOLER
FeO CONCENTRATION (mass%)
8.0 7.5 7.0 6.5 6.0
PALLET SPEED (m/min)
3.2 3.0 2.8 2.6 2.4
BLENDING RATIO OF COKE BREEZE (mass%)
5.8 5.4 5.0 4.6 4.2
SINTERED ORE TEMPERATURE AT DISCHARGE PART OF COOLER (°C)
105 100 95 90 85
0 1 2 3 4 5
TIME (h)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 1464203 A **[0009]**
- JP 5544784 A **[0009]**
- JP 60262926 A **[0009]**
- US 2012103136 A1 **[0009]**
- US 2005050995 A1 **[0009]**