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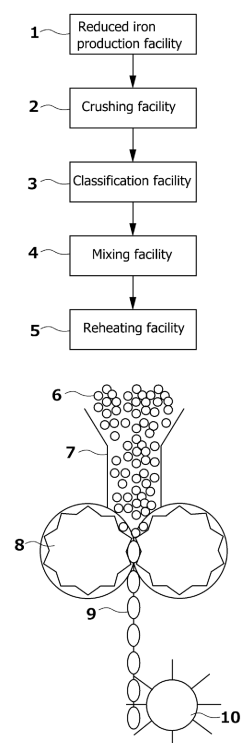
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(54) **METHOD AND DEVICE FOR PRODUCING REDUCED IRON BRIQUETTES**

(57) Proposed is a method for producing a reduced iron briquette that can improve both the apparent density and strength thereof when briquetting reduced iron through hot briquetting. The method for producing a reduced iron briquette of the present invention includes, in performing hot briquetting on a reduced iron aggregate composed of pellet-shaped reduced iron containing an iron component, a step of controlling a particle size distribution of the reduced iron aggregate, and a step of performing hot briquetting on the reduced iron aggregate with the controlled particle size distribution. An apparatus for producing a reduced iron briquette of the present invention includes a reduced iron production facility that produces pellet-shaped reduced iron containing an iron component to form a reduced iron aggregate, a crushing facility that crushes the reduced iron aggregate, a classification facility that screens the crushed reduced iron aggregate, using a sieve having a plurality of sieve meshes, a mixing facility that mixes the reduced iron aggregate having a plurality of particle size levels, separated by the screening, to prevent uneven distribution of the particle sizes within a mold for hot briquetting, and a reheating facility that heats the mixed reduced iron aggregate to a briquetting temperature required for the hot briquetting.

[Fig. 2]



EP 4 772 657 A1

Description

Technical Problem

Technical Field

[0001] The present invention relates to a method and apparatus for producing a reduced iron briquette, and more specifically, to a method for obtaining a reduced iron briquette (hot briquetted iron) through hot briquetting.

Background Art

[0002] Hot briquetted iron (hereinafter also referred to as "HBI") is attracting attention as a raw material to be charged into a furnace that can address the dual challenges of achieving an operation with a high pig-iron production rate and reducing CO₂ emissions. HBI is a briquetted product produced by hot-briquetting reduced iron, i.e., direct reduced iron (hereinafter also referred to as "DRI"). DRI has a porous structure where oxygen of an oxide (FexOy) within a target material has been removed through a reduction reaction. Compared to its pre-reduction state, DRI has a higher proportion of T.Fe and a larger specific surface area, resulting in higher reactivity. Thus, if DRI is stored in an oxygen atmosphere, such as ambient air, it reacts with oxygen, leading to potential heat generation or ignition due to the heat of oxidation. Therefore, storing DRI in an inert gas atmosphere (nitrogen gas) is desirable, which poses a challenge in terms of storage.

[0003] One solution to the challenge of storing DRI is to process it into HBI. Processing DRI into HBI reduces reactivity by reducing voids between DRI particles while compressing the internal pores of DRI in a hot working temperature range, where processing is easier than at room temperature, thereby reducing the specific surface area. This also reduces the risk of heat generation and ignition. Conventionally, techniques described in Patent Literature 1 and Patent Literature 2 are known for producing HBI.

[0004] Patent Literature 1 discloses a technique for producing high-strength, weather-resistant HBI suitable as a raw material for a blast furnace charge, by setting the average C (carbon) content in the surface portion and in the central portion to predetermined values. In addition, Patent Literature 2 discloses an apparatus and method for producing molten iron, in which reduced iron fine and a calcined auxiliary raw material are hot-briquetted.

Citation List

Patent Literature

[0005]

Patent Literature 1: Japanese Patent No. 5059379
Patent Literature 2: Japanese Patent No. 4202326

Summary of Invention

[0006] However, the technique described in Patent Literature 1 relates to a method for producing inexpensive, high-strength, weather-resistant HBI, and it specifies the average C content in the surface portion and the interior of DRI. Therefore, while high strength can be achieved, there is no mention of achieving high density. In addition, the technology described in Patent Literature 2 specifies the optimal production conditions in feeding HBI (briquetted material) into an electric furnace or a blast furnace. Specifically, Patent Literature 2 discloses the desirable particle size distribution of HBI (briquetted material) immediately before it is charged into an electric furnace or a blast furnace after the briquetting of DRI. However, Patent Literature 2 fails to disclose any specific means for achieving such a desirable particle size distribution. Therefore, the technology described in Patent Literature 2 does not necessarily achieve high density of HBI, posing risks associated with longdistance transport.

[0007] The present invention has been made in view of the foregoing circumstances, and an object of the present invention is to propose a method and apparatus for producing a reduced iron briquette that can improve both the apparent density and strength thereof when briquetting reduced iron through hot briquetting.

Solution to Problem

[0008] The method for producing a reduced iron briquette of the present invention includes, in performing hot briquetting on a reduced iron aggregate composed of pellet-shaped reduced iron containing an iron component, a step of controlling a particle size distribution of the reduced iron aggregate, and a step of performing hot briquetting on the reduced iron aggregate with the controlled particle size distribution.

[0009] It should be noted that the method for producing a reduced iron briquette according to the present invention with the foregoing configuration may include the following features, which are considered to be more preferable solution means.

(1) The control step includes a reheating step of heating the reduced iron aggregate to a briquetting temperature required for the hot briquetting.

(2) The control step includes a crushing step of crushing the reduced iron aggregate, a classification step of screening particles of the reduced iron aggregate crushed in the crushing step, using a sieve having a plurality of sieve meshes, and a mixing step of mixing the reduced iron aggregate having a plurality of particle size levels, separated by the screening in the classification step, to prevent uneven distribution of the particle sizes within a mold for hot briquetting, wherein the reheating step involves heating the reduced iron aggregate mixed in the mixing step to the briquetting temperature required

for the hot briquetting.

(3) The mixing step includes mixing the reduced iron having a plurality of particle size levels, separated by the screening in the classification step, into a single reduced iron aggregate, feeding the reduced iron aggregate into a rotary vessel, and then performing mixing through rotation for a given period of time.

(4) The control step involves controlling the particle size distribution such that relationships of $H_A > H_B$ and $W_A < W_B$ are satisfied, where H_A and W_A denote, respectively, a peak height and a peak width of a maximum peak of a reference particle size distribution of the reduced iron aggregate before crushing, and H_B and W_B denote, respectively, a peak height and a peak width of a maximum peak in a particle size distribution of the reduced iron aggregate after crushing, and the peak width W_A is a width at a height position corresponding to half the peak height H_A of the maximum peak, and the peak width W_B is a width at a height position corresponding to half the peak height H_B of the maximum peak.

(5) The T.Fe content of the pellet-shaped reduced iron is less than 85 mass%, and the control step involves controlling the particle size distribution such that relationships of $H_B > (1/2) H_A$ and $W_B > 2W_A$ are satisfied.

[0010] In addition, the apparatus for producing a reduced iron briquette of the present invention is a production apparatus for producing a reduced iron briquette by performing hot briquetting on a reduced iron aggregate composed of pellet-shaped reduced iron containing an iron component, the production apparatus including a reduced iron production facility that produces pellet-shaped reduced iron containing an iron component to form a reduced iron aggregate, a crushing facility that crushes the reduced iron aggregate, a classification facility that screens particles of the crushed reduced iron aggregate, using a sieve having a plurality of sieve meshes, a mixing facility that mixes the reduced iron aggregate having a plurality of particle size levels, separated by the screening, to prevent uneven distribution of the particle sizes within a mold for hot briquetting, and a reheating facility that heats the mixed reduced iron aggregate to a briquetting temperature required for the hot briquetting.

Advantageous Effects of Invention

[0011] According to the method and apparatus for producing a reduced iron briquette of the present invention, it is possible to obtain a reduced iron briquette with improved apparent density and strength by performing hot briquetting on a reduced iron aggregate whose particle size distribution control has been executed.

Brief Description of Drawings

[0012]

[Fig. 1] is a graph illustrating an embodiment of the relationship between the apparent density and porosity of HBI according to the grade of each raw material.

[Fig. 2] is a schematic view for illustrating an embodiment of an apparatus configuration for implementing a method for producing a reduced iron briquette of the present invention.

[Fig. 3] is a graph for illustrating an embodiment of particle size control performed through crushing in the method for producing a reduced iron briquette of the present invention.

[Fig. 4] is a graph for illustrating the relationship between particle size control performed in the method for producing a reduced iron briquette of the present invention and the apparent density of HBI.

Description of Embodiments

[0013] Hereinafter, an embodiment of the present invention will be specifically described. It should be noted that the following embodiment merely illustrates examples of an apparatus and method for embodying the technical idea of the present invention. Thus, the configuration of the present invention is not limited thereto. That is, the technical idea of the present invention may be variously modified within the technical scope recited in the claims.

<Regarding development targets of method for producing reduced iron briquette of the present invention>

[0014] For the maritime transport of HBI, international regulations (IMSBC Code: International Maritime Solid Bulk Cargoes Code) exist, requiring compliance with "an apparent density of 5.0 g/cm³ or greater and a briquetting temperature of 650°C or greater." This requirement is one of the important development indicators for establishing the HBI technology.

[0015] Fig. 1 is a conceptual graph of the relationship between the porosity and apparent density of HBI according to the grade of each raw material. It is known that the porosity and apparent density of HBI have a negative correlation. The graph of HBI obtained by briquetting reduced iron (with a T.Fe content of about 90 mass%) of common-grade iron ore is based on examples A, B, and C of commercially available HBI products on the market. These HBI products have a porosity of 27% or less and achieve the target value (5.0 g/cm³) specified in the apparent density standard of the IMSBC Code for maritime transport. Regarding low-grade ore, compared to common-grade ore, the proportion of gangue components (CaO, Al₂O₃, SiO₂, and MgO) in DRI is higher, and the T.Fe content is lower. Since gangue components

have a lower true density than iron, the density of HBI tends to decrease as the grade of ore decreases. Regarding low-grade and ultra-low-grade ore, it would be difficult to achieve the target apparent density unless the porosity can be reduced more than with common-grade ore. It should be noted that each of the graphs for low-grade ore and ultra-low-grade ore was determined through calculation by, for example, progressively reducing the T.Fe content in increments from the actual graph for common-grade ore (with a T.Fe content of approximately 90 mass%). The T.Fe content in both low-grade ore and ultra-low-grade ore is less than 85 mass%. In Fig. 1, the target apparent density of HBI can be achieved by setting the porosity of the HBI to 20% or less for low-grade ore and 15% or less for ultra-low-grade ore.

<Regarding method for measuring T.Fe Content>

[0016] Before describing the method and apparatus for producing a reduced iron briquette of the present invention, a method for measuring the T.Fe content will be described. First, a predetermined amount of sample is measured and taken, and then, the sample is decomposed to obtain a solution, using either a method (a) or (b) below.

(a) The sample is decomposed with hydrochloric acid in the presence of tin(II) chloride and filtered. The residue is then treated with sulfuric acid and hydrofluoric acid, is melted using potassium disulfate, and is mixed with the filtrate.

(b) The sample is melted with sodium carbonate and sodium peroxide, and the melt is dissolved in warm water. The precipitate is filtered and then dissolved in hydrochloric acid.

[0017] A major portion of iron(III) in the obtained solution is reduced to iron(II) using tin(II) chloride, and the remaining iron(III) is reduced using titanium(III) chloride. Excess titanium(III) chloride is quantitatively oxidized with potassium dichromate. The acid concentration of the solution is adjusted with a mixed acid of sulfuric acid and phosphoric acid, and then, titration is performed with a potassium dichromate solution using sodium diphenylamine-4-sulfonate as an indicator. The T.Fe content in the sample is quantitatively calculated from the titer obtained with dichromate. Such a measurement method is performed in accordance with JIS M 8212 "Gravimetric and Volumetric Analysis," but may also be performed in accordance with other standards or specifications.

<Regarding method and apparatus for producing reduced iron briquette of the present invention>

[0018] In view of the foregoing development targets, the present invention is characterized by controlling the particle size distribution of an aggregate of a pellet-shaped material to be subjected to briquetting before

performing briquetting, in order to improve the apparent density and strength of HBI, thereby solving the foregoing issues. The control of the particle size distribution corresponds to the control of physical properties, and is independent of a method that maintains the chemical composition within specified upper and lower limits. Thus, this control is advantageous in that it allows for evaluation with the briquetting conditions influencing only the briquetting characteristics, without relying on the control of the raw material properties. Further, a method for controlling the particle size distribution, such as screening, crushing, or grinding, is relatively simple in terms of the facility configuration, which poses a low barrier to implementation. Note that "high density" as referred to in the present invention is a relative expression based on the apparent density of commercial HBI. In addition, commercial HBI is defined as HBI having an apparent density of 5.0 g/cm³ or greater.

[0019] Fig. 2 is a schematic view for illustrating an embodiment of a production apparatus for implementing the method for producing a reduced iron briquette of the present invention. The embodiment of the production apparatus illustrated in Fig. 2 includes a reduced iron production facility 1, a crushing facility 2, a classification facility 3, a mixing facility 4, a reheating facility 5, a hopper 7, briquetting rolls 8, and a separator 10. A reduced iron aggregate, which includes a plurality of particles of pellet-shaped reduced iron produced in the reduced iron production facility 1, is fed as a raw material into the crushing facility 2. Particle size distribution control is executed on the reduced iron aggregate in the crushing facility 2, the classification facility 3, and the mixing facility 4. Following the particle size distribution control, the reduced iron aggregate is heated in the reheating facility 5 to become heated DRI 6 with a briquetting temperature. The heated DRI 6 is fed into the hopper 7. The heated DRI 6 fed into the hopper 7 is subjected to briquetting at the briquetting rolls 8 to become HBI 9. The thus obtained HBI 9 is fed into the separator 10.

[0020] The reduced iron production facility 1 may be any type of reduced iron production apparatus, such as a rotary hearth furnace or a direct reduction furnace, for example. The reduced iron produced in the reduced iron production facility 1 is a pellet-shaped material with a diameter per particle of about 10 to 15 mm and a temperature of approximately 700°C. The crushing facility 2 performs crushing involving deformation processing on a portion of the pellet-shaped reduced iron aggregate, thereby altering the particle size distribution of the reduced iron aggregate prior to briquetting. Changing the particle size distribution in the crushing facility 2 contributes to reducing the void ratio in the pellet-shaped reduced iron aggregate within a mold during briquetting. The step of controlling the particle size distribution includes a classification step performed with the classification facility 3, which has a plurality of sieve meshes, following the crushing involving deformation processing for the pellet-shaped reduced iron aggregate. The clas-

sification facility 3 determines the proportion of each particle size in the reduced iron aggregate crushed by the crushing facility 2. With an automatic classifier having a plurality of sieve meshes, it is possible to quantitatively determine the amount of the crushed reduced iron passing through each screen mesh. The step of controlling the particle size distribution includes a mixing step of mixing the reduced iron having a plurality of particle size levels, separated by screening in the classification facility 3, to prevent uneven distribution of the particle sizes within a mold for hot briquetting. The mixing facility 4 is a facility for mixing the classified reduced iron. To fill voids within the forming mold more completely in the subsequent briquetting process, it is necessary to mix the reduced iron particles with the respective sizes, which have been quantitatively determined by the classification facility 3, into a single aggregate, and then agitate the aggregate to a certain degree to prevent uneven distribution of the particle sizes. One agitation method includes, for example, feeding the aggregate into a rotary vessel, such as a kiln, and determining the adequacy of agitation based on rotation for a given period of time.

[0021] The reheating facility 5 reheats the reduced iron mixed in the mixing facility 4. While the particle size distribution of the reduced iron aggregate has been adjusted to the desired particle size distribution by the facilities of up to the mixing facility 4, the temperature of the reduced iron aggregate has dropped from the reduction temperature at the reduced iron production facility 1 as it passes through the series of control processes. Thus, there is a concern that the temperature may drop below the briquetting temperature (650°C). The crushed reduced iron, having smaller individual particle sizes compared to those before crushing, exhibits an increased specific surface area. This leads to enhanced reheating efficiency. In other words, the significance of the crushing, that is, adjusting the particle size distribution is particularly high when hot briquetting is performed. Furthermore, arranging the reheating facility 5 between the facilities for crushing/screening and briquetting is important, as this arrangement allows the reduced iron to be heated to the briquetting temperature even if the reduction temperature at the reduced iron production facility 1 is lower than the briquetting temperature.

[0022] The thus obtained heated DRI 6 is fed into the hopper 7 and supplied by being pushed into the briquetting rolls 8 through the rotation of a screw feeder. The briquetting rolls 8 include a pair of briquetting rolls 8 with the same diameter. Each briquetting roll 8 has a pocket portion carved into its outer peripheral surface, each having the shape of a briquetted product to be obtained. The heated DRI 6 pushed from the hopper 7 is sequentially loaded into the pocket portions. With the rotation of the briquetting rolls 8, the heated DRI 6 is pressurized and compressed by the briquetting rolls 8. A continuous supply of the raw material and synchronous rotation of the briquetting rolls 8 enable HBI 9 to be produced in accordance with the production speed (rotation speed of

the rolls). The HBI 9 is continuously produced on the exit side of the briquetting rolls 8. Immediately after the briquetting, the HBI 9 is not separated into individual pieces but is formed as a single, interconnected mass composed of the individual pieces. The separator 10 separates the HBI 9 into individual pieces. For example, the separator 10 separates the HBI 9 in the connected state into individual pieces of the HBI 9 each having a size of about 100×50×30 mm. The separated pieces of HBI9 are used according to their intended purposes. For example, they are transported over a long distance to be supplied to electric furnaces or melting furnaces at the destinations. In this way, it is possible to produce high-density HBI that meets the targets, such as "an apparent density of 5.0 g/cm³ or greater" specified for the maritime transport of reduced iron.

[0023] That is, according to the present invention, the desired particle size distribution can be achieved with high accuracy, and high density of HBI can be achieved efficiently. In particular, high density of HBI can be achieved more efficiently by performing the steps of crushing, screening, mixing, reheating, and hot briquetting in this order.

[0024] It should be noted that the present invention is particularly effective when lower-grade raw materials are used. Herein, the term "low-grade raw material" refers, for example, to pellet-shaped reduced iron with a T.Fe content of less than 85 mass%. Alternatively, the "low-grade raw material" may be pellet-shaped reduced iron with an even lower iron content, such as a T.Fe content of less than 83 mass% or 80 mass%. As a further alternative, the initial raw material before pelletization, which has a T.Fe content of 63 mass% or less, may be defined as a "low-grade raw material."

Examples

[0025] Assume the following prerequisites for DRI/HBI.

- The particle weight of DRI: 5.0 g/particle
- The particle size of DRI: $\Phi 10$ to 15 mm/particle
- The dimensions of HBI: (long side: 100 mm × short side: 50 mm × thickest portion: 30 mm)/piece
- The shape of HBI: pillow-shaped
- The weight of HBI: 500 g/piece

[0026] The total amount of DRI loaded into each pocket corresponds to one piece of HBI. Therefore, one piece of HBI includes (500 g/piece) / (5.0 g/particle) = 100 DRI particles/piece.

[0027] However, the porosity within the briquetted DRI that forms HBI, as well as the void ratio between the DRI particles, varies depending on the DRI briquetting conditions. The void ratio within a pocket, both immediately before DRI is compressed and when DRI is loaded into the pocket, can be quantitatively evaluated based on the particle size distribution index and the harmonic mean

diameter, for example. It is important to reduce the void ratio within the pocket and thereby increase the number of DRI particles loaded per pocket, by controlling the particle size distribution. As the number of DRI particles increases, a greater variety of large and small DRI particles can fill the pocket. Since the pocket size/shape remains unchanged, the production of higher-density HBI is possible.

[0028] Fig. 3 is a graph for illustrating an embodiment of particle size control performed through crushing in the method for producing a reduced iron briquette of the present invention. A particle size distribution before crushing is used as a reference, and the peak height and peak width of the maximum peak of the reference particle size distribution are denoted as H_A and W_A , respectively. Similarly, H_B and W_B are determined for a particle size distribution after crushing. The peak width W_A is defined as the width at the height position corresponding to half the peak height H_A of the maximum peak. Regarding the reference particle size distribution, the peak position is determined to be at a reduced iron particle size of 12 mm, from the size of the pellet particles forming the reduced iron aggregate, as a representative example. Performing crushing before briquetting can reduce the particle size of some of the particles of the pre-crushed reduced iron aggregate. Consequently, after crushing, the proportion of the particles (peak height) at the peak of the reference particle size distribution decreases compared to that of the reference. This causes the peak to shift to a position smaller than the reference (12 mm), while also widening the peak width. Fig. 3 illustrates that crushing the majority of the pre-crushed pellet-shaped particles with a particle size of $\Phi 12$ mm results in a decrease in the peak position to about $\Phi 8$ mm. From the foregoing, it is found that the particle size distribution is preferably controlled such that the relationships of $H_A > H_B$ and $W_A < W_B$ are satisfied.

[0029] If the grade of the pellet-shaped reduced iron used as a raw material is low, the particle size distribution may be controlled to achieve a wider distribution range. For example, if the T.Fe content of the pellet-shaped reduced iron is less than 85 mass%, the particle size distribution may be controlled such that the relationships of $H_B > (1/2)H_A$ and $W_B > 2W_A$ are satisfied. Controlling the particle size distribution in such a manner can achieve higher density of HBI more efficiently.

[0030] Fig. 4 is a graph for illustrating the relationship between particle size control performed in the method for producing a reduced iron briquette of the present invention and the apparent density of HBI. From the results in Fig. 4, it is found that the apparent density of HBI obtained through briquetting with the crushed particle size distribution is expected to be higher by up to about 10% compared with that of a commercial product as a reference. Note that the apparent density was evaluated based on "ISO 15968: Direct reduced iron - Determination of apparent density and water absorption of hot briquetted iron (HBI)."

Reference Signs List

[0031]

- | | | |
|----|----|----------------------------------|
| 5 | 1 | reduced iron production facility |
| | 2 | crushing facility |
| | 3 | classification facility |
| | 4 | mixing facility |
| | 5 | reheating facility |
| 10 | 6 | heated DRI |
| | 7 | hopper |
| | 8 | briquetting roll |
| | 9 | HBI |
| | 10 | separator |

Claims

1. A method for producing a reduced iron briquette, comprising, in performing hot briquetting on a reduced iron aggregate composed of pellet-shaped reduced iron containing an iron component:

a step of controlling a particle size distribution of the reduced iron aggregate; and
a step of performing hot briquetting on the reduced iron aggregate with the controlled particle size distribution.

2. The method for producing a reduced iron briquette according to claim 1, wherein the control step comprises a reheating step of heating the reduced iron aggregate to a briquetting temperature required for the hot briquetting.

3. The method for producing a reduced iron briquette according to claim 2, wherein:

the control step comprises

a crushing step of crushing the reduced iron aggregate,
a classification step of screening particles of the reduced iron aggregate crushed in the crushing step, using a sieve having a plurality of sieve meshes, and
a mixing step of mixing the reduced iron aggregate having a plurality of particle size levels, separated by the screening in the classification step, to prevent uneven distribution of the particle sizes within a mold for hot briquetting, and

the reheating step is a step of heating the reduced iron aggregate mixed in the mixing step to the briquetting temperature required for the hot briquetting.

4. The method for producing a reduced iron briquette according to claim 3, wherein the mixing step is a step of mixing the reduced iron having a plurality of particle size levels, separated by the screening in the classification step, into a single reduced iron aggregate, and feeding the reduced iron aggregate into a rotary vessel, and then performing mixing through rotation for a given period of time. 5

5. The method for producing a reduced iron briquette according to claim 3, wherein: 10

the control step is a step of controlling the particle size distribution such that relationships of $H_A > H_B$ and $W_A < W_B$ are satisfied, where H_A and W_A denote, respectively, a peak height and a peak width of a maximum peak of a reference particle size distribution of the reduced iron aggregate before crushing, and H_B and W_B denote, respectively, a peak height and a peak width of a maximum peak of a particle size distribution of the reduced iron aggregate after crushing, and 15 20

the peak width W_A is a width at a height position corresponding to half the peak height H_A of the maximum peak, and the peak width W_B is a width at a height position corresponding to half the peak height H_B of the maximum peak. 25 30

6. The method for producing a reduced iron briquette according to any one of claims 1 to 5, wherein: 35

a T.Fe content of the pellet-shaped reduced iron is less than 85 mass%, and 35

the control step is a step of controlling the particle size distribution such that relationships of $H_B > (1/2)H_A$ and $W_B > 2W_A$ are satisfied. 40

7. A production apparatus for producing a reduced iron briquette by performing hot briquetting on a reduced iron aggregate composed of pellet-shaped reduced iron containing an iron component, the production apparatus comprising: 45

a reduced iron production facility that produces pellet-shaped reduced iron containing an iron component to form a reduced iron aggregate; 50

a crushing facility that crushes the reduced iron aggregate;

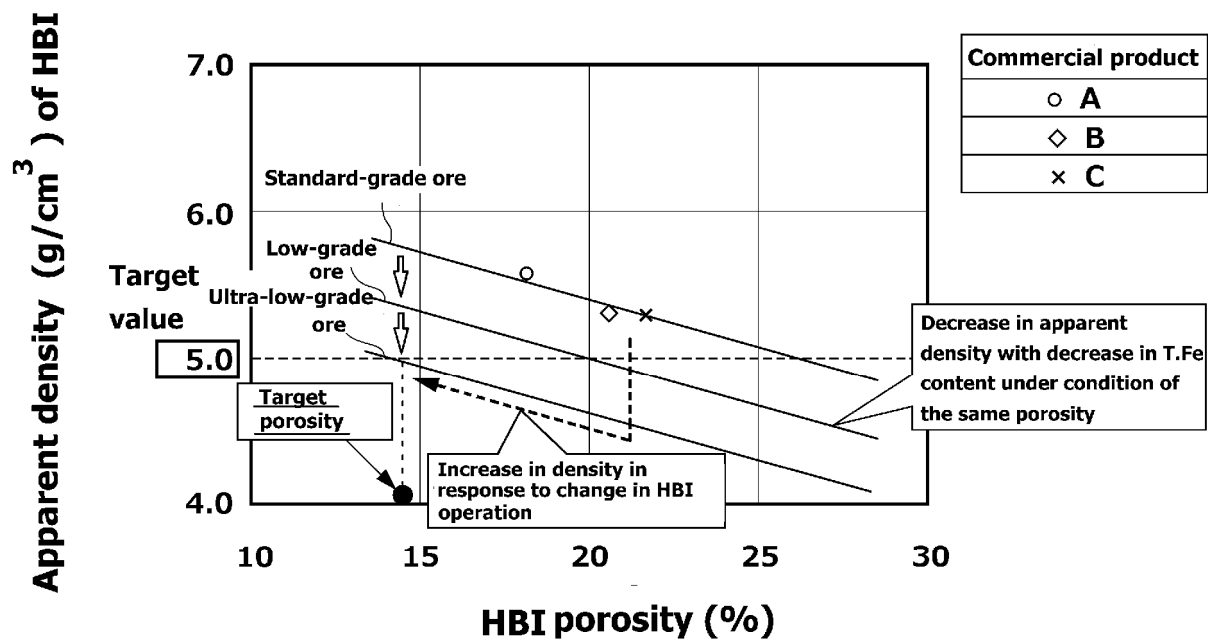
a classification facility that screens particles of the crushed reduced iron aggregate, using a sieve having a plurality of sieve meshes;

a mixing facility that mixes the reduced iron aggregate having a plurality of particle size levels, separated by the screening, to prevent uneven distribution of the particle sizes within 55

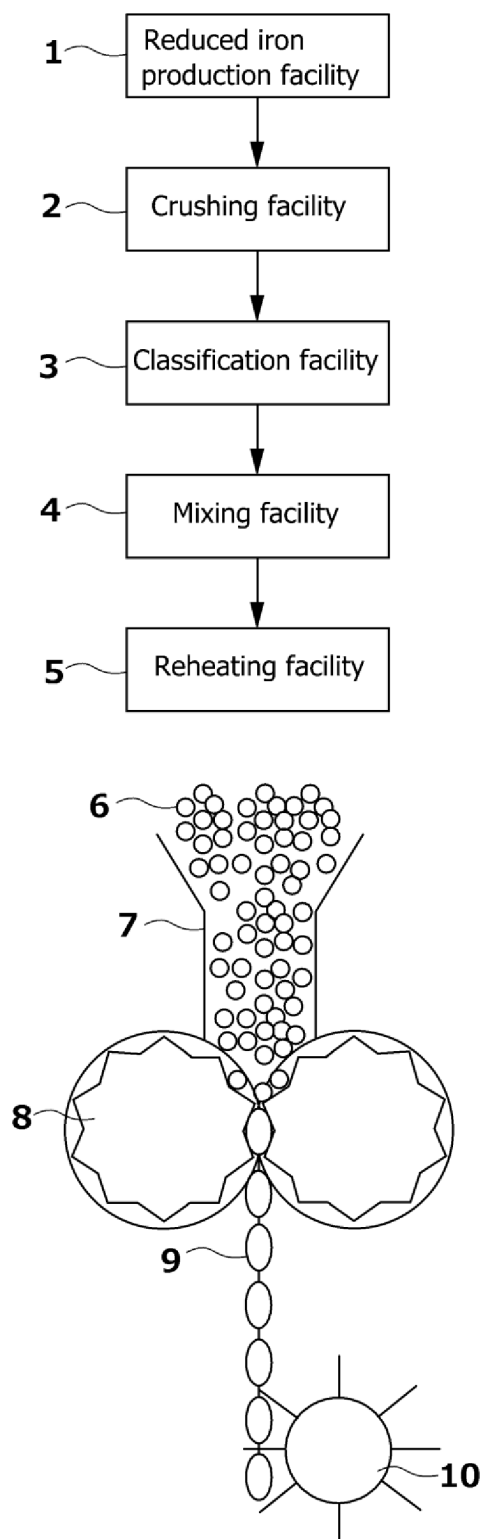
a mold for hot briquetting; and

a reheating facility that heats the mixed reduced iron aggregate to a briquetting temperature required for the hot briquetting.

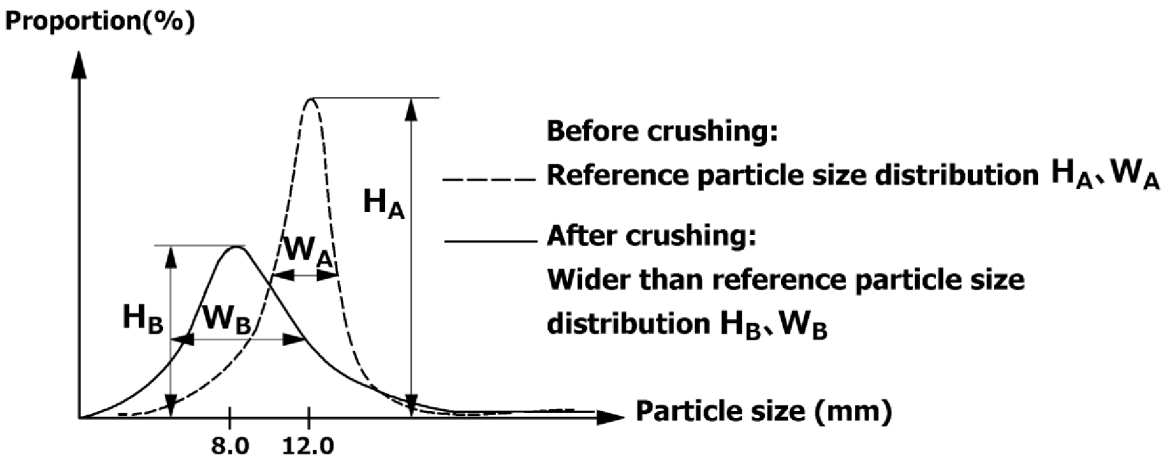
[Fig. 1]



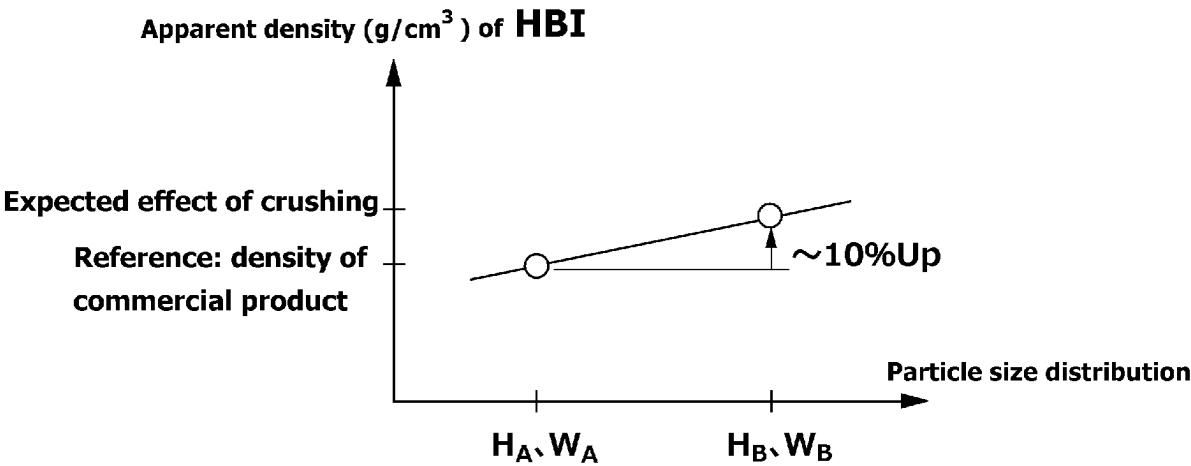
[Fig. 2]



[Fig. 3]



[Fig. 4]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/029097

A. CLASSIFICATION OF SUBJECT MATTER

C22B 1/248(2006.01)i; **C21B 13/00**(2006.01)i
FI: C22B1/248; C21B13/00

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)
C22B1/248; C21B13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2024
Registered utility model specifications of Japan 1996-2024
Published registered utility model applications of Japan 1994-2024

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 51-5321 B1 (KAWASAKI HEAVY IND LTD.) 19 February 1976 (1976-02-19) column 2, lines 3-14, column 3, line 22 to column 4, line 37	1-2
Y		3-7
Y	JP 38-15205 B1 (RN CORPORATION) 19 August 1963 (1963-08-19) p. 3, left column, line 22 to p. 4, right column, line 6	3-7

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

* Special categories of cited documents:

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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

16 October 2024

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29 October 2024

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Information on patent family members

International application No.

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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	51-5321	B1	19 February 1976	(Family: none)	
JP	38-15205	B1	19 August 1963	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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