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(71) Applicant(s)
Tecnored Desenvolvimento Tecnologico S.A.

(72) Inventor(s)
Ferreira Filho, Hermes Joaquim;Lovati, Kleiton Gonçalves;Maia, Luciano Augusto Morais;Da Luz, André Silva;Da Silva, Geovane Viturino;Okada Junior, Roberto

(74) Agent / Attorney
Spruson & Ferguson, GPO Box 3898, Sydney, NSW, 2001, AU

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ABSTRACT

"METALLURGICAL FURNACE FOR PRODUCING METALLIC ALLOYS"

The instant invention relates to metallurgical processes and apparatuses and, more particularly, to a metallurgical furnace capable of operating with a wide range of feedstocks and fuels, including those with high levels of impurities. To this end, the metallurgical furnace of the instant invention comprises (i) at least one upper stack (1), (ii) at least one lower stack (2), (iii) at least one fuel feeder (5) positioned substantially between at least one upper stack (1) and the at least one lower stack (2), and (iv) at least one row of tuyères (3, 4) positioned in at least one of the at least one upper stack (1) and at least one lower stack (2), the at least one row of tuyères (3, 4) providing a fluid communication between the inside of the furnace and the external environment, (v) at least one hood, called *Curtain Wall*, located in the upper stack extending longitudinally through the furnace, and (vi) the at least one permeabilizing fuel charging system in the center of the upper stack called the booster charging system. The use of the booster charging system (8) together with the curtain wall (6) enables a channeling of the gas generated in the combustion of the fuel from the lower stack (2) with the air blown by the primary tuyères (3) and secondary tuyères (4), more efficiently controlling the gas distribution in the furnace.

METALLURGICAL FURNACE FOR PRODUCING METALLIC ALLOYS

TECHNICAL FIELD

[000] The present application is a divisional application of Australian Application No. 2015367250, which is incorporated in its entirety herein by reference.

[001] The instant invention relates to metallurgical processes and apparatuses. More particularly, the instant invention is related to metallurgical processes and apparatuses for producing metallic or non-metallic alloys.

DESCRIPTION OF THE STATE OF THE ART

[002] Classic processes to produce pig iron are already known, such as, for example, in n blast furnaces and electrical reduction furnaces. Other processes for producing alloys from iron oxide or iron ore after granulometric conditioning, classic pellets or other traditional agglomerates are also known, obtaining by traditional operations in these furnaces liquid or solid iron of a certain composition.

[003] In blast furnaces, the filler which may be composed of sorted ore, pellets, sinter or other classical agglomerates, coke and limestone is charged sequentially through the top of the furnace, forming a continuous column. At the bottom of the blast furnace is introduced atmospheric air, preheated in regenerative heaters or not, at an approximate temperature of 300 to 1200°C, through a row of tuyeres in the upper part of a crucible. At this site, a zone with reducing atmosphere is formed due to the presence of carbon monoxide, formed by the reaction of the CO_2 with the carbon of the coke. This CO combines with oxygen from iron oxide, reducing it to metallic iron and producing pig iron.

[004] Impurities, that is, ore gangue and coke ashes form with the limestone a liquid, less dense, slag that floats on the surface of the cast pig iron.

[005] The gases formed in countercurrent with the filler preheat it and

exit from the top. This gas consists mainly of CO, CO_2, H_2 and N_2 and is conducted to the regenerative pre-heaters of the combustion air entering the furnace and other heating devices.

[006] It is also known that, in the classic pellets, the reduction is performed by the reduction of the oxidized filler by the CO generated from the partial combustion of the coke. CO diffuses inside the agglomerate or the ore particles, and the reduction according to the reaction $MeO + CO \rightarrow Me + CO_2$ occurs. CO_2 generated in this reaction spreads in the opposite direction to CO and is incorporated into the gas stream which exits the furnace from the top. This reaction demands a certain time for the complete diffusion of CO inside the ore or the classic pellet, thus requiring furnaces with high residence times of filler inside, as the blast furnaces typically are.

[007] The self-reducing pellets, on the other hand, present conditions much more favorable to the reduction. The closest contact between the ore or oxide and the carbonaceous material, which are finely divided, provides a shorter reaction time in that there is no need for the diffusion stage of CO into the pellet, the reduction taking place by means of the reactions below,pre-built inside the pellet for this purpose:

$$2MeO + C \rightarrow 2Me + CO_2$$

$$CO_2 + C \rightarrow 2CO$$

$$MeO + CO \rightarrow Me + CO_2$$

[008] In this sense, the agglomerate itself establishes, in practice, a semi-closed system in which the atmosphere is reducing during the period of time when there is available carbon inside. Alternatively, self-reducing agglomerates, such as the designation itself, maintain in its inner part a reducing atmosphere which does not depend on the characteristics of the external atmosphere, that is, the type of atmosphere inside the stack furnace provided by the ascending gases.

[009] Thus, it is possible to convert the CO present in the furnace

atmosphere resulting from the partial combustion of the fuel and the reduction reaction inside the pellets into energy for the process.

[0010] On the other hand, in the melting processes in stack furnaces, the presence of coke or other solid fuel, charged from the top during the operation, travels downward with the rest of the filler, reacting with the CO_2, traveling upward, in countercurrent, according to Boudouard's reaction $CO_2 + C_2 \rightarrow 2CO$, thus increasing the consumption of carbonaceous material, without resulting in effective use in the reduction-melting process. If it were possible to burn this CO gas in the process itself, a higher efficiency would be achieved, resulting in savings in fuel coke in cupola furnaces and the fuel and reducer in blast furnaces, as in the case of all other furnaces used in the reduction/melting or only melting of any other alloys.

[0011] Document PI9403502-4, by the same Applicant, solves the above problem by providing a furnace comprising a fuel feed separate from the filler inlet (raw material). In particular, the furnace described in the document PI9403502-4 shows an upper stack, which receives the fillers (oxides/ores, for example) and a lower one, the fuel being inserted approximately at the junction between the two stacks.

[0012] Gases from the lower zone, in countercurrent with the filler, transfer to it the thermal energy required for heating and reduction or simple melting. As the filler in the upper stack does not contain coke, charcoal or any other solid fuel, the Boudouard's reaction ($CO_2 + C \rightarrow 2CO$), which is endothermic and additionally consumes appreciable amounts of carbon, does not occur. Thus, the exhaust gases leaving the apparatus consist mainly of CO_2 and N_2.

[0013] However, in spite of having numerous advantages, such as those mentioned above, the furnace described in the document PI9403502-4 does not have an adequate control of the gaseous flow in the upper stack, allowing abrupt escape of gases in certain points of the furnace thus hindering the control of

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energy exchange between the gas and the filler in the upper stack.

[0014] For the use of self-reducing agglomerates an adequate control of the gaseous flow is essential to allow the self -reduction of the agglomerates in a homogeneous way.

EMBODIMENTS OF THE INVENTION

[0015] An embodiment of the present invention is to provide a metallurgical furnace for obtaining metal alloys by self-reduction of agglomerates containing metal oxides. This includes obtaining liquid iron, including pig iron and cast iron, as well as metallic alloys.

SUMMARY OF THE INVENTION

[0016] In order to achieve the above-described embodiments, the instant invention provides a metallurgical furnace, comprising (i) at least one upper stack, (ii) at least one stack, (iii) at least one fuel feeder positioned substantially between at least one upper stack and the at least one lower stack, and (iv) at least one row of tuyères positioned in at least one of the at least one upper stack and at least one lower stack, the at least one row of tuyères putting in fluid communication the inside of the furnace with the external environment, wherein the furnace of the instant invention further comprises (v) at least one hood called the Curtain Wall located in the upper stack extending longitudinally through the furnace, and (vi) the at least one permeabilizing fuel charging system in the center of the upper stack called the booster charging system.

[0016a] According to one aspect, the present invention provides A metallurgic furnace comprising:

at least an upper stack;

at least a lower stack;

at least one fuel feeder positioned substantially between the at least one upper stack and the at least one lower stack;

at least one row of tuyères positioned in at least one of the at at least one row of tuyères positioned in at least one of the at least one upper stack and at least one lower stack, and at least a row of tuyères providing a fluid communication between the inside of the furnace and the external environment, positioned in at least one of the at least one upper stack and at least one lower stack; and

further comprising at least one permeabilizing fuel column fed by means of a hood extending longitudinally through the furnace,

wherein the furnace comprises at least one fuel feed that is separate from the raw material inlet.

DESCRIPTION OF THE FIGURES

[0017] The detailed description shown below refers to the attached figures, wherein:

- figure 1 shows a first embodiment of the metallurgical furnace according to the instant invention;

- figure 2 shows a second embodiment of the metallurgical furnace according to the instant invention;

- figure 3 shows a hood according to a preferred embodiment of the instant invention;

- figure 4 shows booster charging system according to a preferred embodiment of the instant invention;

- figure 5 shows the gaseous flow obtained through the installation modifications of the Curtain Wall installation with the booster charging system in relation to the gaseous flow of the furnace described in document PI9403502-4.

DETAILED DESCRIPTION OF THE INVENTION

[0018] This description starts with a preferred embodiment of the invention. Nonetheless, the invention is not limited to this specific embodiment, as it will be evident for a person skilled in the art. Furthermore, the content of document PI9403502-4 is included herein as reference.

[0019] The instant invention provides a metallurgical furnace with innovations allowing an adequate control of the gaseous flow to enable the reduction of self-reducing agglomerates in a homogeneous way, also controlling the energy exchange between the gas and the filler, a fundamental principle of the self-reduction process.

[0020] The metallurgical furnace of the instant invention is shown in Figures 1 and 2, consisting essentially of an upper stack 1 where the filler (feedstock) is charged into the furnace. As can be seen, Figure 1 shows a cylindrical-shaped stack (circular cross-section), while Figure 2 shows a parallelepiped-shaped stack (rectangular cross-section). Hence, let us note that the instant invention is not limited to any specific shape of the furnace.

[0021] In the upper stack 1 there is an assembly of at least one row of secondary tuyères 4, which are preferably holes which allow inflation of hot or cold atmospheric air to burn CO and other combustible gases present in the rising gas. The inflated air may optionally comprise O_2 enrichment. Moreover, gaseous, liquid or solid fuel can be injected into the tuyères 4 together with the blown air.

[0022] The furnace of the instant invention further comprises a lower stack 2, preferably of circular or rectangular cross-section, of sufficient diameter or dimensions for solid fuel feed. The diameter or width of the cross section of the stack 2 is greater than the one of the stack 1 sufficient for positioning fuel feeders. In the feeders, located around the junction of the upper stack 1 and the lower one 2, fuel supply ducts 5 may be coupled to ensure the charging of fuel into the bed of the furnace avoiding occurrences of filler drag when using thin materials. As the filler falls on the feeder, preheating, pre-drying and distillation of the volatile fractions present in solid fuels and combustible carbonaceous residues occur.

[0023] The lower stack 2 has one or more rows of primary tuyères 3 which, as well as the secondary tuyères described above, serve to blow hot or cold air and can be enriched with O_2 or not. It is also possible to inject liquid, gaseous or liquid solid fuels for partial combustion of the fuel, producing gas and providing the thermal energy necessary for the reduction and/or melting of the filler.

[0024] If hot air is blown in the primary and/or secondary tuyères 4, blower assemblies 7, as shown in Figure 2, can be used, which can be connected with any air heating system (not shown) known from the prior art.

[0025] Optionally, the lower stack 2 may have refractory lining and/or have refrigerated panels.

[0026] In addition, the upper stack 1 comprises a hood denominated Curtain Wall 6, as shown in Figure 3. This Curtain Wall 6 consists of an apparatus that serves to channel the generated gas, thus controlling the gas distribution of the entire upper stack 1. The Curtain Wall 6 is located above the upper stack 1 and extends longitudinally through the furnace, being limited above the secondary tuyères 4, is formed by a set of structured panels of cast iron, steel or any other alloy, filled with refractory concrete and anchored in a welded plate In the furnace structure. The curtain wall 6 may also be totally or partly made of a refrigerated panel. During operation, part of the curtain wall 6 is buried in the filler, forcing the passage of the generated gases both in the region of the primary tuyère 3 and in the region of the secondary tuyères 4, that is, the curtain wall acts as a gas channeling.

[0027] The basic operating model provides for the charging of a permeabilizing fuel in the center which has the function of ensuring the passage of the gases in the cohesion zone 11, as shown in figure 4. The cohesion zone 11 is where softening and melting of the metal filler occur, with this being the zone of lower permeability, making the passage of gases considerably difficult. This difficulty in the passage of gas causes a preferential passage of the gas at specific points of the upper stack 1, making it impossible to control the gaseous flow and causing an irregular thermal exchange between the filler and the gas. With the booster charging system 8 proposed in the instant invention, a permeabilizer fuel column formation occurs in the center of the furnace, said

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column enabling the formation of a permeability window in the middle of the cohesion zone and allowing the gas to be directed towards the permeabilizing fuel area, said area having the highest permeability.

[0028] The booster 8 charging system is a simple system with an enclosed silo 9 and an open silo 10, with metering valves in the discharge of each silo; it also has a pressure equalization system to enable the charging of the permeabilizer fuel from the closed silo to inside the furnace. The booster charging system 8 together with the curtain wall 6 enables a channeling of the gas generated in the combustion of the fuel from the lower stack 2 with the air blown by the primary tuyères 3 and secondary tuyères 4, more efficiently controlling the gas distribution in the furnace.

[0029] Figure 5 shows the difference in the gaseous flow of the furnace of the instant invention 12 with respect to the gaseous flow of the furnace described in document (PI9403502-4) 13. It is noted that in the furnace of the instant invention there is a channeling of the gas generated due to the area of increased permeability formed by the permeabilizer fuel loaded by the booster charging system 8. This allows a greater control of the permeability of the upper stack 1, thus controlling the energy exchange between the gas and the filler, allowing the reduction of self-reducing agglomerates in a homogeneous way generating gains of operational stability of the process.

[0030] The curtain wall 6 configuration defines the filler distribution in the furnace. Hence, the filler takes the dimensions imposed by it, that is, the width between the walls of curtain wall 6 is the width of the permeabilizing fuel column in the upper stacik that will comply with the dimensions and distances between the walls. During operation, part of the curtain wall 6 is buried in the load, forcing the passage of the generated gases both in the region of the primary tuyère 3 and in the region of the secondary tuyères 4, as shown in figure 5.

[0031] Thus, the furnace of the instant invention prevents the fuel from being fully loaded with the filler at the top of the stack, therefore differing from the classical manufacturing processes and minimizing carbon gasification reactions (Boudouard's reactions) and an increase both of the heat and fuel consumption in the furnace.

[0032] The furnace of the instant invention differs from the furnace described in document PI9403502-4, since fuel is used in small quantities at the top of the stack in order to obtain only a control of the permeability of the upper stack 1. The use of this permeabilizer fuel does not affect the reduction and melting of the filler, because in this furnace it is used self-reducing briquettes, that is to say, the carbon necessary for reduction of the filler is contained within the self-reducing briquette, not requiring that all the gas passes through the filler column as is carried out in the furnace described in the document PI9403502-4 and in the classic processes of manufacture.

[0033] With the improvements in stacks and different zones of reaction, flexibility in the shape of the stacks, and the presence of secondary tuyères, the furnace according to the instant invention improves the fuel burning heat, reducing consumption and enhancing the performance. This is because, unlike traditional manufacturing technologies, such as blast furnaces or other stack furnaces, carbon monoxide and other gases formed in the lower part of the furnace can be burned in the upper part, due to the injection of air in the secondary tuyères, transferring energy to the filler coming down the stack. In other words, the gases coming from the lower zone, countercurrent with the filler, are burned in the upper stack and transfer the necessary thermal energy to the heating, the reduction and/or the simple melting of the filler.

[0034] The metallurgical furnace proposed in the instant invention allows, due to its high calorific value and efficiency, greater flexibility of operations, and can be used for the melting of scrap, pig iron, sponge iron, metallic materials returned from foundry or steelworks, as well as any alloys, such as, for example, those used in classic cupola furnace.

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[0035] Countless variations affecting the scope of protection of this application are allowed. Therefore, it is to be emphasized that this invention is not limited to the specific configurations/embodiments described above.

[0036] The reference to any prior art in this specification is not, and should not be taken as an acknowledgement or any form of suggestion that the prior art forms part of the common general knowledge.

[0037] In the present specification and claims, the term ‘comprising’ and its derivatives including ‘comprises’ and ‘comprise’ is used to indicate the presence of the stated integers but does not preclude the presence of other unspecified integers.

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CLAIMS

1. A metallurgic furnace comprising:

at least an upper stack;

at least a lower stack;

at least one fuel feeder positioned substantially between the at least one upper stack and the at least one lower stack;

at least one row of tuyères positioned in at least one of the at least one upper stack and at least one lower stack, and at least a row of tuyères providing a fluid communication between the inside of the furnace and the external environment, positioned in at least one of the at least one upper stack and at least one lower stack; and

further comprising at least one permeabilizing fuel column fed by means of a hood extending longitudinally through the furnace,

wherein the furnace comprises at least one fuel feed that is separate from the raw material inlet.

2. The metallurgic furnace, according to claim 1, wherein the at least one hood consists of a set of structured panels made of cast iron, steel or any other alloy, filled with refractory concrete and anchored in a sheet welded to the furnace structure.

3. The metallurgic furnace, according to claim 1 or 2, wherein_the at least one hood is fully or partially made of cooled panels.

4. The metallurgic furnace, according to any one of claims 1 to 3, further comprising a filler means of a permeabilizing fuel through the at least one hood.

5. The metallurgic furnace, according to claim 4, wherein the permeabilizing fuel is at least one among a group consisting of metallurgical coke, green petroleum coke, coal, charcoal, anthracite and fuel briquette.

6. The metallurgic furnace, according to claim 4, wherein the filler means comprises an enclosed silo and an open silo, with metering valves in the discharge of each silo.

7. The metallurgic furnace, according to any one of claims 4 to 6, wherein the filler means comprises a pressure equalizing system.

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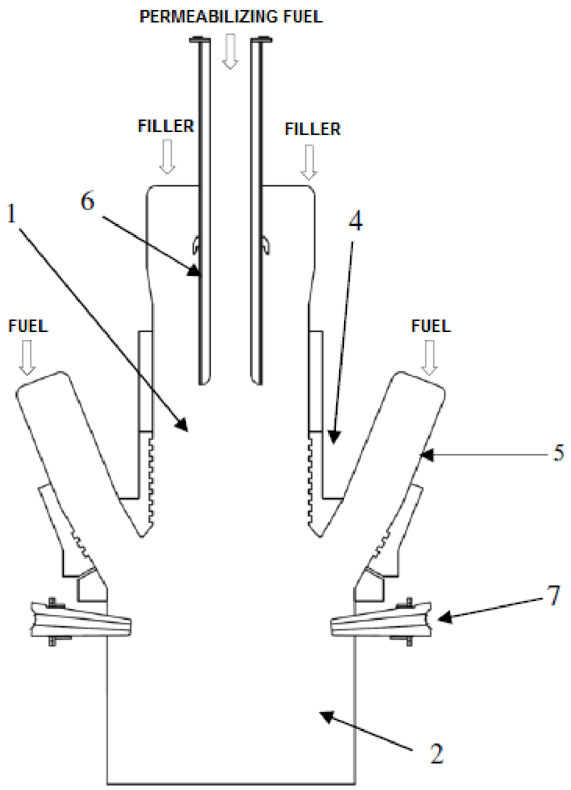

FIG. 1

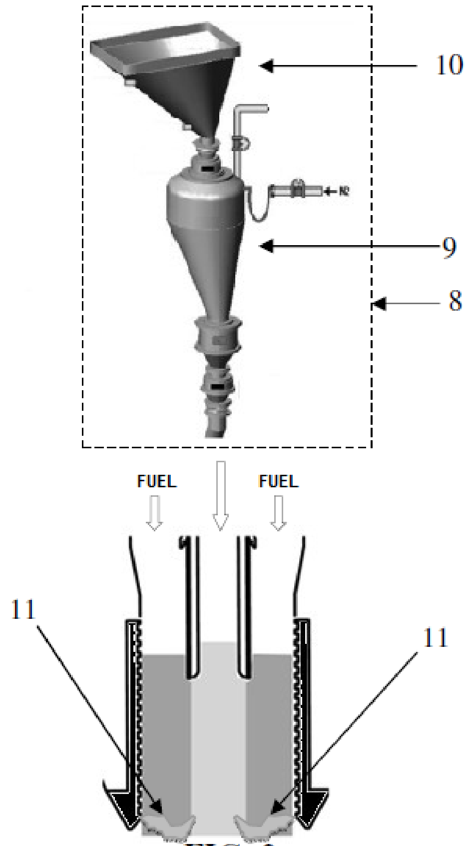

FIG. 2

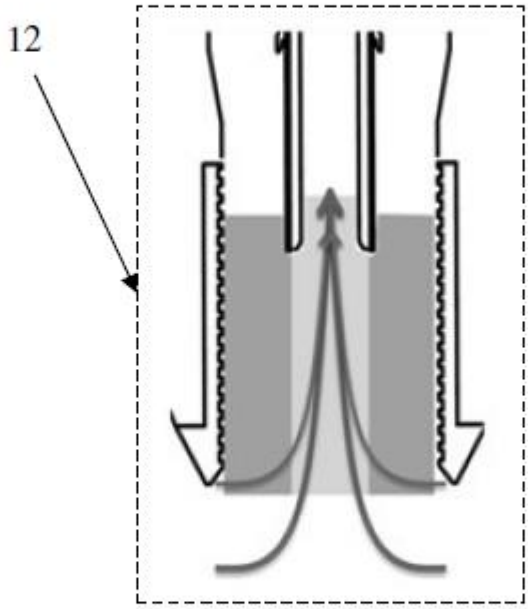

FIG. 3A

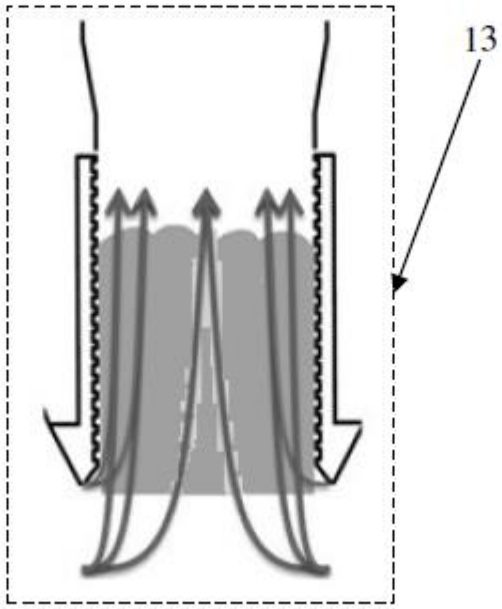

FIG. 3B