(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 015 396**
B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **15.05.85**

(51) Int. Cl.⁴: **C 21 C 5/44**, C 21 C 5/36

(21) Application number: **80100604.0**

(22) Date of filing: **06.02.80**

(54) **A method for increasing vessel lining life for basic oxygen furnaces.**

(30) Priority: **07.02.79 US 10315**

(43) Date of publication of application:
17.09.80 Bulletin 80/19

(45) Publication of the grant of the patent:
15.05.85 Bulletin 85/20

(84) Designated Contracting States:
BE DE FR GB IT LU NL

(56) References cited:
DE-A-2 323 165
DE-A-2 745 722
DE-A-2 816 897
FR-A-1 346 148
FR-A-1 536 457
FR-A-2 322 202
US-A-3 288 592
US-A-3 726 665
US-A-3 915 696

STAHL UND EISEN, vol. 98, no. 16, 1978, Düsseldorf, K.H. OBST et al. "Beeinflussung der Kalkauflösung durch natürliche und synthetische Flussmittel", pages 834 to 841
Stahl und Eisen 96 (1976), pages 878/879

(73) Proprietor: **UNION CARBIDE CORPORATION**
Old Ridgebury Road
Danbury Connecticut 06817 (US)
(73) Proprietor: **NATIONAL STEEL CORPORATION**
2800 Grant Building
Pittsburg, Pennsylvania 15219 (US)

(72) Inventor: **Spruell, Jerry Vernon**
21404 Masi Court
Grosse Ile, Michigan (US)
Inventor: **Lewis III, Jennings Bryan**
R.D. 3, Florence Road
Putnam Valley, New York (US)

(74) Representative: **Schwan, Gerhard, Dipl.-Ing.**
Elfenstrasse 32
D-8000 München 83 (DE)

EP 0 015 396 B1

Courier Press, Leamington Spa, England.

Description

This invention relates to a method for increasing the life of the refractory lining of a basic refractory-lined vessel for the production of steel by blowing oxygen into a ferrous melt from above the surface of the melt, comprising introducing slag-forming ingredients into the vessel, including high-calcium lime and dolomitic lime.

One problem frequently encountered in making basic-oxygen steel is the limited life of the vessels's refractory lining. It is periodically necessary therefore to reline the vessel, incurring loss of production and relining expense.

Prior methods of improving lining life have been to add dolomitic lime to the slag, see for example Kristiansen et al, "The Effects of Operating Variables On Sulfur Performance in a BOF Shop," *1976 Open Hearth Proceedings*, ISS-AIME, pp. 28 to 41 and Stahl und Eisen 98 (1978), pp. 834 to 841. In conformity with the latter publication dolomitic lime was used in amounts of up to more than 30% of the total additions leading to MgO contents of the slag from 6 to 13%. This, however, causes a substantial increase of the viscosity of the slag, thereby rendering it more and more difficult to attain the desired sulfur and phosphorus specifications of the steel.

Furthermore, it is known (FR—A1—2 322 202) to provide in a top blow refining method for stirring of molten metal and slag by injecting stirring gas from the bottom into the melt in order to cause the components of the melt to more readily approach the thermodynamic equilibrium.

It is an object of this invention to increase the life of refractory linings for basic oxygen vessels without interfering with the ability to make steel having a low sulfur content.

The above and other objects, which will readily be apparent to those skilled in the art, are achieved by the present invention in that dolomitic lime is introduced in an amount which is at least equal to that of the high-calcium lime introduced, and that inert gas is introduced from above the melt surface into the melt in such a manner as to cause intensive interaction between the slag and the melt.

The term "inert gas" as used throughout the present specification and claims is intended to means a gas other than oxygen having as many as possible of the following characteristics: low reactivity, low specific heat, absence of objectionable contaminants, and high density. The preferred inert gas is argon. However, if nitrogen contamination of the melt is not a problem, nitrogen or air may be used. Other possible inert gases for use in practicing the invention include helium, neon, krypton, xenon, carbon dioxide, steam, ammonia, and mixtures thereof. However, argon, which may be either commercially pure or crude argon is by far the most preferable inert gas.

The preferred method of introducing inert gas is through the oxygen lance admixed with oxygen.

The iron charged to a basic oxygen furnace typically contains carbon, silicon, sulfur, and other impurities. The main purpose of the oxygen is to remove carbon and silicon from the melt. The silicon is oxidized to silicon dioxide which floats on the surface of the melt. The carbon is oxidized to carbon monoxide gas which escapes from the mouth of the vessel. Slag forming ingredients, typically including high-calcium lime, dolomitic lime, lime stone, and fluorspar, are added to the melt to form a basic slag. The high-calcium lime, normally containing at least 90 percent by weight of CaO, also removes sulfur by reacting with it to form calcium sulfide. Dolomitic lime, i.e. lime containing at least 30% by weight magnesium oxide, is known to improve the life of a vessel's lining, but in addition, it increases the viscosity of the slag, thereby reducing the amount of interaction between the lime in the slag and the melt. The reduced interaction makes it difficult for the lime to remove sulfur from the melt. Since the conventional solution to the problem of obtaining long vessel lining life makes it difficult to make steel having a sufficiently low sulfur content, the amount of dolomitic lime charged to the vessel for conventional oxygen blowing must be limited.

In accordance with the present invention, dolomitic lime is introduced to the slag in an amount which is at least equal to that of the high-calcium lime introduced. Of course, the slag forming compounds should be introduced in an amount sufficient to reduce the sulfur content of the melt to a desired level, based upon the stoichiometric and thermodynamic aspects of the reaction of sulfur with the compounds.

The use of the indicated amounts of dolomitic lime is essential to increasing the life of the vessel's refractory lining. The sulfur content of the steel can be reduced to meet the specification, even if the amount of dolomitic lime is equal to 2 to 3 times the amount of lime introduced.

Extra agitation or mixing is required in the vessel because of the increased slag viscosity caused by the larger amount of dolomitic lime. The extra agitation is provided by introducing inert gas into the vessel in such manner as to cause intensive interaction between the slag and the melt.

The present invention may be practiced in conjunction with the method disclosed in DE—A1—27 45 722 for using argon in the BOF or make low nitrogen and low oxygen steel.

The inert gas must be introduced in such manner as to cause intensive interaction between the slag and the melt. Preferably, the inert gas is introduced through the oxygen lance by metering it into the oxygen line. Alternatively, the inert gas may be introduced through a separate lance directed to impinge oxygen-free fluid against the surface of the melt. However, there is no reason for incurring the extra expense of adding a second lance to a basic oxygen vessel.

Since the sulfur content of the melt, at the end of the oxygen blow, is one of the most difficult variables to control in the basic oxygen process,

occasionally, even when the present invention is practiced the sulfur content of the melt at the end of a blow will be higher than desired. However, the sulfur content of the melt may be lowered in accordance with a further development of the present invention by adding at least one sulfur-removing compound, such as high-calcium lime, to the slag in the vessel and re-blowing the melt with inert gas alone in such a manner as to cause intensive interaction between the slag and the melt until the sulfur content is reduced to the desired level.

If the slag already contains sufficient sulfur-removing compounds, then merely reblowing the melt with inert gas alone in the above described manner may be used to lower the sulfur content to the desired level.

Specific embodiments of the invention are described in more detail below with reference to the drawings.

Fig. 1A illustrates a basic oxygen refining vessel together with an oxygen lance through which inert gas likewise is introduced by metering it into the oxygen line.

Fig. 1b illustrates a modified embodiment for practicing the method of the invention, wherein the inert gas is introduced through a separate lance.

In Fig. 1a a basic oxygen vessel 1 is provided with a refractory lining 2. A lance 4 is used to inject oxygen and inert gas which is metered into the oxygen line connected to lance 4. The gases are blown into the melt 5 from above the melt surface through lance 4 whereby an emulsion 6 composed of a complex mixture of liquid oxides, gas bubbles, solid oxide particles and droplets of liquid metal is formed.

In the embodiment of Fig. 1b a separate lance 3 is provided in addition to oxygen lance 4. The inert gas is introduced through lance 3 directed to impinge oxygen-free fluid against the surface of melt 5.

Examples

The following examples will serve to illustrate the advantage of practicing the invention. A series of heats was performed in a BOF (Basic Oxygen Furnace) system having the following characteristics:

nominal vessel volume: . . . . . 142 m^3
tap weight of heat: . . . . . 213 t
inert gas used: . . . . . argon

The normal dolomitic lime charge for this vessel was 7,257 kg. The normal slag-forming ingredients were comprised of 7,257 kg of dolomitic lime and 10,886 kg of high-calcium lime, and 907 kg of flurospar.

The dolomitic lime charge was increased to 15,876 kg and the high-calcium lime charge was reduced to 4,536 kg and argon was injected into the vessel in accordance with the method of addition disclosed in DE—A1—27 45 722 mentioned previously. The argon was injected at a constant rate of 99 standard m^3/min during the latter portion of the oxygen blow. As a result of practicing the invention, the life of the lining of this vessel was extended from a previous life of about 780 heats to about 1100 heats. In spite of the very large amounts of dolomitic lime added as slag forming ingredients, no difficulty was encountered making steel having sulfur content as low as desired. Furthermore, during this test flurospar, which is known to aid sulfur removal, was not used. In spite of the omission of the normal amount of flurospar, the process was still able to produce steel meeting low-sulfur specifications. Hence, another advantage of the invention is a saving in the amount of flurospar charged to the vessel. The typical maximum sulfur content allowed by the specifications for steel made by this vessel was 0.025% sulfur.

It can be seen that the practice of the inventions yields significant results. The life of the vessel lining was increased to more than 40% beyond that which had been previously obtained for this vessel.

Claims

1. A method for increasing the life of the refractory lining of a basic refractory-lined vessel for the production of steel by blowing oxygen into a ferrous melt from above the surface of the melt, comprising introducing slag-forming ingredients into the vessel, including high-calcium lime and dolomitic lime, characterized in that dolomitic lime is introduced in an amount which is at least equal to that of the high-calcium lime introduced, and that inert gas is introduced from above the melt surface into the melt in such a manner as to cause intensive interaction between the slag and the melt.

2. The method of claim 1 wherein the inert gas is introduced through the oxygen lance.

3. The method of claim 1 wherein the inert gas is introduced through a separate lance directed to impinge the inert gas against the surface of the melt.

4. The method of any one of the preceding claims wherein the sulfur content of the melt is higher than desired at the end of the oxygen blow, further comprising the steps of reblowing the melt with inert gas alone in such manner as to cause intensive interaction between the slag and the melt until the sulfur content is reduced to the desired level.

5. The method of claim 4 wherein at least one sulfur-removing compound is added to the slag in the vessel prior to the reblowing step.

6. The method of any one of the preceding claims wherein the amount of dolomitic lime introduced is at least two times the amount of high-calcium lime introduced.

7. The method of any one of the preceding claims wherein the inert gas is argon.

Patentansprüche

1. Verfahren zum Steigern der Lebensdauer der feuerfesten Auskleidung eines feuerfest ausgekleideten basischen Gefäßes für die Herstellung von Stahl durch Blasen von Sauerstoff in eine Eisenschmelze von oberhalb der Oberfläche der Schmelze, bei dem schlackebildende Stoffe, einschließlich hochkalziumhaltiger Kalk und Dolomitkalk, in das Gefäß eingeführt werden, dadurch gekennzeichnet, daß der Dolomitkalk in einer Menge eingeführt wird, die mindestens gleich derjenigen des eingeführten hochkalziumhaltigen Kalks ist, und daß inertes Gas von oberhalb der Schmelzoberfläche in die Schmelze derart eingeleitet wird, daß eine intensive Wechselwirkung zwischen der Schlacke und der Schmelze bewirkt wird.

2. Verfahren nach Anspruch 1, bei dem das inerte Gas über die Sauerstofflanze eingeleitet wird.

3. Verfahren nach Anspruch 1, bei dem das inerte Gas über eine gesonderte Lanze eingeleitet wird, die derart gerichtet ist, daß sie das inerte Gas auf die Oberfläche der Schmelze auftreffen läßt.

4. Verfahren nach einem der vorhergehenden Ansprüche, bei dem der Schwefelgehalt der Schmelze höher als am Ende des Sauerstoffblasvorganges gewünscht ist, wobei die Schmelze nur mit inertem Gas derart nachgeblasen wird, daß eine intensive Wechselwirkung zwischen der Schlacke und der Schmelze bewirkt wird, bis der Schwefelgehalt auf den Sollwert abgesenkt ist.

5. Verfahren nach Anspruch 4, wobei mindestens eine schwefelbeseitigende Verbindung der Schlacke in dem Gefäß vor dem Nachblasvorgang zugesetzt wird.

6. Verfahren nach einem der vorhergehenden Ansprüche, wobei die Menge des eingeführten Dolomitkalks mindestens das Zweifache der Menge des eingeführten hochkalziumhaltigen Kalks ist.

7. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das inerte Gas Argon ist.

Revendications

1. Procédé pour augmenter la longévité du garnissage réfractaire d'une cuve à garnissage réfractaire basique pour la production d'acier par soufflage d'oxygène dans une charge ferreuse fondue à partir du dessus de la surface de la charge fondue, comprenant l'introduction dans la cuve d'ingrédients de formation de laitier comprenant de la chaux à haute teneur en calcium et de la chaux dolomitique, caractérisé en ce que la chaux dolomitique est introduite en une quantité qui est au moins égale à celle de la chaux à haute teneur en calcium introduite, et en ce qu'un gaz inerte est introduit par-dessus la surface de la charge fondue, dans la charge fondue, d'une manière provoquant une interaction intense entre le laitier et la charge fondue.

2. Procédé selon la revendication 1, dans lequel le gaz inerte est introduit par l'intermédiaire de la lance à oxygène.

3. Procédé selon la revendication 1, dans lequel le gaz inerte est introduit par l'intermédiaire d'une lance séparée dirigée de façon à projeter le gaz inerte contre la surface de la charge fondue.

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel la teneur en soufre de la charge fondue est plus élevée que souhaité à la fin du soufflage d'oxygène, comprenant en outre l'étape d'un nouveau soufflage, sur la charge fondue, d'un gaz inerte seul de manière à provoquer une interaction intense entre le laitier et la charge fondue jusqu'à ce que la teneur en soufre soit réduite au niveau souhaité.

5. Procédé selon la revendication 4, dans lequel au moins un composé d'élimination du soufre est ajouté au laitier dans la cuve avant l'étape du nouveau soufflage.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel la quantité de chaux dolomitique introduite est d'au moins deux fois la quantité de chaux à haute teneur en calcium introduite.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel le gaz inerte est de l'argon.

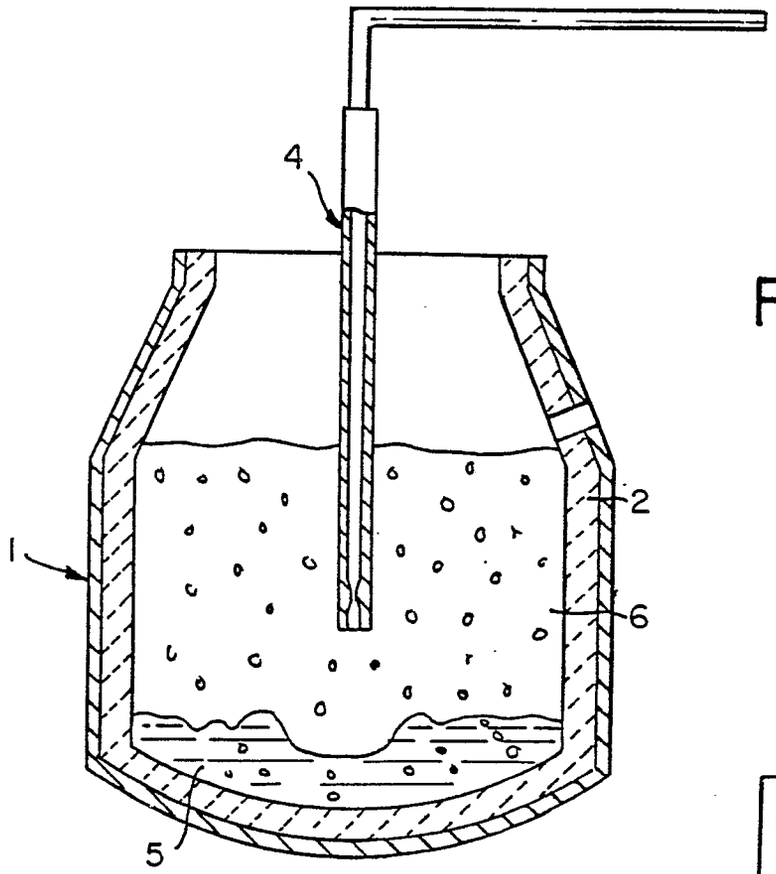

FIG. Ia

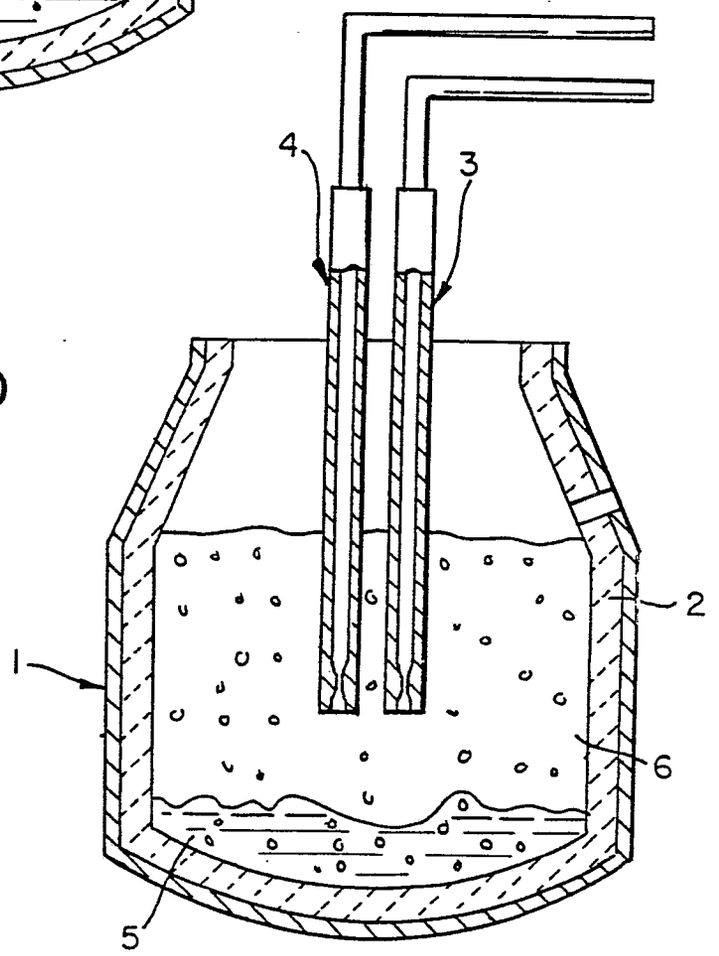

FIG. Ib