

IMPROVEMENTS IN ELECTRIC FURNACES

This invention relates to improvements in the method of fusing, in an electric furnace, those discrete fusible oxide compounds of metals/nonmetals (for example, slag), which become electrically conductive when molten.

5. The invention further relates to improvements in electric furnaces which are useful for the fusing of those compounds, for example prior to the formation of insulating fibres.

BACKGROUND OF THE INVENTION

- Slag which is sometimes used for the production of fibrous insulating material is a waste product from blast furnace operations, and can for example contain 39% CaO, 37% SiO₂, 18% Al₂O₃, 4% MgO, and some small quantity of Fe₂O₃ besides traces of other materials. Such material is somewhat similar to material from which the refractory bricks are made, and will actually dissolve or wash away the refractory bricks if the temperature is sufficient to ensure that the slag is free running. This is one of two reasons why electric furnaces are normally not used in the melting of slag before the slag is poured onto a spinning wheel for production of fibrous insulating material. The other reason is the difficulty of preventing clogging of an outlet, and an invention to overcome that other difficulty is the subject of a companion application.

- Because of those two difficulties, slag is usually heated in a coke fired furnace, and as the slag melts

it percolates through the coke bed and runs out an aperture in the base of the furnace.

- The temperature at which the furnace runs can be as much as $1,600^{\circ}\text{C}$ (usually between $1,450$ and $1,500^{\circ}\text{C}$) and
5. at this temperature, the steel walls of the furnace can be seriously damaged. Consequently, it is usual practice in a coke fired furnace to surround the furnace with a jacket through which water continually passes, and the water has the effect of chilling the slag which forms immediately
10. adjacent the inner wall of the surface, so that the slag itself solidifies and forms its own refractory insulation. With age and the continual use, the steel wall of the furnace gradually deteriorates, but when it deteriorates to the point where water from the surrounding jacket can
15. enter the furnace, the water will enter a furnace containing a relatively small amount of molten slag, and a relatively large amount of burning coke, the water then merely tending to quench combustion and chilling the contents of the furnace, and those contents must be then separately removed and the
20. walls separately replaced.

This arrangement however, is entirely unsatisfactory for an electric furnace. If a wall of an electric furnace deteriorates to the point where water from a surrounding jacket can enter the electric furnace, explosion is likely

25. to occur because of the relatively large amount of molten

slag within that furnace, and the absence of large amounts of coke. For this reason, heretofore electric furnaces used in the fusing of slag have utilised linings of refractory bricks which are frequently replaced.

In the U.S. Patent 1,946,083 of LAMBIE there was described a flux wall having tuck stones arranged to be air-cooled, in a gas fired glass furnace. The U.S. Patent 2,042,660 HULTON also described an air-cooling arrangement for furnace walls.

U.S. Patent 2,686,821 McMULLEN described an electric furnace for melting inorganic refractory oxidic material which utilised a water cooling jacket. The danger of explosion referred to above does not exist in this arrangement, however, since the melt is confined to the upper portion of the container, and is decanted by tilting the container.

U.S. Patent 2,790,019 STALEGO explains the difficulty encountered in the freezing of the melt adjacent a pouring spout, and uses the overflow principle in a refractory lined furnace.

Although BERCZYNSKI described in his U.S. Patent 3,612,501 an annular water-cooling jacket, this was used for water-cooling a refractory lining, and, as said above, such linings are unsatisfactory in the fusing of metal oxides.

The main object of this invention is to provide improvements whereby an electric furnace can be used for production of fused oxide compounds for example, such as are used in the production of mineral fibre insulating batts,

and can be used for a continuous production for a much longer period of time than in the "overflow" type furnaces of McMULLEN or STALEGO aforesaid.

BRIEF SUMMARY OF THE INVENTION

5. An electric furnace has a side wall of steel, and when the slag or other fusible oxide compounds of metals/non-metals are melted within the furnace, the outer layer of the melt which is in contact with the inner surface of the furnace side wall is frozen by chilling the outer surface of the
10. furnace side wall with a stream of water flowing over the wall. This enables the slag to become its own "refractory lining" which is continuously replenished as it is depleted. In turn this enables the melt to be withdrawn continuously from a low locality in the furnace, so that the furnace can
15. be recharged from the top, without interruption of production.

The slag layer adjacent the walls of the furnace can be maintained by always using the furnace under chilled wall conditions, but since there is no head of water as exists around a jacketed furnace, deterioration of the wall to the

20. point where water can enter the furnace is of no consequence. Any such water which tends to enter the furnace will be immediately vapourised and the vapours expelled from within the furnace back into the stream of water flowing over the outside. Thus the risk of explosion is greatly reduced.

25. More specifically, the method of this invention consists

of charging said furnace container with at least some of said fusible oxide compounds, establishing a melt of some of said oxide compounds in said furnace and passing electric current between said electrodes and through said melt to thereby fuse further of said oxide compounds, passing a free flowing continuous film of water over the outer surface of said side walls to thereby cool and freeze a layer of said fused compounds contiguous with the inner surface of the side wall, discharging said oxide compounds after having been fused from the furnace container as a continuous stream through a discharge sleeve which extends through said side wall and said frozen layer into the melt, at a locality between the upper and lower ends of the container, and controlling the rate of discharge of said fused oxide compounds by adjusting a flow control valve on the outer end of said sleeve.

An electric furnace in this invention comprises a base and steel side walls defining a furnace container, a plurality of electrodes depending into the container, a coolant distributing conduit surrounding the container near its upper end, and a furnace discharge sleeve extending through said side wall between its upper and lower ends, the inner end of said sleeve terminating in the container a sufficient distance inward from the side wall that, when the furnace is in use by any said method, the sleeve extends

into melt within the furnace, the outer end of said discharge sleeve terminating a distance outward from the side wall, and further comprising a flow control valve co-operating with said outer end.

In a preferred arrangement, a further discharge sleeve extending through the side wall is provided but located approximately in the plane of the furnace base. This second sleeve constitutes a topping valve and allows iron for example which has been reduced to the metallic form and which settles at the lowermost part in the furnace, to be tapped off continuously or periodically during operation of the furnace.

BRIEF SUMMARY OF THE DRAWINGS

An embodiment of the invention is described hereunder in some detail with reference to and as illustrated in the accompanying drawings in which

Fig. 1 is a diagrammatic layout showing an installation
5. which includes an electric furnace in accordance with this invention,

Fig. 2 is a diagrammatic section showing the electric furnace and the manner in which it is utilised,

Fig. 3 is a constructional section through the furnace,
10. and

Fig. 4 is a fragmentary section taken on line 4-4 of Fig. 3.

In this embodiment the furnace described is intended for the melting of slag, and the furnace 10 comprises a refractory lined steel floor 11, a side wall 12 and a charging wall 13 sur-
15. mounting the side wall 12. Although the floor 11 and the charging wall 13 can be made from other materials, the side wall 12 is of necessity made from steel. The space surrounded by the steel side wall 12 is a furnace container and contains the melt of fused material designated 15, a
20. layer 16 contiguous with the inner surface of the side wall 12 of melt which has been frozen, and, for starting purposes, a layer 17 of coke or other carbonaceous material.

The furnace 10 has a plurality of electrodes 20 depending into it, the electrodes 20 being carbon rods which are connected
25. by conductors 21 to a three-phase power transformer 22.

- Located a little above and radially outwardly from the upper end of the side wall 12 is a circular coolant distributing conduit 24 which is provided with a plurality of depending tubes 25 each comprising an outlet for coolant, and arranged to direct
5. coolant flow over the outer surface of the side wall 12. The side wall 12 is stiffened by a plurality of stiffening bars 27, and the depending tubes 25 are directed against the outer surface of the wall between the bars 27 and so spaced that, excepting where interrupted by the bars 27, a continuous
10. film of coolant water passes over the outer surface of the side wall 12. The coolant runs into a sump 28, and is pumped upwardly by a pump 29 driven by motor 30 to be recirculated.

- The side wall 12 has extending through it an annular water jacket sleeve 31 which is formed from thick stainless
15. steel, and which also has water passing through it for cooling purposes. The sleeve 31 extends through the wall 12 to terminate at its inner end 32 a distance inwardly from the inner surface of the side wall 12, and at its outer end 33 a distance outward from the outer surface of that wall. The sleeve 31
20. contains a carbon liner 34 which is readily replaced. There is also provided a hinged valve member 36 which is also formed from stainless steel and also water-cooled, and this co-operates with the aperture through the liner 34 to control the outlet orifice and thereby control the rate of discharge
25. of fused oxide compounds of metals from the melt within the

container portion of the furnace.

- Located at floor level, is a second tapping valve 37 comprising jacket sleeve 37'', and a carbon liner 37', and is of similar construction to valve 31, the valve 37 being used to tap and control iron which may settle to the bottom of the furnace.
- 5.

- Reference is now made to Figs. 1 and 2, which between them illustrate the use of the furnace 10 in an installation. There is provided a crusher 38 which crushes the compounds into a suitable size, and for the fusing of granular slag, the size usually lies between $\frac{1}{4}$ and $\frac{1}{2}$ inch mesh. The discrete slag 39 is elevated by elevator 40 and discharged into a weighing hopper 41 (if required). The discrete slag 39 is then transported by a belt 42 (when required) to be charged into the charging space of the furnace 10 through chutes 43.
- 10.
- 15.

- The invention is necessarily limited to those fusible oxide compounds of metals/non-metals which are conductive when in their molten state, and there are some uses of the invention wherein it is necessary for the melt to be established by "clean" means, for example by the use of gas-fired furnaces.
- 20.

- However in the production of mineral fibre insulation batts or sheets, this is not a requirement and it is particularly convenient to establish a melt by firstly placing a quantity of coke 17 or other carbonaceous material into the base of the furnace, and heating that quantity of coke by the passage of ele-
- 25.

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ctric current between the electrodes 20. Although this can be done after charging of the furnace with the particulate slag 39, it is preferred to separately heat the coke (which takes only a short period of time) and subsequently charge the furnace.

5. The coke heats partly by electrical conductivity, partly by plasma heating and partly by combustion. When sufficient temperature has been reached, some particulate material is charged into the base of the container and this quickly establishes a melt due to its physical contact with the incandescent coke. Once the melt is thus established, the function of the coke ceases to be so critical, since the melt itself becomes conductive and the furnace can then be fully charged with the particulate slag which is progressively melted.

- The passage of chilling water over the outer surface of
15. the side wall 12 freezes a layer of the melt contiguous with the inner surface of the side wall 12 (and to top of the refractory floor), and this then functions as its own "refractory and as the development and movement of further melt of
20. washed away it is automatically replenished. Since the inner end 32 of the sleeve 31 is positioned inwardly from the inner surface of the side wall 12, it can penetrate the melt and the tendency to block is substantially reduced. Since the outer end 33 of the sleeves 31 terminates outwardly from
25. the outer surface of the wall 12, there is very little

likelihood of chilling water encountering the melt as it passes outwardly through the liner 34. There is necessarily a deterioration of the steel side wall 12 of the furnace, but this deterioration ceases to constitute a danger since 5. any water which penetrates the side wall 12 into the furnace merely encounters the frozen layer 16 of the compound, is vapourised and repelled.

As shown in Fig. 3 of the drawings, the refractory floor is also water-cooled by the water in the sump, this affording 10. further protection by means of a mixed mass of the oxide compounds, iron and some molten refractory all in varying stages of solidification.

The fused compound flows outwardly through the sleeve 31 and its liner 34 as a continuous stream 45, and the stream 15. intercepts a jet of air from a nozzle 46 to encounter a spinning discoid member 47 (which can be flat, conical or curved), and the mineral fibre is formed and packed in accordance with known art.

Iron which has been reduced to the metallic form and 20. which settles in the hearth of the furnace can be tapped and controlled by the control valve situated at floor level.

CLAIMS

1. A method of fusing fusible oxide compounds of metals/non-metals in an electric furnace having a container with a steel side wall containing a plurality of electrodes, comprising;

charging said furnace container with at least some of said fusible oxide compounds,

establishing a melt of some of said oxide compounds in said furnace and passing electric current between said electrodes and through said melt to thereby fuse further of said oxide compounds,

passing a free flowing continuous film of water over the outer surface of said side walls to thereby cool and freeze a layer of said fused compounds contiguous with the inner surface of the side wall,

discharging said oxide compounds after having been fused from the furnace container as a continuous stream through a discharge sleeve which extends through said side wall and said frozen layer into the melt, at a locality between the upper and lower ends of the container, and

controlling the rate of discharge of said fused oxide compounds by adjusting a flow control valve on the outer end of said sleeve.

2. A method according to claim 1 wherein said establishing of a melt is effected by placing a quantity

CLAIMS

1. A method of fusing fusible oxide compounds of metals/non-metals in an electric furnace having a container with a steel side wall containing a plurality of electrodes, comprising;

charging said furnace container with at least some of said fusible oxide compounds,

establishing a melt of some of said oxide compounds in said furnace and passing electric current between said electrodes and through said melt to thereby fuse further of said oxide compounds,

passing a free flowing continuous film of water over the outer surface of said side walls to thereby cool and freeze a layer of said fused compounds contiguous with the inner surface of the side wall,

discharging said oxide compounds after having been fused from the furnace container as a continuous stream through a discharge sleeve which extends through said side wall and said frozen layer into the melt, at a locality between the upper and lower ends of the container, and

controlling the rate of discharge of said fused oxide compounds by adjusting a flow control valve on the outer end of said sleeve.

2. A method according to claim 1 wherein said establishing of a melt is effected by placing a quantity

of discrete carbonaceous material in said furnace container and in contact with said electrodes, and heating said carbonaceous material with electric current passing between said electrodes, and charging said furnace with said fusible oxide compounds in discrete form such that some of said fusible oxide compounds are brought into physical contact with said heated carbonaceous material.

3. A method according to claim 1 or claim 2 comprising further charging of said oxide compounds in discrete form into said container from its upper end to replace said discharged stream.

4. A method according to any previous claim further comprising passing said stream of water over the outer surface of the side wall from a plurality of outlets of a coolant distributor conduit surrounding the side wall near its upper end.

5. A method according to any preceding claim wherein a further discharge sleeve is provided approximately at the level of the floor.

6. An electric furnace useful for the fusing of discrete fusible oxide compounds of metals/non-metals by the method of any previous claim, comprising:

a base and steel side walls defining a furnace container,

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a plurality of electrodes depending into the container, a coolant distributing conduit surrounding the container near its upper end, and

a furnace discharge sleeve extending through said side wall between its upper and lower ends, the inner end of said sleeve terminating in the container a sufficient distance inward from the side wall that, when the furnace is in use by any said method, the sleeve extends into melt within the furnace,

the outer end of said discharge sleeve terminating a distance outward from the side wall, and further comprising a flow control valve co-operating with said outer end.

7. An electric furnace according to claim 6 wherein said sleeve comprises an outer water jacket and an inner carbon liner.

8. An electric furnace according to claim 6 wherein the base is refractory lined and further comprising a second discharge sleeve extending through the side wall provided at or near to the level of the refractory floor.

9. A method of fusing fusible oxide compounds of metals/non-metals substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

10. An electric furnace for the fusing of discrete fusible oxide compounds of metals/non-metals substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.