METHOD OF PRE-HEATING A REFRACTORY LINED VESSEL

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9 Claims

ABSTRACT OF THE DISCLOSURE

A method of preheating a refractory lined vessel prior to receiving molten steel in which a mixture of fluid hydrocarbon fuel and oxygen is burned within the vessel with the oxygen-to-fuel ratio being maintained sufficiently low to produce combustion products which will be reducing to iron oxides at the temperature within the vessel. Thus, there will be no molten iron oxide to dissolve the refractory lining.

This invention relates to a method of preheating a refractory lined vessel and more particularly to preheating the vessel prior to filling it with molten steel or other ferrous metal. The method is particularly applicable for use with continuous mixed liquid steel degassing apparatus which is preferably preheated to a temperature between 2700 and 3000°F. These temperatures eliminate the need for extra super heat in the steel, prevent freezing during degassing, and eliminate the need for skimming and chipping of the lining of the degassing apparatus. Such preheating is also advantageous and sometimes essential in the handling of steel in other operations such as continuous casting. Prior to my invention the preheating was done by conventional forced air combustion. The products of this combustion are highly oxidizing at high temperatures to steel remaining in the vessel as the result of splatter, skidding or incomplete draining. Thus, such preheating resulted in the formation of viscus slags containing higher oxides of iron and iron-oxide refractory solutions. At these high temperatures the refractories of the lining are soluble in molten iron oxide. In addition to plugging restricted openings within the vessel these iron oxide slags contain substantial quantities of oxygen which may contaminate and alter the chemical composition of the steel being processed.

It is therefore an object of my invention to provide a method of preheating refractory lined vessels which are free of the disadvantages of conventional forced air combustion.

This and other objects will be more apparent after referring to the following specification and attached drawings, in which:

FIGURE 1 is a schematic view of apparatus used in degassing molten steel;
FIGURE 2 is an enlarged view of the burner used in my invention; and
FIGURE 3 is a view taken on the line III—III of FIGURE 2.

Referring more particularly to FIGURE 1 of the drawings, reference numeral 2 indicates a degassing chamber having a refractory lining 4 and an inlet 6 for receiving molten steel. An outlet 8 is connected to a vacuum pump not shown. The degassing chamber is heated above the melting point of the iron oxide slags by means of a vertical duct 10 and a horizontal duct 12 to a pouring box or tundish 14. The ducts 10 and 12 and tundish 14 are lined with refractory 16. An opening 18 in the bottom of the tundish 14 is located above a burner 20. An overflow opening 22 is provided in the tundish 14. No novelty is claimed for this apparatus which may be considered conventional insofar as the present invention is concerned. Apparatus such as shown in my co-pending application Ser. No. 511,513 filed Dec. 3, 1965, is illustrative of vessels which may be preheated according to the present invention.

According to my invention I provide a burner or gas injector 24 for delivering fuel and oxygen through a port 26 into the degassing chamber 2 and a similar burner 28 for introducing fuel and oxygen into the tundish 14. Since the burners 24 and 28 are essentially duplicates, only burner 24 will be described in detail. As shown in FIGURES 2 and 3, burner 24 includes two concentric tubes 30 and 32 with a partition 34 extending between the inner wall of tube 30 and the outer wall of tube 32 intermediate their ends. A collar 36 is attached to the forward end of tubes 30 and 32 and bears against a water cooled collar 38 at the entry end of port 26. Collar 36 is provided with a cooling water chamber 40 having diametrically aligned paritions 42 therein with openings 44 therethrough. Tubes 46 extend through partition 34 and collar 36 to the discharge end of the burner. Shorter tubes 48 extend through and are supported by the walls of collar 36. Cooling water enters chamber 40 through inlets 50 and passes between and around tubes 46 and 48 and through openings 54 in line with tube 32 is covered with a silt glass 56. Fuel is introduced through conduit 58 into tube 30 and passes through tubes 46 into the chamber 2. Oxygen is introduced through conduit 60 into tube 32 and passes through tubes 48 into the chamber 2. Valves 62 and 64 are provided for controlling flow of fuel and oxygen to the burner. The fuel used is preferably natural gas which is substantially all methane, but may also be any suitable fluid hydrocarbon fuel such as atomized fuel oil or fluidized powdered coal. The oxygen need not be pure oxygen, but must be a gas containing at least 50% oxygen. It is preferred that commercially pure oxygen be used. The oxygen-to-fuel ratio is adjusted to a value that will result in a combustion product composition that is reducing to iron oxides at high temperatures and yet sufficient to provide the necessary heat of combustion. With any fluid hydrocarbon fuel the CO to CO₂ ratio is maintained between 0.06 and 0.22. When natural gas is the fuel, the volumetric oxygen-to-fuel ratio is between 0.8 and 1.1. With this ratio being maintained the gas firing rate is set at a value that will provide the desired preheating temperature. The injection velocities of the fuel and oxygen are maintained above the rate of flame propagation and should be maintained well below sonic velocities. It is preferred to have the velocities between 50 and 600 ft per second. Burning of the fuel and oxygen is continued until the refractory lining has been heated to the desired temperature which is generally between 2700 and 3000°F. The products of combustion pass out through opening 6. The firing is then discontinued and a ladle 1 filled with molten steel is then positioned over opening 6 and the chamber 2 and tundish 14 evacuated in the usual manner.

While one embodiment of my invention has been shown and described, it will be apparent that other adaptations and modifications may be made.

I claim:

1. A method of preparing, for receiving molten ferrous metal, a refractory lined vessel having ferrous metal on the inner surface of the refractory, said refractory being substantially free of iron oxide at elevated temperature, which method comprises injecting fluid hydrocarbon fuel and oxygen into the vessel, burning said fuel and oxygen, maintaining the oxygen-to-fuel ratio sufficiently low so that the combustion products resulting from their burning will be reducing to iron oxides at the temperature within the vessel, and maintaining injection velocities of the fuel and oxygen above the rate of flame propagation.
2. The method of claim 1 in which the CO₂ to CO ratio in the combustion products is between 0.06 and 0.22.
3. The method of claim 2 in which the injection velocity of the fuel and oxygen is between 50 and 600 ft. per second.
4. The method of claim 1 in which the surface of the refractory lining is heated to a temperature at which the iron oxide becomes molten.
5. The method of claim 4 in which the CO₂ to CO ratio in the combustion products is between 0.06 to 0.22.
6. The method of claim 5 in which the injection velocity of the fuel and oxygen is between 50 and 600 ft. per second.
7. The method of claim 1 in which the fuel is natural gas and the volumetric oxygen-to-fuel ratio is between 0.8 and 1.1.

8. The method of claim 7 in which the surface of the refractory lining is heated to a temperature at which the iron oxide becomes molten.
9. The method of claim 8 in which the injection velocity of the fuel and oxygen is between 50 and 600 ft. per second.

References Cited

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