METHOD AND APPARATUS FOR PREVENTING THE ADHESION OF DUST IN A FURNACE OR FLUIDIZED BED INCINERATOR

The present invention relates to a method for preventing dust from adhering to a wall, such as a furnace wall or exhaust duct, and also to a furnace, fluidized bed incinerator and nozzle structure adapted to the method .

A prior art nozzle structure for water injection to cool hot exhaust gas containing a large quantity of dust is shown in Fig. 8.

The water injection nozzle 1 extends into a gas cooling chamber 2 through a refractory body 3. Water 4 for cooling the gas is introduced from a water inlet 5 of the injection nozzle 1 into a pipe 5a extending axially in said nozzle. The water 4 is thus injected from the tip end of the nozzle 1 into the gas cooling chamber 2. Excess water is returned to the water return line via a water outlet 6 of a pipe 6a which surrounds the pipe 5a. A sleeve 10, on the other hand, surrounds the nozzle 1. Nozzle cooling and purging air or inert gas 9 is introduced into the gas cooling chamber 2 from the tip end of the nozzle 1 through the space which is defined between the sleeve 10 and the nozzle 1.

In the water injection nozzle of the prior art, as shown in Fig. 4, the water 4 is injected from the tip of the water injection nozzle 1 at a high speed and thus generates a wake (or vortexes) 24 as indicated by arrow b. Dust 22, which is being carried by hot exhaust gas 16 flowing in the direction of arrow a, is caught by the

wake 24 thus producing flower 23 around the nozzle or otherwise causing the dust to adhere to the furnace wall.

As the amount of flower 23 increases, it begins to cause disturbance directly in the path of the injected water.

Finally, a stable injection of water is prevented, and the flower 23 is wetted together with the refractory wall 3 by unstable water injection whereby the refractory body 3 is exposed to the worst conditions for durability of the refractory. Moreover, when the exhaust gas 16 contains hydrogen chloride (HCl) and/or sulfur oxide (Sox), and are absorbed by the wet flower 23, acidic water generated by HCl and/or Sox seeps into the refractory body 3 and has the potential to corrode a shell 12 extending to the outer casing of the furnace.

An object of the present invention is to solve the above-identified problems in the prior art.

According to one aspect of the present invention, there is provided a method of preventing dust from adhering to an interior surface defining a furnace where cooling fluid is introduced into the furnace via injection means, such as an area of the furnace wall or an exhaust duct for the furnace, wherein the area surrounding the injection means is formed by a refractory porous material, and air or an appropriate gas is injected into the furnace through the pores of said porous material to produce a flow which surrounds said injection means and attenuates the wake of the

fluid introduced via said injection means, whereby the surface is not only purged of dust, but the dust is inhibited from adhering to the surface to prevent the production of flower.

Where the method is to be used for the furnace wall of a fluidized bed incinerator, said method comprises injecting an atomized spray of water via said injection means into a combustion chamber located above the fluidized bed, forming an area of the wall of said combustion chamber surrounding the injection means with said porous refractory material having one side exposed to said combustion chamber and another side facing outwardly with respect to said chamber; and injecting air or an appropriate gas through the pores of said porous refractory material to produce a flow which surrounds said injection means and attentuates the wake of the atomised spray of water.

According to another aspect of the invention, there is provided a furnace adapted to the above method, comprising a wall having an interior surface defining the furnace and injection means for injecting cooling fluid into the furnace, wherein an area of the furnace wall surrounding the injection means is made of refractory porous material, and wherein air/gas feeding means are provided and adapted to inject air/gas through the pores of said material into the furnace to produce a flow which surrounds said injection means and attenuates the wake of fluid introduced via said injection means.

The furnace may be a fluidized bed incinerator, comprising an incinerator wall defining the cooling gas chamber therein, the incinerator wall including an

area comprising a refractory porous material having one side exposed to the gas cooling chamber and another side at the exterior of said wall, a nozzle extending through said refractory porous member and having a tip end terminating adjacent said one side of said refractory porous material, the nozzle having at least one passageway extending therethrough to its tip so as to be open into said gas cooling chamber; and feeding means for injecting air/gas through said refractory porous material into said gas cooling chamber to produce a flow which surrounds said injection means and attenuates the wake of fluid introduced via said nozzle.

According to a further aspect of the invention, in a nozzle structure comprising a nozzle having at least one passageway for injecting an appropriate liquid or gas, and adapted to the method, said nozzle extends through a refractory porous member having opposite side surfaces with its tip end terminating adjacent one side surface of said refractory porous member, and feeding means are provided for directing forced air/gas through the pores of said refractory porous member from the other side surface of said refractory porous member to said one side surface thereof whereby to produce a flow which surrounds said nozzle and attenuates the wake of fluid introduced via said nozzle to purge the latter surface of dust and to inhibit further accumulation of dust thereon.

Other objects and features of the present invention will become apparent from the following

description made with reference to the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of an embodiment of water injection nozzle according to the present invention;

Fig. 2 is a schematic diagram of a fluidized bed incinerator in which injection nozzles according to the present invention are incorporated;

Figs. 3 (a) and 3 (b) are detailed side elevation and transverse sectional views, respectively, of the water injection nozzle; and

Fig. 4 is a longitudinal sectional view of a prior art gas cooling water injection nozzle.

First, reference will be made to the fluidized bed incinerator shown in Fig. 2 which makes use of water injection nozzles in accordance with the present invention.

The fluidized bed incinerator is fed with material to be burned such as sludge by way of a hopper 32 and a feeding device 39. The sludge or the like is fed to the bottom of a fluidized bed incinerator 31 where it is burned at 38 on a sand layer using combustion air 41 which is introduced from an air box 40. Cooling water and a mixture of ammonia and water for treating the combustion gas are introduced into a cooling chamber 2 defined in the upper zone of the fluidized bed incinerator through the side wall thereof at locations indicated by A and B, respectively. The exhaust gas produced as a result of the combustion flows

in the direction of the arrows in Fig. 2 through a heat exchanger 33, such as a boiler, and through an exhaust gas treating device 34 and an electric dust collector 35 in which the exhaust gas is cleaned. The cleaned exhaust gas is discharged from a stack 37 by an induced draft fan 36. On the other hand, the unburned components are discharged from a discharge port 42 which is located at the bottom of the fluidized bed incinerator 31.

The injection nozzles are disposed at the above-mentioned locations A and B for injecting water or other appropriate liquid into the cooling chamber 2. Referring now to Fig. 1, each water injection nozzle 1 extends through a refractory porous member 11 of foamed ceramics provided to form that part of the side wall of the fluidized bed incinerator defining the gas cooling chamber 2. The refractory porous member 11 is surrounded by a refractory castable body, or by refractory bricks 3. Cooling air 9 is fed, as in the prior art water injection nozzle shown in Fig. 8, into the gas cooling chamber 2 from the tip end of the water injection nozzle 1 by passing through the space defined between a sleeve 10 and the nozzle 1.

An air chamber 8 is disposed on the exterior side of the refractory member 11 and comprises a box-like structure surrounding the water injection nozzle 1 and open at a side thereof disposed against the porous refractory member 11. The box 8 feeds a flow of air 7 into the hot gas in the gas cooling chamber 2 via

the porous refractory member 11 by passing from one side to the other thereof through the pores in the refractory member so as to cool the same and prevent the formation of flower on that portion of the side wall adjacent the tip end of the water injection nozzle.

Advantageously, the air 7 fed into the hot gas purges the tip end of the water injection nozzle 1 of dust scattered thereabout, and also attenuates the wake of the water injected from said tip end into the cooling chamber, thereby preventing an entrainment of dust in the injected water.

The detailed structure of the nozzle is shown in Figs. 3(a) and 3(b). The opening at the side of the box 8 facing the refractory porous member 11 is formed as a square, having a dimension of 350 mm. Also, the porous refractory member 11 adjacent the opening are of a square cross-section having a dimension of 450mm to 500mm, and a thickness of about 60 mm. The refractory member 11 is a laminate comprising a number of adjacent layers of ceramic foams, as shown in Fig. 3(b). The laminate is shaped to conform its outer surface to the inner curved surface of a shell 12 disposed outside the refractory body 3 so that the laminate effectively becomes substantially entirely embedded in the refractory body 3.

The sleeve 10 through which the cooling air is injected is inclined with respect to the center of the fluidized bed so as to define an injection axis tangential to circle C coaxial with the fluidized bed

incinerator 31. This imaginary circle has an area of about 4% of the sectional area of the exhaust gas to be cooled in the incinerator. The exhaust gas in the fluidized bed incinerator is swirled by the injected water jet to facilitate the mixing of said injected water jet (atomized spray) and rising exhaust gas.

Preferably, the refractory porous member 11 is foamed from ceramic such as cordierite, cordierite plus alumina, SiC or silicon nitride. From the practical standpoint of durability, the desired properties of the foamed material are: a bulk specific gravity of 0.35 to 0.45; a porosity of 80 to 90%; a compression strength of 20 to 25 Kg/cm^2; a pressure loss at ceramics of 20 to 60 mm Ag.; and 6 to 13 pores over a length of 25mm. With such material an appropriate inert gas can be used to pass therethrough instead of air.

Under the following operation conditions, it was confirmed that apparatus incorporating injection nozzles in accordance with the present invention could run stably without producing any flower at the tip of the nozzle:

Burning Rate of Sludge	50 Tons/day
Air Flow	6,800 Nm^3/hour
Exhaust Gas Temperature	850-900°C
Exit Gas Temperature	350°C
Water Injection Rate	about 3 Tons/hour
Porous refractory member	Ceramic Foam of Al_2O_3
Exhaust Gas Flow Speed	about 1.5 m/sec.

Air Speed from refractory porous member about 2 m/sec.

It is to be understood that various changes and modifications of the present invention within the scope of the appended claims will be apparent to those of ordinary skill in the art from the description above. For example, inert gas instead of air can be fed from the chambers 8 through the refractory porous member 11.

CLAIMS

1. A method of preventing dust from adhering to an interior surface defining a furnace where cooling fluid is introduced into the furnace via injection means, such as an area of the furnace wall or an exhaust duct for the furnace, wherein the area surrounding the injection means is formed by a refractory porous material, and air or an appropriate gas is injected into the furnace through the pores of said porous material to produce a flow which surrounds said injection means and attenuates the wake of the fluid introduced via said injection means, whereby the surface is not only purged of dust, but the dust is inhibited from adhering to the surface to prevent the production of flower.

2. A method according to Claim 1 specifically adapted for the furnace wall of a fluidized bed incinerator, said method comprising:

injecting an atomized spray of water via said injection means into a combustion chamber located above the fluidized bed, forming an area of the wall of said combustion chamber surrounding the injection means with said porous refractory material having one side exposed to said combustion chamber and another side facing outwardly with respect to said chamber; and injecting air or an appropriate gas through the pores of said porous refractory material to produce a flow which surrounds said injection means and attenuates the wake of the atomised spray of water.

3. A furnace adapted to the method of Claim 1,

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comprising a wall having an interior surface defining the furnace and injection means for injecting cooling fluid into the furnace, wherein an area of the furnace wall surrounding the injection means is made of a refractory porous material, and wherein air/gas feeding means are provided and adapted to inject air/gas through the pores of said material into the furnace to produce a flow which surrounds said injection means and attenuates the wake of fluid introduced via said injection means.

4. A fluidized bed incinerator adapted to the method of claim 2 comprising: an incinerator wall defining a gas cooling chamber therein, the incinerator wall including an area comprising a refractory porous material having one side exposed to the gas cooling chamber and another side at the exterior of said wall, a nozzle extending through said refractory porous member and having a tip end terminating adjacent said one side of said refractory porous material, the nozzle having at least one passageway extending therethrough to its tip so as to be open into said gas cooling chamber; and feeding means for injecting air/gas through said refractory porous material into said gas cooling chamber to produce a flow which surrounds said injection means and attenuates the wake of fluid introduced via said nozzle.

5. An incinerator as claimed in Claim 4, wherein said feeding means is a box-like structure covering at least a portion of said another side of said refractory porous material, the box being open at a side thereof

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disposed against said another side of said refractory material such that the interior of the box is in open communication with the pores of said refractory porous material.

6. An incinerator as claimed in claim 4 or 5, wherein said refractory porous material is a laminate of several layers of said material.

7. An incinerator as claimed in any one of claims 4, 5 or 6, wherein said refractory porous material comprises ceramics such as cordierite, cordierite plus alumina, SIC, or silicon nitrite.

8. An incinerator as claimed in any one of claims 4 to 7, and further comprising a shell extending around said incinerator wall, wherein said another side of said refractory porous material is shaped to be complementary to said shell.

9. A nozzle structure adapted for the method of Claim 1, or 2 said nozzle structure comprising a nozzle having at least one passageway for injecting an appropriate liquid or gas, wherein said nozzle extends through a refractory porous member having opposite side surfaces with its tip end terminating adjacent one side surface of said refractory porous member, and feeding means are provided for injecting air/gas through the pores of said refractory porous member from the other side surface of said refractory porous member to said one side surface thereof whereby to produce a flow which surrounds said nozzle and attenuates the wake of fluid introduced via said nozzle to purge the latter surface

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of dust and to inhibit further accumulation of dust thereon.

10. A nozzle structure as claimed in claim 9, wherein said feeding means for directing forced air/gas includes a chamber in the form of a box covering at least a portion of the other side surface of said refractory porous member, the box being open at a side thereof disposed against said other side surface of said refractory porous member such that the interior of the box is in open communication with the pores of said refractory porous member.

11. A nozzle structure as claimed in claim 9, or 10, wherein said refractory porous member is a laminate of blocks of refractory porous material.

12. A nozzle structure as claimed in any one of claims 9 to 11, wherein said refractory porous member comprises ceramics such as cordierite, cordierite plus alumina, SIC, or silicon nitrite.

13. A method of preventing dust from adhering to an interior surface defining a furnace, a furnace, fluidized bed incinerator, or a nozzle structure therefor, all adapted to said method, substantially as hereinbefore described with referance to Figures 1 to 3 of the accompanying drawings.

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