

SPECIFICATION

Method and apparatus for the neutralisation and precipitation of acid or acid-containing pollutants in flue gases

This invention relates to methods of neutralization and precipitation of acid or acid-containing pollutants in flue gases from furnaces, for example refuse incinerators having means for utilising waste heat from the flue gases, wherein a suspension in water of solids having a basic reaction, for example lime, is introduced into the flue gas and dispersed in an amount such that by reaction of the solids with the pollutant and by means of the residual heat in the flue gas a dry neutral salt is formed and the salt together with flue dust is, for example by means of an ordinary dust-precipitator, removed from the flue gas. The invention also relates to apparatus for the performance of this method.

In order to neutralize acid or acid-containing pollutants in flue gases from furnaces, neutralization agents, e.g., aqueous suspensions of lime are sprayed continuously into the flue gases by means of pump-driven liquid atomizers. By doing this the pollutants are converted into neutral salts which are then removed together with the flue dust in a dust-precipitator. Simultaneously, the carrier water in the suspension is evaporated.

Neutralization in this way has hitherto been performed at flue gas temperatures of more than 500°C so that taking into consideration the temperature limits set by the condensation point a cooling range of about 350°C is available. This wide cooling range allows the introduction of relatively large amounts of water in very dilute suspensions which greatly help the dispersal or distribution of the suspension in the flue gas and thereby aid the chemical reaction.

However, if flue gases are supplied from installations having waste heat utilization, the flue gas temperatures are only 200 to 250°C and therefore a cooling range of only about 100°C is available.

Further, if the furnace is a refuse incinerator in which heterogeneous fuel is burnt, there occur in addition both wide fluctuations in the amount of flue gas and also in the proportion of pollutant in the flue gas. In order to guarantee the necessary reduction in pollutant even at high concentrations of pollutant, the neutralization agent is proportioned at any time to the highest value of the amount of flue gas and the highest proportion of pollutant. This naturally causes a high consumption of neutralisation agent. On the other hand the amount of water to be introduced in the suspension is orientated towards the smallest amount of flue gas occurring.

The object of the present invention is to provide a method of neutralization of acid or acid-containing pollutants in flue gases with dry precipitation of neutral salt, which works even at low flue gas temperatures such as are usual in the flues of furnaces having waste heat utilization. It is a further object of the invention to provide apparatus for carrying out this method in such a way that under the conditions described above, economical operation is possible, in particular with regard to the wear

of the installation and the consumption of the neutralization agent.

Thus, according to one aspect of this invention, we provide a method of neutralization and precipitation of acid, or acid-containing, pollutants in flue gas from a furnace in which a viscous suspension in water of solids having a solid to liquid mixture ratio by weight in the range of from 1:20 to 1:2 and having a basic reaction is introduced into the flue gas and is atomised by a compressed gaseous atomising agent in an amount such that, by reaction of the solids with the pollutant and by means of the residual heat in the flue gas, a dry neutral salt is formed and the salt together with flue dust is removed from the flue gas, wherein the suspension is introduced into the flue gas under substantially the same pressure as the flue gas and after entry into the flue gas is atomised and dispersed by a stream of the gaseous atomising agent which is directed at least substantially perpendicular to the direction of introduction of the suspension.

Preferably the mixture ratio by weight of the viscous suspension is in the range of from 1:6 to 1:3.

Because of the employment of a viscous suspension as described, the flue gases are cooled down only relatively little, so that neutralization and drying of the salts of neutralization can be effected even at flue gas temperature of 200 to 250°C, without the condensation point being reached. The employment of a gaseous or vapourous atomizing agent, for which purpose compressed gas, and preferably compressed air, or steam are particularly suitable, furthermore allows the suspensions to be able to be conveyed through feed pipes without high pump pressure and at low speed, so that wear by the suspension, which in itself has a very erosive action, scarcely arises, particularly not in parts of the atomiser which affect the quality of the atomization.

Preferably the amount of suspension and/or atomizing agent introduced is adjusted to correspond with alterations in the amount of flue gas and/or the proportion of pollutant in the flue gas to produce a neutralization reaction which proceeds substantially stoichiometrically. Owing to these measures the method is particularly suitable for use with furnaces in which the amount and composition of the flue gas is perpetually altering, as is the case especially with refuse incinerators. In this way the consumption of neutralization agent and also of atomization agent can be kept economically low.

The alteration is effected in such a way that upon alteration in the rate of flow or flue gas, both the amount of suspension introduced and also that of the atomizing agent are correspondingly altered and upon alteration of only the concentration of pollutant in the flue gas, only the amount of suspension is altered.

According to another aspect of the invention, apparatus for carrying out the method in accordance with the invention comprises preparation equipment for producing a viscous suspension in water of solids having a basic reaction, a compressed gas-operated atomising device having an atomizing member extending into a flue gas conduit, the atomizing member including an outlet for the sus-

pension and a compressed gas duct, means for supplying the suspension from the preparation equipment to the outlet at substantially the same pressure as that of the flue gas in the conduit at the outlet and means for supplying compressed gas to the compressed gas duct, the duct having a compressed gas outlet in the conduit adjacent the outlet for the suspension, the compressed gas outlet being directed at least substantially perpendicular to the outlet for the suspension so that, in use, the compressed gas from the gas outlet atomises the suspension from the suspension outlet and disperses the suspension in the flue gas in the conduit.

A compressed-gas atomizer is especially suitable for the distribution of the viscous suspension, since the suspension can be conveyed relatively slowly in piping leading to a flue gas conduit and hence wear scarcely arises. In addition, with a compressed-gas atomizer a better and more easily adjustable dispersion into the flue gas can be achieved. This improves the economy of the apparatus.

Preferably, the compressed gas duct is in the form of a jacket tube arranged concentrically around a suspension feed tube and at the end of the jacket tube there is a U-shaped ductpiece forming the outlet of the compressed gas duct. This gives rise to very compact construction in which the atomizing gas acts simultaneously as insulation to keep the flue gas temperature away from neutralization agent, and also if the compressed gas is pre-heated by a heater, this avoids lowering of the temperature in the outer tube below the condensation point.

The feed tube may be axially movably guided adjacent its outlet end in a scraper ring.

By moving the feed tube to and fro, deposits in the region of the outlet end of the feed tube may be scraped off, so that the geometry of the atomizer and hence the atomizing quality are maintained. The axial movement may be effected by a piston which moves in a cylinder and which is connected to the feed tube. One side of the piston is acted upon by a pressure medium against the action of a spring. Preferably, for the periodic admission of pressure, e.g., by means of automatic timeswitch equipment, a two-way solenoid valve may be provided. This valve is connected to the compressed gas generating equipment.

According to a further preferred feature of the invention, the atomizing member has a ball-joint mounting built into a wall of the flue gas conduit. This enables the direction of the stream of the suspension to be optionally adapted to the data of the flue gas flow.

If compressed air is used for atomisation there is preferably heating of the compressed gas, firstly in order to enable Winter operation, and secondly in order to avoid effects of cooling down in the region where the condensation point may occur as this would cause deposits and corrosion upon the flue gas side of the atomizing member.

The compressed-gas atomizer may be provided with means for adjusting the rate of flow of the compressed gas. This allows the amount of the atomizing agent being introduced to be adapted to the amount of flue gas at any instant. Furthermore

the apparatus preferably includes a device for adjusting the rate of flow of the suspension in order to be able to change the rate to correspond with alterations in the amount of pollutant, whether due to alteration in the rate of flow of flue gas or of the proportion of pollutant in the flue gas in order to achieve a neutralization process proceeding substantially stoichiometrically.

In order to make this adjustment automatic, the apparatus preferably includes a device for measuring the rate of flow of flue gas and a device for measuring the proportion of pollutant in the flue gas, these devices being connected via a control device to the device for adjusting the flow of the suspension in such a way that upon an alteration occurring in the flow of flue gas a corresponding alteration is effected both in the flow of compressed gas and also in the flow of the suspension, upon an alteration occurring only of the proportion of pollutant in the flue gas only a corresponding alteration of the flow of the suspension is effected and upon alterations occurring both in the flow of flue gas and also in the proportion of pollutant in the flue gas, corresponding alterations in flow of the compressed gas and of the suspension are effected. This arrangement ensures an optimum low consumption of neutralization agent simultaneously with an optimum neutralization effect.

An overflow device may be provided between the preparation equipment for the suspension and the compressed-gas atomizer. This sets a feed head for the suspension to the compressed-gas atomizer. Hence the conveyance of the suspension into the flue gas glow is effected solely on the basis of a feed head, so that only low flow speeds and pressures arise. This contributes to a reduction in the wear. The overflow device may have a return duct leading back to the preparation equipment.

This makes it possible to feed an amount of suspension to the overflow equipment equal to at least twice the amount of suspension fed to the compressed gas atomizer. There is thus a constant circulation of suspension so that deposits of lime which can occur in particular with viscous suspensions, are prevented with great certainty.

In order to be able to set the amount of suspension introduced into the flue gas flow, the overflow may be provided with a device for adjusting the level of suspension. In this way the feed head to the compressed-gas atomizer can be altered, and this has the result of a corresponding alteration of the amount of suspension supplied. The adjustment of the level can in this case consist of a telescopic overflow tube, a telescopic part of which tube is movable upwards and downwards by an electric servomotor. Any other adjusting drive may equally well be used.

Two examples of methods and of apparatus in accordance with the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a flow diagram of one example of the method and apparatus using compressed air generated in the apparatus as the atomizing agent and calcium hydroxide as the neutralization agent;

Figure 2 is a cross-section through an atomizing member of the apparatus of Figure 1;

Figure 3 is a cross-section through an overflow device of the apparatus of Figure 1;

5 Figure 4 is a flow diagram of a second example of the method and apparatus using steam as the atomizing agent and calcium hydroxide as the neutralization agent; and

10 Figure 5 is a section through an atomizing member of the apparatus of Figure 4;

The apparatus shown in Figure 1 comprises a preparation equipment 1 which includes a vessel 2 of calcium hydroxide and a stock tank 3 containing a suspension of calcium hydroxide and water. The 15 calcium hydroxide is introduced by a screw conveyor 4, which is driven by a motor M, into the stock tank 3, a water supply 5 is provided under the control of a float 6. In addition the water supply is connected via a regulating circuit 7 to the screw conveyor 4, so 20 that a constant composition of the suspension is ensured. Although the example illustrated works with a solids to liquid mixture ratio of 1:4, the setting of the mixture ratio can readily be changed. A stirrer 8 dipping in the suspension in the tank 3 is provided.

25 From the preparation equipment 1, the suspension is pumped by means of a motor (M) driven pump 9 through a feed pipe 10 to an overflow device 11 which comprises a container 12 and an overflow tube 13 arranged in it. The excess suspension 30 supplied flows back via openings provided in an overflow tube 13 and also via a drain pipe 14 into the stock tank 3. Since the pump 9 always feeds considerably more suspension than is used, generally more than about twice that required, a circuit is 35 formed which keeps the level of the suspension in the overflow device 11 constant to correspond with the height of the openings in the overflow tube 13 and ensures that no deposits of lime arise in the system.

40 The overflow tube 13 is adjustable for height telescopically so that the level of the suspension may be set or altered. This is done by a servo-drive, in the example illustrated in Figure 1 via an electric servomotor 15 which is connected via a crank 16, a 45 connecting rod 17, a double lever 18 and a further connecting rod 19 to the top end of the overflow tube 13.

From the overflow device 11, the feed pipe 10 continues to an atomizing member 20 of a compressed-air atomizer 21. The compressed-air atomizer 21 has, besides the atomizing member 20, a pressure generating device 22 which consists of a motor (M) driven compressor 23, a compressed air reservoir 24 and a heater 25. Between the compressor 23 and the compressed air reservoir 24, a 55 regulating circuit 26 is connected in order to ensure a substantially constant filling of the compressed air reservoir 24.

60 From the pressure-generating device 22, the compressed air arrives via a compressed air pipe 27 at the atomizing member 20. The atomizing member 20 is supported by means of a ball-joint 28 in the wall 29 of a flue gas conduit 30 and projects at its outlet end 31 about as far as the middle of the conduit. The 65 outlet end 31 is lower than the level of the suspen-

sion in the overflow device 11, so that a feed head exists between the two. This ensures the supply of the suspension through the feed pipe 10 and its emergence at the outlet end 31 of the atomizing member 20. By alteration of the level of the suspension in the overflow device 11 the feed head and hence the rate of discharge at the atomizing member 20 can be altered as required.

75 The compressed air itself is discharged via a U-shaped ductpiece 32 at right angles to the direction of flow of the suspension which is thereby atomized in the direction of the flue gas flow. The rate of flow of compressed air discharged can be set by a valve 34 controlled by a servomotor 33.

80 The adjustment of the level of the suspension and thereby the flow of the suspension into the flue gas flow as well as the adjustment of the valve 34 and hence the flow of the atomizing air is effected automatically by a control device. The control device 85 obtains information about the rate of flow of flue gas at any time from a device 35 for measuring amounts of flue gas. The device 35 comprises a venturi nozzle in the flue gas conduit 30, as well as a probe 36 projecting into the flue gas conduit 30 and having an 90 analyser apparatus, so that the concentration of pollutant in the flue gas is measured as well as the rate of flow of the flue gas.

The signal produced by the device acts via a control 37 as a correcting variable for controlling the 95 valve 34 in such a way that an increase in the rate of flow of flue gas brings about a corresponding increase in the flow of compressed air. At the same time the signal is passed on to a further control 38 which is connected to the servomotor 15 of the 100 overflow device 11 and this produces a corresponding increase in the flow of suspension also. Thus the ratio of the flow of compressed air to the flow of suspension remains constant.

If only the concentration of pollutant in the flue gas 105 is altered, the signal produced by the probe 36 is transmitted to the control 38 and from it to the servomotor 15. Then only the level of the suspension and hence the flow of suspension to be atomized gets altered, whilst the flow of compressed air 110 remains constant.

If both the flow of flue gas and also the concentration of pollutant in the flue gas are altered, the alteration of the flow of compressed air and the flow of suspension no longer occurs in proportion. The 115 signal from the device 35 for measuring flow of flue gas is increased or decreased in comparison with the flow of suspension in the control 38 by the signal coming from the probe 36. Thus the flow of suspension is altered more than the flow of compressed air.

120 In addition there are in the compressed air pipe 27 and in the feed pipe 10 and the discharge pipe 14 measuring points 39, 40, 41, the measured values at which are converted into signals and are transmitted back to the corresponding controls 37, 38 as position 125 reports.

In the preparation equipment 1 and the pressure-generating device 22 branches may, as required, be connected from the feed pipe 10 or the compressed air pipe 27 in order to supply further atomizing 130 members. This is indicated in Figure 1 by pipes 42.

Figure 2 shows a cross-section through the atomizing member 20. This comprises a feed tube 43 through which the suspension flows in the direction of the outlet end 31. The feed tube 43 is surrounded concentrically by a jacket tube 44 which is connected at one end to the compressed air pipe 27 and at the other end to the U-shaped ductpiece 32 and serves for the conveyance of the compressed air. A mouth 45 of the ductpiece 32 is arranged underneath and at right angles to the mouth 46 of the feed tube 43 so that the compressed air flowing out of the ductpiece 32 entrains the suspension coming out of the feed tube 43 and in doing so atomizes it finely.

The feed tube 43 is mounted in the jacket tube 44 so that it can slide axially. To produce the axial movement, an actuating device 47 is provided with an actuating piston 48 which is screwed on to the feed tube 43 and slides in a cylinder 49. On the left hand side of the piston in Figure 2, a pressure chamber 50 is provided and is connected to a two-way solenoid valve 51 which controls the admission of pressure medium to the pressure chamber 50 and hence to the actuating piston 48. A pressure medium pipe 42 leading up to the two-way solenoid valve 41 is in this example, connected to the compressed air pipe 27.

By periodic reversal of the two-way solenoid valve 51 the pressure chamber 50 may be pressurised and vented so that the piston is forced towards the right and after venting is forced back towards the left by a spring 53. By doing this the freely projecting end of the feed tube 43 is reciprocated so that a scraper ring 54 scrapes off lime and dust residues which may have become deposited. This keeps the mouth 46 of the tube 43 always clean. The jacket space in the coaxially arranged tube 44 which is under atomizer pressure, in combination with the ample tolerance at the free end ensures that the material scraped off the tube 43 gets blown away.

The unit comprising the feed tube 43 and the jacket tube 44 is supported via the ball joint 28 in the wall 29 of the flue gas conduit 30 in an adjustable manner so that the atomizing member 20 may have its position adapted in an optimum manner to the conditions of the flue gas flow at any time.

Figure 3 shows, also in cross-section, the overflow device 11 with the container 12, the overflow tube 13 and the servomotor 15 to an enlarged scale. The overflow tube 13 has a smaller diameter than the drain pipe 14 which is connected to it at its bottom, so that the two can move telescopically in and out of one another. If required the two parts may in addition be sealed together by a flexible bellows 55. Above the bellows 55 the overflow tube 13 has a number of overflow openings 56 the bottom edges of which determine the level of the suspension at any time.

The top end of the overflow tube 13 is connected by a hinge to the double lever 18, and here, in contrast to the illustration in Figure 1, the connecting rod 19 is omitted. In this case the function of the rod 19 is fulfilled by the double lever 18 which is hinged to a rocker 57 supported on the container 12. The bottom end of the double lever 18 is connected via the connecting rod 17 to the crank 16 on the

servomotor 15.

In the position shown in full lines in Figure 3, the overflow tube 13 is in its highest position i.e., the head above the atomizing member 20 shown in Figure 1 and hence the flow of suspension being introduced into the flue conduit is at its greatest. By turning the crank 16 anti-clockwise the linkage adopts the position shown in chain-dotted lines in which the overflow tube 13 is retracted into the drain pipe 14. The level of the suspension drops accordingly, so that the head to the atomizing member 20 decreases.

Figure 4 illustrates a second example of the method and apparatus. The apparatus is in function identical with that described in connection with Figure 1 and is distinguished in construction and use exclusively by the use of steam as the atomizing agent instead of compressed air.

From the overflow device 11, the feed pipe 10 continues to an atomizing member 60 of a steam atomizer 61. The steam atomizer 61 has, besides the atomizing member 60, a steam generating device which comprises a steam boiler 62 for producing saturated steam or slightly superheated steam, a heater 63 on the water side, controlled via the steam pressure, as well as water preparation and after-storage devices 64. A regulating circuit 65 for the inlet pressure and a regulating circuit 66 for water filling of the boiler enable largely supervision-free operation of the apparatus to take place.

From the boiler 62 the steam arrives via a steam pipe 67 at the atomizing member 60 which is supported by means of a ball-joint 28 in the wall 29 of the flue gas conduit 30 and projects at its outlet end 68 as far as about the middle of the flue gas conduit. The outlet end 68 is lower than the level of the suspension in the overflow device 11, so that between the two there is a feed head which brings about the conveyance of the suspension through the feed pipe 10 and its discharge at the outlet end 68 of the atomizing member 60. By alteration of the level of the suspension in the overflow device 11, the feed head and hence the outlet flow rate at the atomizing member 60 can be altered as required.

The steam is discharged via a U-shaped ductpiece 69 at right angles to the suspension which is thus atomized in the direction of the flue gas flow. The amount of steam escaping can be set via a valve 34 controlled by a servomotor 33.

The adjustment of the level of the suspension and hence of the flow rate of the suspension discharged into the flue gas flow as well as the adjustment of the valve 34 and hence of the flow rate of atomizing steam discharged is effected automatically via a controller such as is described in connection with the example of Figure 1.

In the preparation equipment 1 and the boiler 62 branches may be connected as required from the feed pipe 10 and the steam pipe 67 in order to supply further atomizing members. This is indicated by the pipes 42.

Figure 5 shows a cross-section through the atomizing member 60. This comprises a feed tube 43 through which the suspension flows in the direction of the outlet end 68. The feed tube 43 is surrounded

concentrically by a jacket tube 44 which screens the feed tube 43 against the effect of heat from the atomizing steam and also prevents condensation of the atomizing steam on the cold feed tube 43. The feed tube 43 and the jacket tube 44 are surrounded concentrically by a further jacket tube 70. The jacket tube 70 connects the steam feed pipe 67 at one end to the U-shaped ductpiece 69 and thus serves for the conveyance of the steam. The jacket tube 70 carrying the steam is protected by a protective jacket 72 of corrosion-resistant sheet metal against contact, but also against heat loss outwards. The mouth 45 of the ductpiece 69 is arranged underneath and at right angles to the mouth 46 of the feed tube 43 so that the steam flowing out of the ductpiece 69 entrains the suspension coming out of the feed tube 43 and thereby atomizes it finely.

The feed tube 43 is mounted in the jacket tube 44 so that it can slide axially. To produce the axial movement an actuating device 47 is provided with an actuating piston 48 which is screwed on to the feed tube 43 and slides in a cylinder 49. On the left hand side of the piston in Figure 5, a pressure chamber 50 is provided which is connected to a two-way solenoid valve 51 which controls the admission of pressure medium to the pressure chamber 50 and thereby to the actuating piston 48. The pressure medium-pipe 52 leading to the two-way solenoid valve 51 is connected to the steam pipe 67. The operation of this axial sliding arrangement for cleaning of the outlet opening 46 is similar to that described in connection with the example of Figure 1.

To improve the heat-protective effect for the feed tube 43, the space between the tube 43 and the jacket tube 44 is provided with air inlet holes 73 and a generously dimensioned gap 74 at the end adjacent the flue gas conduit. The reduced pressure constantly prevailing in the flue gas conduit causes cold ambient air to flow through the holes 73 past the feed tube 43 into the flue gas conduit so that the air brings about the required cooling.

CLAIMS

1. A method of neutralization and precipitation of acid, or acid-containing, pollutants in flue gas from a furnace, in which a viscous suspension in water of solids having a solid to liquid mixture ratio by weight in the range of from 1:20 to 1:2 and having a basic reaction is introduced into the flue gas and is atomised by a compressed gaseous atomising agent in an amount such that, by reaction of the solids with the pollutant and by means of the residual heat in the flue gas, a dry neutral salt is formed and the salt together with flue dust is removed from the flue gas, wherein the suspension is introduced into the flue gas under substantially the same pressure as the flue gas and after entry into the flue gas is atomised and dispersed by a stream of the gaseous atomising agent which is directed at least substantially perpendicular to the direction of introduction of the suspension.

2. A method according to Claim 1, in which the amount of the suspension and/or of the atomizing

agent introduced is varied to correspond with variations in the flow of flue gas and/or the proportion of pollutant in the flue gas to produce a neutralization reaction which proceeds substantially stoichiometrically.

3. A method according to Claim 2, in which upon alterations in the flow of flue gas taking place, both the amount of suspension introduced and also the amount of the atomizing agent are correspondingly altered.

4. A method according to Claim 2, in which upon alterations only of the proportion of pollutant in the flue gas taking place, only the amount of suspension introduced is altered.

5. A method according to any one of Claims 1 to 4, in which the gaseous atomizing agent is air.

6. Apparatus for carrying out the method in accordance with Claim 1, the apparatus comprising preparation equipment for producing the said viscous suspension in water of solids having a basic reaction, a compressed gas-operated atomising device having an atomizing member extending into a flue gas conduit, the atomising member including an outlet for the suspension and a compressed gas duct, means for supplying the suspension from the preparation equipment to the outlet at substantially the same pressure as that of the flue gas in the conduit at the outlet and means for supplying compressed gas to the compressed gas duct, the duct having a compressed gas outlet in the conduit adjacent the outlet for the suspension, the compressed gas outlet being directed at least substantially perpendicular to the outlet for the suspension so that, in use, the compressed gas from the gas outlet atomises the suspension from the suspension outlet and disperses the suspension in the flue gas in the conduit.

7. Apparatus according to Claim 6, in which the compressed gas duct is in the form of a jacket tube arranged concentrically around a suspension feed tube and at the end of the jacket tube there is a U-shaped ductpiece forming the outlet of the compressed gas duct.

8. Apparatus according to Claim 6 or Claim 7, in which the feed tube is axially movably guided adjacent its outlet end in a scraper ring.

9. Apparatus according to Claim 8, in which the feed tube is connected to and axially movable by a piston which moves in a cylinder, one side of the piston being acted upon by fluid pressure against the action of a spring.

10. Apparatus according to Claim 9, in which for cleaning the outlet end of the feed tube, automatic admission of fluid under pressure to the cylinder is provided for by means of a two-way solenoid valve which controls the supply of compressed gas from the pressure generating device to the cylinder.

11. Apparatus according to any one of Claims 7 to 10, in which the atomizing member has a ball-joint mounting built into a wall of the flue gas conduit.

12. Apparatus according to any one of Claims 6 to 11, in which a heater is provided for heating compressed gas for the atomizer.

13. Apparatus according to any one of Claims 6 to 12, in which the compressed gas atomizer is



concentrically by a jacket tube 44 which screens the feed tube 43 against the effect of heat from the atomizing steam and also prevents condensation of the atomizing steam on the cold feed tube 43. The feed tube 43 and the jacket tube 44 are surrounded concentrically by a further jacket tube 70. The jacket tube 70 connects the steam feed pipe 67 at one end to the U-shaped ductpiece 69 and thus serves for the conveyance of the steam. The jacket tube 70 carrying the steam is protected by a protective jacket 72 of corrosion-resistant sheet metal against contact, but also against heat loss outwards. The mouth 45 of the ductpiece 69 is arranged underneath and at right angles to the mouth 46 of the feed tube 43 so that the steam flowing out of the ductpiece 69 entrains the suspension coming out of the feed tube 43 and thereby atomizes it finely.

The feed tube 43 is mounted in the jacket tube 44 so that it can slide axially. To produce the axial movement an actuating device 47 is provided with an actuating piston 48 which is screwed on to the feed tube 43 and slides in a cylinder 49. On the left hand side of the piston in Figure 5, a pressure chamber 50 is provided which is connected to a two-way solenoid valve 51 which controls the admission of pressure medium to the pressure chamber 50 and thereby to the actuating piston 48. The pressure medium-pipe 52 leading to the two-way solenoid valve 51 is connected to the steam pipe 67. The operation of this axial sliding arrangement for cleaning of the outlet opening 46 is similar to that described in connection with the example of Figure 1.

To improve the heat-protective effect for the feed tube 43, the space between the tube 43 and the jacket tube 44 is provided with air inlet holes 73 and a generously dimensioned gap 74 at the end adjacent the flue gas conduit. The reduced pressure constantly prevailing in the flue gas conduit causes cold ambient air to flow through the holes 73 past the feed tube 43 into the flue gas conduit so that the air brings about the required cooling.

CLAIMS

1. A method of neutralization and precipitation of acid, or acid-containing, pollutants in flue gas from a furnace, in which a viscous suspension in water of solids having a solid to liquid mixture ratio by weight in the range of from 1:20 to 1:2 and having a basic reaction is introduced into the flue gas and is atomised by a compressed gaseous atomising agent in an amount such that, by reaction of the solids with the pollutant and by means of the residual heat in the flue gas, a dry neutral salt is formed and the salt together with flue dust is removed from the flue gas, wherein the suspension is introduced into the flue gas under substantially the same pressure as the flue gas and after entry into the flue gas is atomised and dispersed by a stream of the gaseous atomising agent which is directed at least substantially perpendicular to the direction of introduction of the suspension.

2. A method according to Claim 1, in which the amount of the suspension and/or of the atomizing

agent introduced is varied to correspond with variations in the flow of flue gas and/or the proportion of pollutant in the flue gas to produce a neutralization reaction which proceeds substantially stoichiometrically.

3. A method according to Claim 2, in which upon alterations in the flow of flue gas taking place, both the amount of suspension introduced and also the amount of the atomizing agent are correspondingly altered.

4. A method according to Claim 2, in which upon alterations only of the proportion of pollutant in the flue gas taking place, only the amount of suspension introduced is altered.

5. A method according to any one of Claims 1 to 4, in which the gaseous atomizing agent is air.

6. Apparatus for carrying out the method in accordance with Claim 1, the apparatus comprising preparation equipment for producing the said viscous suspension in water of solids having a basic reaction, a compressed gas-operated atomising device having an atomizing member extending into a flue gas conduit, the atomising member including an outlet for the suspension and a compressed gas duct, means for supplying the suspension from the preparation equipment to the outlet at substantially the same pressure as that of the flue gas in the conduit at the outlet and means for supplying compressed gas to the compressed gas duct, the duct having a compressed gas outlet in the conduit adjacent the outlet for the suspension, the compressed gas outlet being directed at least substantially perpendicular to the outlet for the suspension so that, in use, the compressed gas from the gas outlet atomises the suspension from the suspension outlet and disperses the suspension in the flue gas in the conduit.

7. Apparatus according to Claim 6, in which the compressed gas duct is in the form of a jacket tube arranged concentrically around a suspension feed tube and at the end of the jacket tube there is a U-shaped ductpiece forming the outlet of the compressed gas duct.

8. Apparatus according to Claim 6 or Claim 7, in which the feed tube is axially movably guided adjacent its outlet end in a scraper ring.

9. Apparatus according to Claim 8, in which the feed tube is connected to and axially movable by a piston which moves in a cylinder, one side of the piston being acted upon by fluid pressure against the action of a spring.

10. Apparatus according to Claim 9, in which for cleaning the outlet end of the feed tube, automatic admission of fluid under pressure to the cylinder is provided for by means of a two-way solenoid valve which controls the supply of compressed gas from the pressure generating device to the cylinder.

11. Apparatus according to any one of Claims 7 to 10, in which the atomizing member has a ball-joint mounting built into a wall of the flue gas conduit.

12. Apparatus according to any one of Claims 6 to 11, in which a heater is provided for heating compressed gas for the atomizer.

13. Apparatus according to any one of Claims 6 to 12, in which the compressed gas atomizer is



- provided with a device for adjusting the rate of flow of compressed gas.
14. Apparatus according to Claim 13, in which there is a device for adjusting the rate of flow of the suspension into the flue gas.
15. Apparatus according to Claim 14, in which there is a device for measuring the rate of flow of flue gas and a device for measuring the proportion of pollutant in the flue gas, these devices being
10. connected via a control device to the device for adjusting the flow of compressed gas and the device for adjusting the flow of the suspension in such a way that upon an alteration occurring in the flow of flue gas a corresponding alteration is effected both
15. in the flow of compressed gas and also in the flow of the suspension, upon an alteration occurring only of the proportion of pollutant in the flue gas only a corresponding alteration of the flow of the suspension is effected, and upon alterations occurring both
20. in the flow of flue gas and also in the proportion of pollutant in the flue gas corresponding alterations in flow of the compressed gas and of the suspension are effected.
16. Apparatus according to any one of Claims 6 to 15, in which an overflow device is provided between the preparation equipment and the compressed gas atomizer.
17. Apparatus according to Claim 16, in which the overflow device has a return duct leading back to
30. the preparation equipment and the amount of the suspension fed to the overflow device is at least twice the amount of the suspension fed to the compressed gas atomizer.
18. Apparatus according to Claim 16 or Claim 17, in which there is a device for adjusting the level of the suspension at which overflow takes place at the overflow device.
19. Apparatus according to Claim 18, in which the device for adjusting the overflow level comprises
40. a telescope overflow tube.
20. Apparatus according to Claim 19, in which a telescopic part of the overflow tube is movable upwards and downwards by an electric servomotor.
21. A method according to Claim 1, substantially as described with reference to Figures 1 to 3 or Figures 4 and 5 of the accompanying drawings.
22. Apparatus according to Claim 6, substantially as described with reference to Figures 1 to 3 or Figures 4 and 5 of the accompanying drawings.
50. 23. A refuse incinerator having a flue gas outlet conduit and means for utilising waste heat from the flue gases, wherein the conduit is fitted with apparatus in accordance with any one of Claims 6 to 20 or Claim 22.