

United States Patent

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[54] ELECTRO-PRECIPITATION

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[51] Int. Cl.B03c 3/01

[58] Field of Search.....55/5, 10, 11, 107, 106, 122, 55/134, 139; 239/566; 159/4. F

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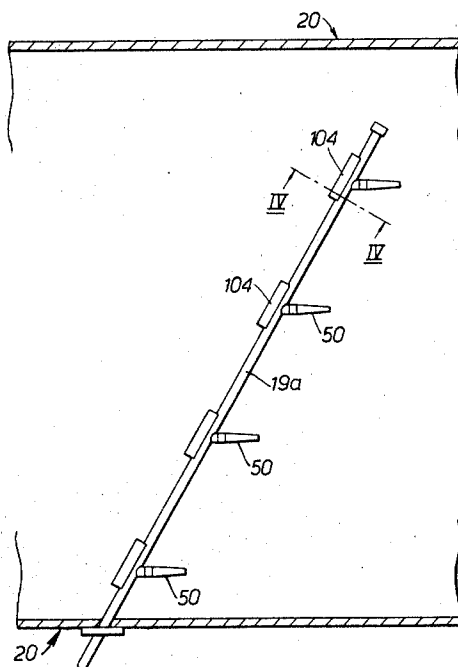
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[57] ABSTRACT

An injection assembly for injecting SO_3 conditioning agent into a duct carrying gas to be cleaned to an electro-precipitator comprises a manifold extending across the duct and a plurality of elongated nozzles extending from the manifold. Each nozzle and associated structure presents an aerofoil configuration of controlled dimensional parameters so that optimum aerodynamic conditions are obtained for the SO_3 injection.

11 Claims, 4 Drawing Figures



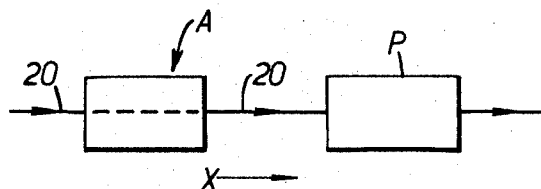


FIG. 1.

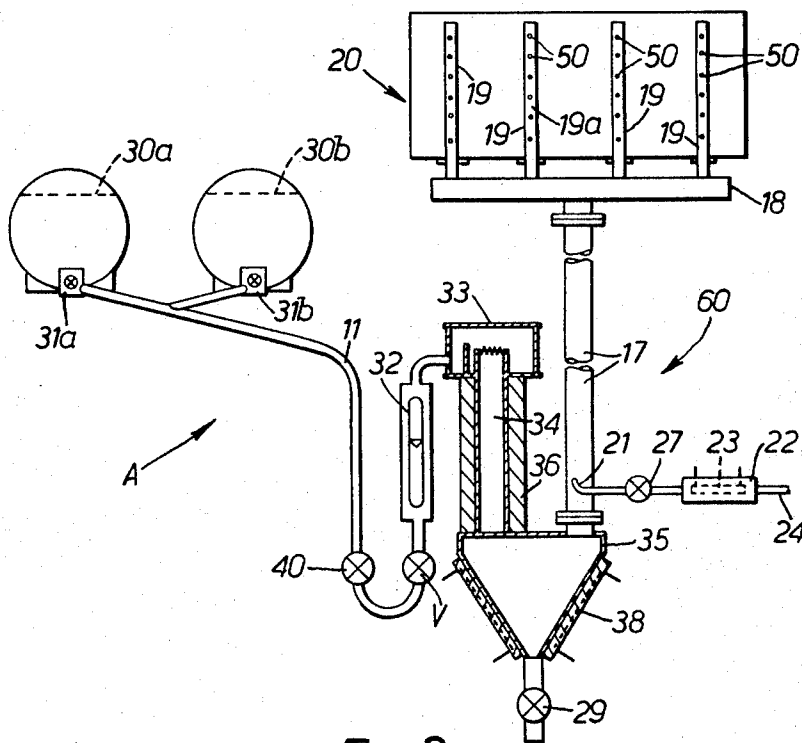


FIG. 2.

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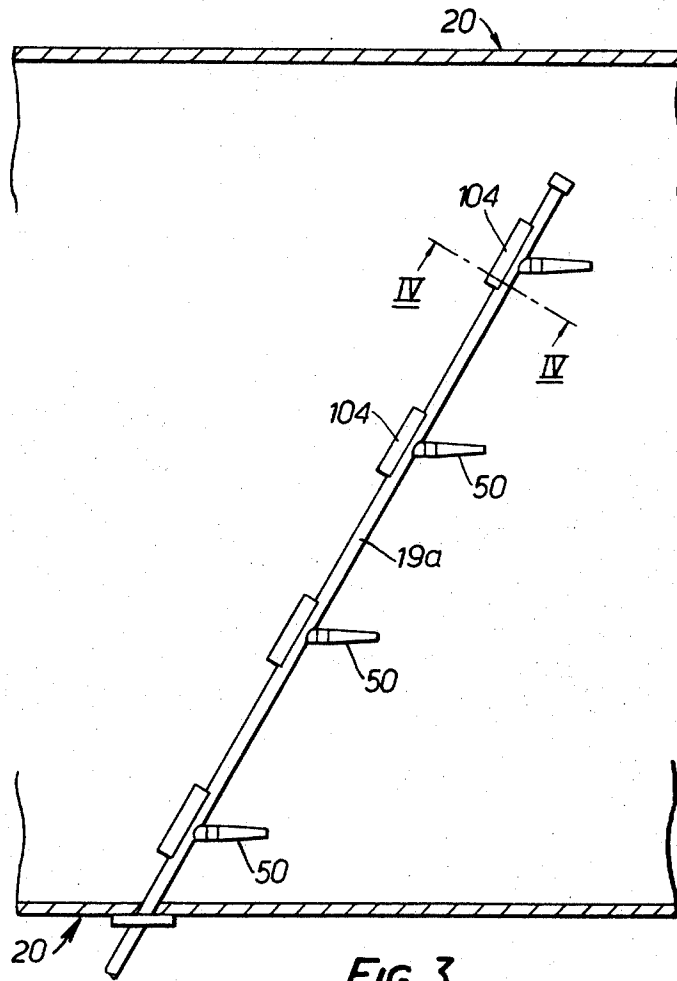


FIG. 3.

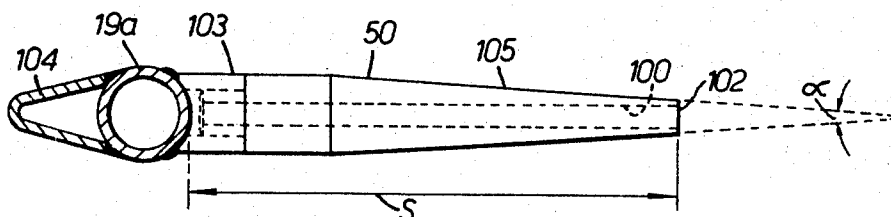


FIG. 4.

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ELECTRO-PRECIIPITATION

This invention is concerned with improvements in or relating to electro-precipitation.

In the electro-precipitation of dust or the like from gases, under certain conditions the properties of the dust or the like tend to affect adversely the efficiency of the precipitator. It has been previously proposed to correct this adverse effect by the addition of conditioning agents to the gases. Efficient injection of the conditioning agent at times presents a problem due to adverse aerodynamic effects such as eddy currents around the injection points.

It is an object of the invention to provide for improved efficient injection of conditioning agents in electro-precipitation.

The conditioning agent employed in the present invention is sulphur trioxide which may be provided for example by vaporizing stabilized liquid or by the catalytic conversion of sulphur dioxide, which has been produced by burning sulphur or pyrites.

The invention provides apparatus adapted for use in supplying conditioning agent to gas to be cleaned by electro-precipitation comprising a duct arranged to conduct gas to be cleaned to an electro-precipitator, an injection assembly in the duct, and means for supplying conditioning agent to the injection assembly for injection into the gas to be cleaned; the injection assembly comprising a manifold extending across the duct and a plurality of elongated nozzles extending from the manifold generally in the direction of gas flow; the arrangement being such that in the operation of the apparatus a generally aerofoil configuration is presented to the gas flowing along the duct past each nozzle.

The invention also provides electro-precipitation plant comprising an electro-precipitator, a duct connected to an inlet of the electro-precipitator and arranged to conduct gas to be cleaned to the electro-precipitator, a plurality of injection assemblies in the duct, and means for supplying conditioning agent comprising SO_3 gas to the injection assemblies for the injection of the conditioning agent into the gas to be cleaned; each injection assembly comprising a plurality of manifolds extending across the duct and a plurality of elongated nozzles extending from each manifold generally in the direction of gas flow; the arrangement being such that in the operation of the apparatus a generally aerofoil configuration is presented to the gas flowing along the duct past each nozzle; and each nozzle having an outlet at a distance not less than about 3 inches from its manifold and being tapered at an angle of not more than about 14° to provide a trailing portion of the aerofoil configuration.

The invention also comprehends a method of cleaning a gas comprising the steps of supplying conditioning agent to the gas to be cleaned using an injection assembly according to the invention and then treating the gas by electro-precipitation.

The invention also provides gas when cleaned by a method according to the invention.

Each nozzle is tapered in the direction of gas flow to provide a trailing portion of the aerofoil configuration and the angle of taper is not more than about 14° . The manifold may provide a leading portion of the aerofoil configuration or a baffle may be secured to the manifold upstream of the nozzle to provide a leading portion of the aerofoil configuration.

There now follows a description, to be read with reference to the accompanying drawings, of electro-precipitation plant embodying the invention. This description is also illustrative of method aspects of the invention and is given by way of example of the invention only and not by way of limitation thereof.

FIG. 1 shows a purely diagrammatic view of the plant;

FIG. 2 shows a part-sectional view of parts of the plant;

FIG. 3 shows a side view of parts of an injection assembly of the plant; and

FIG. 4 shows an enlarged section on the line IV—IV of FIG. 3.

The plant comprises an electro-precipitator P and apparatus A adapted for use in supplying vaporized sulphur trioxide conditioning agent to gas to be cleaned by the electro-precipitator P. The apparatus A comprises a horizontal duct 20 arranged to conduct the gas to be cleaned to the electro-precipitator P. The duct 20 is connected to an inlet of the electro-precipitator P. The electro-precipitator P is known type and details thereof per se form no part of the present invention.

The direction of gas flow is indicated in the drawings by the arrow X.

The SO_3 supply apparatus A (FIG. 2) comprises two reservoirs 30a, 30b for stabilized liquid SO_3 and an evaporator 60; the reservoirs 30a, 30b are each connected to a conduit 11 leading to the evaporator 60 and are each provided with an outlet valve 31a, 31b so that liquid SO_3 may be caused to flow into the conduit 11 from one reservoir while the other one is being filled. A control valve V is provided in the conduit 11 and another valve 40 is also provided therein to limit the possible rate of supply of SO_3 to the duct 20, in case the valve V is opened excessively. From the valve V the conduit 11 leads via a rotameter 32 to a weir box 33 of the evaporator 60 which box 33 is connected by a conduit 34 to the interior of a conical chamber 35; a drain cock 29 is provided in the base of the chamber 35.

The conduit 34 is surrounded by a heater 36 and the chamber 35 is surrounded by a heater 38. In the operation of the apparatus stabilized liquid SO_3 is evaporated in the conduit 34; if any liquid remains to enter the chamber 35, it is completely evaporated therein.

A conduit 17 leads from the chamber 35 to a header 18 and a plurality of injection assemblies 19 which extend into the duct 20. Each assembly 19 comprises a manifold 19a extending across the duct 20 and a plurality of elongated nozzles 50 (shown only diagrammatically in FIG. 2) extending from the manifold 19a generally in the direction of gas flow (see FIG. 3). Hot dry air is injected into the conduit 17 in the operation of the apparatus through conduits 21, 24 and a chamber 22 containing a heater 23; a valve 27 is provided in the conduit 21. In the operation of the apparatus dry SO_3 gas is mixed in the conduit 17 with dry air from the conduit 21, and the dry (SO_3 /air) mixture flows through the header 18 and the nozzles 50 of the injection assemblies 19 into the duct 20.

The linear velocity of gas along the duct 20 past the nozzles 50 is for example between 20 and 60 feet per second.

The concentration of SO_3 in the SO_3 /air mixture is not more than $12\frac{1}{2}$ percent with respect to the mixture, and the concentration of SO_3 supplied to the gas in the

duct 20 is usually not more than 50 parts per million with respect to the gas in the duct, e.g. between 3 and 25 parts per million.

Each manifold 19a is of circular cross-section (FIG. 4) and when viewed in a direction at right angles to the direction of gas flow (FIG. 3) extends forwardly and upwardly in the duct so that any solid material collecting around the outlet of an upper nozzle 50 does not fall near to the outlet of a lower aligned nozzle 50, which might result in blockage of the lower nozzle.

The nozzles 50 extend horizontally from the manifold 19a.

Each nozzle 50 has a circular external cross section and comprises (FIG. 4) a bore 100 of uniform diameter which terminates in an outlet 102 which is at a distance S not less than 3 inches from the manifold 19a. The diameter of the bore 100 is such that the linear velocity of SO₃ leaving the outlet 102 is greater than the linear velocity of gas along the duct 20 past the nozzle 50. The nozzle 50 is externally tapered in the direction of gas flow and provides a trailing portion of a generally aerofoil configuration (FIG. 4). A V-shaped baffle 104 is secured to the manifold 19a upstream of the nozzle 50 and provides a leading portion of the aerofoil configuration. The aerofoil configuration is presented to the gas flowing along the duct 20 past the nozzle in the operation of the apparatus. The baffle 104 may be omitted and it will be realized that if the baffle 104 is omitted the configuration provided by the manifold 19a and the nozzle 50 is still generally aerofoil. The nozzle 50 comprises a straight portion 103 of uniform circular cross section followed by the tapered portion 105 also of circular cross section.

Each nozzle 50 is for example of corrosion-resistant material e.g. polytetrafluoroethylene, but the manifolds 19a may be of ordinary mild steel.

The distance S for each nozzle is for example about 6 inches with an angle of taper (α) of about 14°. The diameter of the bore 100 is for example about one-quarter inch.

In a modification the manifolds 19a slope rearwardly but in that case a greater angle of slope is required.

Instead of the tube 19a being of circular cross-section it may itself be of aerofoil cross-section.

The duct 20 may be vertical instead of horizontal in which case the nozzles 50 are vertical and the manifolds 19a are horizontal.

The evaporator 60 and associated parts may be replaced by apparatus arranged to produce SO₃ gas by burning sulphur followed by catalytic conversion of the resultant SO₂ in a catalytic converter.

It is believed that the injection arrangements which have been described provide aerodynamic conditions such that efficient mixing of SO₃ with gas to be cleaned is obtained with minimization of adverse formation of masses of dust around the outlets 102 as a result of eddy currents; such masses of dust would be saturated with sulphuric acid and liable to fall from the nozzles creating blockage and corrosion problems.

I claim:

1. In electro-precipitation apparatus, the combination of:

a duct arranged to conduct gas to be cleaned to an electro-precipitator,
an injection assembly in the duct,

means for supplying conditioning agent comprising SO₃ gas to the injection assembly for injection into the gas to be cleaned;

the injection assembly comprising a manifold extending across the duct and a plurality of elongated nozzles extending from the manifold generally in the direction of gas flow, each nozzle having an outlet at a distance not less than about 3 inches from the manifold; and

means defining a generally aerofoil configuration for presentation to the gas flowing along the duct past each nozzle, each nozzle being tapered at an angle of not more than about 14° to provide a trailing portion of the aerofoil configuration.

2. The combination according to claim 1 wherein the manifold extends upwardly in the duct and the nozzles are in staggered relationship whereby any solid material collecting around an upper nozzle outlet cannot fall therefrom near to a lower nozzle outlet.

3. The combination according to claim 1, wherein the manifold provides a leading portion of the aerofoil configuration.

4. The combination according to claim 1, wherein a baffle is secured to the manifold upstream of the nozzle to provide a leading portion of the aerofoil configuration.

5. The combination according to claim 1 wherein the duct is horizontal at the injection assembly and the manifold extends forwardly and upwardly in the duct.

6. The combination according to claim 1, wherein the supply means comprises an evaporator adapted to supply conditioning agent comprising SO₃ gas by the evaporation of stabilized liquid SO₃.

7. Electro-precipitation plant comprising an electro-precipitator having an inlet, a duct connected to the inlet of the electro-precipitator and arranged to conduct gas to be cleaned to the electro-precipitator,

a plurality of injection assemblies in the duct, an evaporator for the evaporation of stabilized liquid SO₃ to supply conditioning agent comprising SO₃ gas to the injection assemblies for the injection of the conditioning agent into the gas to be cleaned;

each injection assembly comprising a plurality of manifolds extending across the duct and a plurality of manifolds extending across the duct and a plurality of elongated nozzles extending from each manifold generally in the direction of gas flow, each manifold extending upwardly in the duct and the nozzles extending from said manifold being in staggered relationship whereby any solid material collecting around an upper nozzle outlet cannot fall therefrom near to a lower nozzle outlet; and

means defining a generally aerofoil configuration for presentation to the gas flowing along the duct past each nozzle;

each nozzle having an outlet at a distance not less than about 3 inches from its manifold and being tapered at an angle of not more than about 14° to provide a trailing portion of the aerofoil configuration.

8. A method of cleaning a gas comprising the steps of

(a) supplying conditioning agent comprising SO₃ gas to the gas to be cleaned by injecting the conditioning agent into a flowing stream of the gas via an injection assembly which comprises an elongated nozzle which is

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not less than about 3 inches long and presents a generally aerofoil configuration to the gas flowing past the nozzle, the nozzle being tapered in the direction of gas flow at an angle of not more than about 14° to provide a trailing portion of the aerofoil configuration, and (b) treating the gas by electro-precipitation.

9. A method according to claim 8 wherein the conditioning agent comprises SO₃ obtained by evaporation from stabilized liquid SO₃.

10. A method of cleaning a gas comprising the steps of (a) evaporating stabilized liquid SO₃, supplying the resultant SO₃ gas to the gas to be cleaned by injecting the SO₃ into a flowing stream of the gas via an injection assembly which comprises a plurality of elongated nozzles, each of which is not less than about 3 inches long and which injection assembly presents a generally aerofoil configuration to the gas flowing past the nozzle, each nozzle being tapered in the direction of gas flow at an angle of not more than 14° to provide a trailing portion of said aerofoil configuration and the nozzles being arranged one above another in staggered relationship whereby any solid material collecting

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around an upper nozzle outlet cannot fall therefrom near to a lower nozzle outlet, and (c) treating the gas by electro-precipitation.

11. In electro-precipitation apparatus, a duct through which gas to be cleaned is conveyed to an electro-precipitator, and means in the duct for distributing vaporized sulphur trioxide into the stream of gas to be cleaned comprising a series of side by side manifolds extending upwardly across the interior of the duct, each of said manifolds lying in planes substantially parallel to the direction of gas flow and being inclined upwardly and at an acute angle in the respective planes, and a series of nozzles projecting in the same direction from each manifold to extend substantially parallel to the direction of gas flow, said manifolds all being of substantially aerofoil configuration to reduce gas turbulence, and the outlets of the nozzles on each of said manifolds being staggered in the direction of gas flow so that solid material collecting at the outlet of an upper nozzle falls clear of the outlets of lower nozzles of that manifold.

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