

A SYSTEM AND METHOD FOR SCRUBBING PARTICULATE LADEN EXHAUST AIR/GAS

Field of the Invention

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The present invention relates to a system, and method for scrubbing exhaust gases that contain particulates (sticky or non-sticky).

Background

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The following background is provided to detail one possible area of application of the present invention. It is appreciated that other possible areas of application are available.

15 Acid scrubbers are typically used in the semiconductor industry for scrubbing acidic exhaust gases containing HCl and HF vapours present in an air stream from upstream processes. These scrubbing systems typically use an alkaline solution to scrub the acidic vapours. In particular, the alkaline solution is pumped from an integral sump of the scrubber to a top of a mass transfer packing using spray nozzles located above
20 the packing to neutralize the HCl, HF, or other acidic vapours in the air stream before exhausting the treated air to the environment.

In addition, the mass transfer packing inside the scrubber also ensures scrubbing and neutralisation of the acidic vapor. A pH sensor/transmitter located on a feedback loop
25 on a discharge side of the recirculation pump measures the pH of scrubbing solution and operates a dosing pump that delivers NaOH from an NaOH tank to scrubber. A level switch placed inside the scrubber sump automatically replenishes the level inside the sump with water from the mains by controlling a first on-off valve. There is also a conductivity sensor/transmitter within the aforementioned feedback loop, that
30 measures salt formation in the scrubbing solution and when the amount of salt inside the scrubbing solution is at a pre-defined percentage (obtained from a determination

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of conductivity), it automatically discharges the scrubbing solution to wastewater treatment by operating a second on-off valve.

However, in some circumstances, SiO₂ or other particulates are also generated in the upstream processes, and the particulates are inadvertently extracted into the scrubbers. Since SiO₂ or certain types of particulates are insoluble in water, these often form a sludge that plug up the packing and spray nozzles. Additional clogging of the scrubber system recirculation pump inlet, mass transfer packing, and SiO₂ or other particulate build up on an induced draft fan impeller is also likely. This clogging leads to loss of efficiency and detrimentally results in expensive and regular downtime during production.

There are evident issues that currently exist when scrubbing acidic exhaust gases laden with SiO₂ or other particulates.

Summary

In a first aspect, there is provided a system for scrubbing particulate laden acidic exhaust gases. The system includes:

a main body, a central portion of the main body being configured to house packing;

a plurality of cleaning sprays being directed at the packing;

a base portion of the main body including an inclined plane; and

a plate and frame filter press;

the system being configured to carry out steps including:

activate the plurality of cleaning sprays;

collect slurry comprising used washing liquid at a collection region of the base portion; and

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feed the slurry comprising the used washing liquid to the plate and frame filter press.

It is advantageous that the activation of the cleaning sprays minimises adherence of
5 SiO₂ particulates to the packing.

In a second aspect, there is provided a method for scrubbing particulate laden acidic exhaust gases, the method including:

activating a plurality of cleaning sprays, the plurality of cleaning sprays being
10 directed at packing;
collecting slurry comprising used washing liquid at a collection region; and
feeding the slurry comprising the used washing liquid to a plate and frame filter press.

15 It is advantageous that the activation of the cleaning sprays minimises adherence of SiO₂ particulates to the packing.

It will be appreciated that the broad forms of the invention and their respective features can be used in conjunction, interchangeably and/or independently, and reference to
20 separate broad forms is not intended to be limiting.

Brief Description of the Drawings

A non-limiting example of the present invention will now be described with reference
25 to the accompanying drawings, in which:

FIG 1 is a schematic view of an embodiment of a system for scrubbing acidic exhaust gases or air that is laden with SiO₂ or insoluble particulates;

FIG 2 is a process flow of an embodiment of a method for scrubbing acidic exhaust
30 gases or air that is laden with SiO₂ or insoluble particulates; and

FIG 3 is an example of packing used in the system of FIG 1.

Detailed Description

Embodiments of the present invention provide users with a system and method for
5 scrubbing acidic exhaust gases or air that is laden with SiO₂ or insoluble particulates.
The system and method enables continual removal of SiO₂/insoluble particulates from
the exhaust gases in a manner which reduces manufacturing downtime, minimises
wear and tear of the scrubbing system, and lowers maintenance costs for the
scrubbing system. The system and method can be used in semiconductor
10 manufacturing, as well as other industries which generate and process acidic exhaust
gases or air laden with SiO₂ or insoluble particulates.

Referring to FIG 1, there is shown a schematic view of an embodiment of a system
100 for scrubbing acidic exhaust gases or air laden with SiO₂ or insoluble particulates.
15 Parts and components of the system 100 can be present in FIG 1 but not described in
detail as they are not essential aspects. The system 100 is configured to carry out
continual removal of SiO₂ or insoluble particulates from the exhaust gases/air passing
through the system 100. The system 100 includes a main body 110. A central portion
115 of the main body 110 is configured to house packing 120 which is typically of an
20 "open" type, and less susceptible to plugging. For example, the packing 120 can be
Tellerette™ packing as shown in FIG 3.

A lower end 125 of the central portion 115 of the main body 110 includes a plurality of
cleaning sprays 130 configured for washing the packing 120. Each of the plurality of
25 cleaning sprays 130 has a full cone nozzle, is clog resistant and has wide spray angle.
The plurality of cleaning sprays 130 is configured to enable jet washing parts of the
packing 120 located at the lower end 125 of the central portion 115 to substantially
minimise adherence of SiO₂ particulates to the packing 120. The plurality of cleaning
sprays 130 is fed with washing liquid using a scrubber's recirculation pump 135. The
30 washing liquid is stored in the scrubber's integral sump 128. The washing liquid can
contain NaOH that is dosed into the scrubber's integral sump 128 or into the scrubber

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recirculation pump 135 from tank 133 using chemical dosing pumps/transfer pumps 131. The actual chemical used will depend on a nature of the particulates. The washing liquid is fed in accordance with a pre-defined frequency and duration timer administered by a controller for the system 100. For example, activation is carried out
5 once every four hours for five minutes at each time. The scrubber control system includes a timer to operate an on-off valve to activate the plurality of cleaning sprays 130.

In some embodiments, the plurality of cleaning sprays 130 can also be located at a
10 top end 128 of the central portion 115 to enable continuous scrubbing of the acid gases as well as residual SiO₂ particulates by spraying the washing liquid at the top end 128 of the central portion 115.

A base portion 140 of the main body 110 is configured to collect the SiO₂ or insoluble
15 particulates that are prevented from adhering to the packing 120. These SiO₂ particulates form a slurry consequent of their removal from the packing 120. The base portion 140 of the main body 110 includes an inclined plane 145, whereby a surface of the inclined plane 145 is coated or treated to minimise a friction coefficient of the surface. For example, the surface can be coated with ceramic or other types of
20 coating/lining such as, for example, various forms of epoxy coatings, polypropylene, Teflon™, and the like, depending on a chemistry of the slurry. The inclined plane 145 can be part of a conical structure, whereby a collection region 150 is at an apex of the conical structure. The low friction coefficient of the surface of the inclined plane 145 and gravity enables the collection region 150 to accumulate the slurry comprising used
25 washing liquid (collectively called cleaning by-products).

The system 100 also includes a screw pump 155 which is configured to drain the cleaning by-products at the collection region 150, and the screw pump 155 consequently feeds the cleaning by-products to a plate and frame filter press 160. The
30 filter press 160 is configured to separate SiO₂ and/or insoluble particulates from the bulk of the cleaning by-products. It should be noted that the cleaning by-products also

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- contain water with dissolved salts such as, for example, NaCl, NaF, resultant from neutralization of the acid gases. The cleaning by-products are circulated through closely packed plates in the filter press 160. The filter press 160 is configured to physically separate the particulates / SiO₂ in the cleaning by-products to obtain a substantially clean filtered solution (filtrate). The filtrate is re-cycled back to the scrubber sump as washing liquid. The SiO₂ particulates trapped by the filter press 160 are removed as waste during periodic cleaning cycles of the filter press 160 which can be dependent on, for example, pressure drop, timer, and so forth.
- 10 In nearly all embodiments, the system 100 also includes an exhaust fan 123, located downstream of the system 100 along the air/gas stream, that includes at least one impeller cleaning spray. The at least one impeller cleaning spray has a full cone spray nozzle, is clog resistant and has high spray angle. The at least one impeller cleaning spray is fed with industrial grade fresh water. Whenever the exhaust fan 123 is not in
- 15 operation, the at least one impeller cleaning spray is activated, either manually or automatically, to clean the impeller in a manner which does not require dis-assembly of the exhaust fan 123. The spraying of the industrial grade fresh water onto the impeller ensures cleaning of a layer of SiO₂ and other particulates on the impeller of the exhaust fan 123. The exhaust fan 123 can also be known as an induced draft fan.
- 20 The post-cleaning water is drained to wastewater treatment.

The system 100 will have less downtime compared to existing acidic gas scrubbing setups given the continual removal of SiO₂ and/or insoluble particulates. In addition, maintenance of the system 100 is also easier, and correspondingly cheaper,

25 compared to existing setups due to the continual removal of SiO₂ and/or insoluble particulates. Moreover, the system 100 can operate using similar amounts of water compared to existing setups.

Referring to FIG 2, there is shown a process flow for a method 200 for scrubbing acidic exhaust gases or air laden with SiO₂ and/or insoluble particulates. While the method

30 200 can be carried out using the system 100 as described earlier, the method 200 can

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also be carried out with any suitable setup. The method 200 can also be carried out manually or in an automated process. In addition, the respective steps of the method 200 need not be carried out in the sequence as described in order to achieve desired outcomes.

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For the sake of clarity and visualisation, the method 200 will be described in relation to components described for system 100, but it should be noted that the method 200 can be carried out using other suitable setups.

- 10 At step 210, a plurality of cleaning sprays 130 is activated at a pre-defined frequency/duration. For example, activation is carried out every four hours for five minutes. This enables the plurality of cleaning sprays 130 to carry out jet washing of parts of the packing 120 located at the lower end 125 of the central portion 115 to substantially minimise adherence of SiO₂ and/or insoluble particulates to the packing
- 15 120. The plurality of cleaning sprays 130 is fed with washing liquid using a scrubber's recirculation pump 135. The washing liquid is stored in the scrubber's integral sump. The washing liquid can contain NaOH that is dosed into the scrubber's integral sump or into the scrubber recirculation pump 135 from tank 133 using chemical dosing pumps/transfer pumps. The washing liquid is fed in accordance with a pre-defined
- 20 frequency and duration timer. The plurality of cleaning sprays 130 is also be located at a top end 128 of the central portion 115 to enable continuous scrubbing of the acid gases as well as residual SiO₂ particulates by spraying the washing liquid at the top end 128 of the central portion 115.
- 25 At step 220, the jet washing of the packing 120 causes a slurry comprising SiO₂ and/or insoluble particulates that are prevented from adhering to the packing 120, the slurry being collected at the base portion 140 of the main body 110. The base portion 140 of the main body 110 includes an inclined plane 145, whereby a surface of the inclined plane 145 is coated or treated to minimise a friction coefficient of the surface. For
- 30 example, the surface can be coated with ceramic or other types of coating/lining such as, for example, various forms of epoxy coatings, polypropylene, Teflon™, and the

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like, depending on a chemistry of the slurry. The inclined plane 145 can be part of a conical structure, whereby a collection region 150 is at an apex of the conical structure. The low friction coefficient of the surface of the inclined plane 145 and gravity enables the collection region 150 to accumulate the slurry comprising used washing liquid
5 (collectively called cleaning by-products).

At step 230, the cleaning by-products at the base portion 140 are fed to the plate and frame filter press 160 using the screw pump 155.

10 At step 240, the filter press 160 is configured to separate SiO₂ particulates from the cleaning by-products. It should be noted that the cleaning by-products also contain water with dissolved salts such as, for example, NaCl, NaF, resultant from neutralization of the acid gases. The cleaning by-products is circulated through closely packed plates in the filter press 160. The actual chemical used will depend on a nature
15 of the particulates.

At step 250, the filter press 160 is configured to remove the dissolved salts and the filtered solution (filtrate) is re-cycled as washing liquid for the packing 120 at the scrubber sump. The SiO₂ or insoluble particulates trapped by the filter press 160 are
20 removed as waste during periodic cleaning cycles of the filter press 160 which can be dependent on, for example, pressure drop, timer, and so forth.

At step 260, the at least one impeller cleaning spray is activated to clean the impeller in a manner which does not require dis-assembly of an exhaust fan 123, located
25 downstream of the system 100 along the air/gas stream. The at least one impeller cleaning spray has a full cone spray nozzle, is clog resistant and has high spray angle. The at least one impeller cleaning spray is fed with industrial grade fresh water. The automatic or manual spraying of the industrial grade fresh water onto the impeller ensures cleaning of a layer of SiO₂ or insoluble particulates on the impeller of the
30 exhaust fan 123. The post-cleaning water is drained to wastewater treatment.

The carrying out of the method 200 will enable less downtime compared to existing acidic gas scrubbing setups given the continual removal of SiO₂ or insoluble particulates. In addition, the method 200 also ensures easier and more economical maintenance of the particulate laden acidic gas scrubbing setups, compared to
5 existing setups due to the continual removal of SiO₂ particulates. Moreover, the method 200 can be carried out using similar amounts of water compared to existing setups.

Throughout this specification and claims which follow, unless the context requires
10 otherwise, the word “comprise”, and variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated integer or group of integers or steps but not the exclusion of any other integer or group of integers.

Persons skilled in the art will appreciate that numerous variations and modifications
15 will become apparent. All such variations and modifications which become apparent to persons skilled in the art, should be considered to fall within the spirit and scope that the invention broadly appearing before described.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A system for scrubbing particulate laden acidic exhaust gases, the system including:
 - 5 a main body, a central portion of the main body being configured to house packing;
a plurality of cleaning sprays being directed at the packing;
a base portion of the main body including an inclined plane; and
a plate and frame filter press;
 - 10 the system being configured to carry out steps including:
activate the plurality of cleaning sprays;
collect slurry comprising used washing liquid at a collection region of the base portion; and
feed the slurry comprising the used washing liquid to the plate and frame filter
15 press;
 - wherein the activation of the cleaning sprays minimises adherence of SiO₂ particulates to the packing.
2. The system of claim 1, further including an exhaust fan, the exhaust fan
20 including at least one impeller cleaning spray.
3. The system of either claim 2 or 3, wherein filtrate from the plate and frame filter press is re-usable by the plurality of cleaning sprays.
- 25 4. The system of any of claims 1 to 3, wherein the used washing liquid contains at least one chemical dependent on a nature of the particulates.
5. The system of any of claims 1 to 4, wherein the activation of the plurality of cleaning sprays is carried out at a pre-defined frequency and duration.
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6. The system of any of claims 1 to 5, wherein the inclined plane is processed with either a coating or lining to minimise a coefficient of friction of a surface of the inclined plane.

5 7. The system of any of claims 1 to 6, wherein the inclined plane is part of a conical structure, the collection region being at an apex of the conical structure.

8. A method for scrubbing particulate laden acidic exhaust gases, the method including:

10 activating a plurality of cleaning sprays, the plurality of cleaning sprays being directed at packing;

collecting slurry comprising used washing liquid at a collection region; and

feeding the slurry comprising the used washing liquid to a plate and frame filter press,

15 wherein the activation of the cleaning sprays minimises adherence of SiO_2 particulates to the packing.

9. The method of claim 8, further including activating at least one impeller cleaning spray for an exhaust fan.

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10. The method of either claim 8 or 9, wherein filtrate from the plate and frame filter press is re-usable by the plurality of cleaning sprays.

11. The method of any of claims 8 to 10, wherein the used washing liquid contains
25 at least one chemical dependent on a nature of the particulates.

12. The method of any of claims 8 to 11, wherein the activation of the plurality of cleaning sprays is carried out at a pre-defined frequency and duration.

30 13. The method of any of claims 8 to 12, wherein the feeding of the slurry comprising the washing liquid is carried out using a screw pump.