

(12) Indian Patent Application

(21) Application Number: 202241013443

(22) Filing Date: 11/03/2022 (43) Publication Date: 15/09/2023

(71) Applicant(s): L&T TECHNOLOGY SERVICES LIMITED

(72) Inventor(s): Gopalbhai, Patel Jigneshkumar
Prajapati, Neel

(51) International Classifications: B01D 53/50 F23J 15/00 B01D 53/56 B01D 53/79 C10K 1/00

(54) Title: A SYSTEM AND METHOD FOR REFINING FLUE GASES

(57) Abstract: A system (100) for refining flue gases is disclosed that may include an inner tower (104) defining a first treatment zone (120) configured to treat a stream of flue gas with anhydrous Ammonia, to remove Nitrogen-based components from the flue gas to generate a stream of a first treated gas. The system (100) may further include an outer tower (102), such that the inner tower (104) is positioned inside the outer tower (102). The outer tower (102) may define a second treatment zone (122) configured to treat the stream of the first treated gas with aqueous Ammonia to remove Sulphurbased components and generate a stream of a second treated gas. The outer tower (102) may further define a third treatment zone (124) configured to treat the stream of the second treated gas with aqueous Ammonia to remove Carbon-based components.

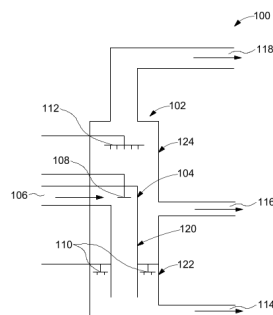


FIG. 1

FORM 2

THE PATENTS ACT 1970
(39 OF 1970)
&
The Patent Rules, 2003
Complete Specification
(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

A SYSTEM AND METHOD FOR REFINING FLUE GASES

2. APPLICANT(S)

(a) NAME : **L&T TECHNOLOGY SERVICES LIMITED**
(b) NATIONALITY : **INDIAN**
(c) ADDRESS : **DLF IT SEZ Park, 2nd Floor – Block 3,
1/124, Mount Poonamallee Road, Ramapuram,
Chennai – 600 089, INDIA.**

3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is to be performed.

DESCRIPTION

Technical Field

[001] This disclosure relates generally to flue gas refinement, and more particularly to a system and method for efficiently removing contaminants from flue gases.

BACKGROUND

[002] Gases emitted by combustion processes, also referred to as flue gases, may contain Carbon-based (CO_x) components, Sulphur-based (SO_x), and other potentially hazardous components. It is therefore important to treat the flue gas, in particular, to remove the hazardous components from the flue gases before being released into the atmosphere. However, removal of these hazardous components from the flue gases poses multiple challenges.

[003] Some technologies are available in the existing state of the art that are directed at removal of NO_x and SO_x components. However, these technologies generally ignore removal of CO_x components, or are incapable of removing all of the NO_x, SO_x, and CO_x components through a single process and in an effective and efficient manner. For example, some existing techniques are available that are about removing of SO_x, NO_x, and CO₂ via separate units.

[004] It may be therefore desirable to treat the flue gases through an apparatus that has simple construction, requires less space, is less energy-intensive, and is capable of efficiently removing the hazardous components.

SUMMARY OF THE INVENTION

[005] In an embodiment, a system for refining flue gasses is disclosed. The system may include an inner tower defining the first treatment zone. The first treatment zone may be configured to receive a stream of flue gas and treat the received stream of flue gas with anhydrous Ammonia to remove Nitrogen-based components from the flue gas to generate a stream of first treated gas. The system may further include an outer tower defining the second treatment zone between an inner periphery of the outer tower and an outer periphery of the inner tower. The second treatment zone may be configured to receive the stream of first treated gas from the first treatment zone and treat the received stream of the first treated gas with aqueous Ammonia to remove Sulphur-based components from the first treated gas to generate a stream of second treated gas. The system may further include a third treatment zone positioned between the inner periphery of the outer tower and the outer periphery of

the inner tower. The third treatment zone may be configured to receive the stream of the second treated gas from the second treatment zone and treat the received stream of the second treated gas with aqueous Ammonia to remove Carbon-based components from the second treated gas to generate a stream of a third treated gas.

[006] In another embodiment, the system may include a first set of dispensers positioned in the first treatment zone that may be configured to dispense anhydrous Ammonia to treat the stream of flue gas received in the first treatment zone. The system may further include a second set of dispensers positioned in the second treatment zone that may be configured to dispense a first supply of low-temperature aqueous Ammonia to treat the stream of the first treated gas received in the second treatment zone. The system may further include a third set of dispensers positioned in the third treatment zone that may be configured to dispense a second supply of low-temperature aqueous Ammonia to treat the stream of the second treated gas received in the third treatment zone.

[007] In another embodiment, a method for refining flue gases is disclosed. The method may include receiving a stream of flue gas and treating the received stream of flue gas in a first treatment zone with anhydrous Ammonia to remove Nitrogen-based components from the flue gas to generate a stream of first treated gas. The method may further include receiving the stream of the first treated gas in a second treatment zone from the first treatment zone and treating the received stream of the first treated gas in the second treatment zone with chilled aqueous Ammonia to remove Sulphur-based components from the first treated gas to generate a stream of second treated gas. The method may further include receiving the stream of the second treated gas in a third treatment zone from the second treatment zone and treating the received stream of second treated gas in the third treatment zone with chilled aqueous Ammonia to remove carbon-based components from the second treated gas to generate a stream of third treated gas.

BRIEF DESCRIPTION OF THE DRAWINGS

[008] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, serve to explain the disclosed principles.

[009] **FIG. 1** illustrates a schematic sectional view of a system for refining flue gases, in accordance with an embodiment of the present disclosure;

[010] **FIG. 2** illustrates a schematic sectional view of a system for refining flue gases, in accordance with another embodiment of the present disclosure; and

[011] FIG. 3 illustrates a flowchart of a method of refining flue gases, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

[012] Exemplary embodiments are described with reference to the accompanying drawings. Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are described herein, modifications, adaptations, and other implementations are possible without departing from the spirit and scope of the disclosed embodiments. It is intended that the following detailed description be considered as exemplary only, with the true scope and spirit being indicated by the following claims. Additional illustrative embodiments are listed.

[013] Referring now to FIG. 1, a schematic sectional view of a system 100 for refining flue gases is illustrated, in accordance with an embodiment of the disclosure. The system 100 may include an outer tower 102 and an inner tower 104. Further, the system 100 may include an inlet 106 for receiving a supply of flue gases inside the system 100, for example, from an exhaust of an industrial setup, a road vehicle or a marine vehicle. In some embodiments, the system 100 may further include a first set of dispensers 108, a second set of dispensers 110, and a third set of dispensers 112. Further, in some embodiments, the system 100 may include an outlet 118 for releasing the treated flue (i.e. a third treated flue gas, as will be explained in subsequent sections of this disclosure).

[014] In some embodiments, the outer tower 102 may be a hollow cylindrical structure that may be erected vertically on the ground, or on another structure. The inner tower 104 may be a hollow cylindrical structure that may be positioned inside the outer tower 102. In some embodiments, the inner tower 104 may be positioned concentrically with the outer tower 102.

[015] The inner tower 104 may define a first treatment zone 120 in a region towards a top end of the inner tower 104. The outer tower 102 may define a second treatment zone 122 in a region between an inner periphery of the outer tower 102 and an outer periphery of the inner tower 104 and towards a lower end of the outer tower 102. The outer tower 102 may further define a third treatment zone 124 in a region near a top end of the outer tower 102, and above the inner tower 104.

[016] The first treatment zone 120 may be fluidically coupled to the inlet 106 to receive the supply of the flue gases (i.e. from the exhaust of an industrial setup, a road vehicle, or a marine vehicle). The first treatment zone 120 may be configured to treat the stream of flue gas received in the first treatment zone 120 with anhydrous Ammonia. In some embodiments, the anhydrous

Ammonia may be dispensed by the first set of dispensers 108 positioned in the region defining the first treatment zone 120. The first set of dispensers 108 may be configured to dispense a supply of anhydrous Ammonia to treat the stream of flue gas received in the first treatment zone 120. By way of the treatment, Nitrogen-based components may be removed from the flue gas, and as a result, a stream of a first treated gas may be generated. As such, the first treated gas may be substantially depleted of the Nitrogen-based components.

[017] The second treatment zone 122 may be configured to receive the stream of the first treated gas from the first treatment zone 120. Further, upon receiving the stream of the first treated gas, the second treatment zone 122 may treat the stream of the first treated gas with aqueous Ammonia to remove Sulphur-based components from the first treated gas. In some embodiments, the aqueous Ammonia may be dispensed by the second set of dispensers 110 positioned in the region defining the second treatment zone 122. As a result, a stream of a second treated gas may be generated in the second treatment zone 122. The second treated gas may be substantially depleted of the Sulphur-based components.

[018] The third treatment zone 124 may receive the stream of the second treated gas from the second treatment zone 122. Upon receiving the stream of the second treated gas, the third treatment zone 124 may treat the stream of the second treated gas with aqueous Ammonia to remove Carbon-based components from the second treated gas. In some embodiments, the aqueous Ammonia may be dispensed by the third set of dispensers 112 positioned in the region defining the third treatment zone 124. As a result, a stream of a third treated gas may be generated in the third treatment zone 124. The third treated gas may be substantially depleted of the Carbon-based components.

[019] The third treated gas generated in the third treatment zone 124 may be released into the atmosphere via the outlet 118. In some embodiments, the outlet 118 may be provided at the top end of the outer tower 102. The system 100 may further include a first drain outlet 114 and a second drain outlet 116 to remove and collect the by-products generated during the treatment of the flue gases. For example, the first drain outlet 114 may be provided in the outer tower 102 and positioned near a bottom end of the outer tower 102. The first drain outlet 114 may drain by-products generated during treatment of the stream of the first treated gas received in the second treatment zone 122 with aqueous Ammonia. These by-products may include Ammonium Sulphate and Ammonium Bi-Sulphate. The second drain outlet 116 may be provided in the outer tower 102 and may be positioned vertically above the region defining the second treatment zone 122. The second drain outlet 116 may drain Ammonium Carbonate-type crystals, Ammonium Bicarbonate-type crystals, and Ammonium

Carbamate-type crystals, generated upon treatment of the stream of the second treated gas with aqueous Ammonia and uncollected in the one or more perforated trays. These crystals may be generated upon treatment of the stream of the second treated gas received with aqueous Ammonia.

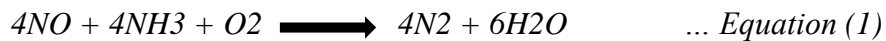
[020] Referring now to **FIG. 2**, another schematic sectional view of a system 200 (corresponding to the system 100) for refining flue gases is illustrated, in accordance with an embodiment of the disclosure. The system 200 may include an outer tower 202 and an inner tower 204. Further, the system 200 may include an inlet 206 for receiving a supply of flue gases inside the system 200, for example, from an exhaust of an industrial setup, a road or a marine vehicle. In some embodiments, the system 200 may further include a first set of dispensers 208, a second set of dispensers 210, and a third set of dispensers 212. Further, in some embodiments, the system 200 may include an outlet 218 for releasing the treated flue (i.e. a third treated flue gas, as will be explained in subsequent sections of this disclosure).

[021] In some embodiments, as discussed in conjunction with FIG. 1, the outer tower 202 may be a hollow cylindrical structure that may be erected vertically on the ground, or on another structure, and the inner tower 204 may be a hollow cylindrical structure that may be positioned inside the outer tower 202. The inner tower 204 may be positioned concentrically with the outer tower 202. The inner tower 204 may define a first treatment zone 220 in a region towards a top end of the inner tower 204. The outer tower 202 may define a second treatment zone 222 in a region between the inner periphery of the outer tower 202 and the outer periphery of the inner tower 204 and towards a lower end of the outer tower 202. The outer tower 202 may further define a third treatment zone 224 in a region near a top end of the outer tower 202, and above the inner tower 204. In some embodiments, the region defining the second treatment zone 222 may be located vertically below the region defining the first treatment zone 220. Further, the region defining the third treatment zone 224 may be located vertically above the region defining the first treatment zone 220 and the region defining the second treatment zone 222.

[022] Once the stream of the flue gas is received inside the inner tower 204, the stream of the flue gas may move vertically down the inner tower 204, to be directed towards the first treatment zone 220. As such, the first treatment zone 220 may be fluidically coupled to the inlet 206 to receive the supply of flue gas. Upon receiving the stream of flue gas, the first treatment zone 220 may treat the stream of the flue gas with anhydrous Ammonia. To this end, in some embodiments, the anhydrous Ammonia may be dispensed by the first set of dispensers 208 positioned in the region defining the first treatment zone 220. It should be noted that the first treatment zone 220 may be

maintained at a temperature within a range of 300-410 degrees Celsius. It should be further noted that the flue gases may be received at high temperature and high pressure from the source of their emission. As such, the high temperature of the flue gases may be made use of in maintaining the temperature of the first treatment zone 220 between the range of 300-410 degrees.

[023] In some embodiments, a set of catalytic grids 226 may be positioned in the inner tower in the region defining the first treatment zone 220. The set of catalytic grids 226 may include a catalyst for expediting treatment of the stream of the flue gas received in the first treatment zone with anhydrous Ammonia. By way of an example, the set of catalytic grids 226 may include a porous mesh dispersed with catalyst particles selected from metals like Platinum, Vanadium, Titanium, Tungsten, metal oxides, and so on. A reaction of the flue gases with the anhydrous Ammonia may take place in the presence of the catalyst particles in the catalytic grids 226 that may result in the removal of Nitrogen-based components from the flue gas. As a result, a stream of the first treated gas may be generated. The reaction of the flue gases with anhydrous Ammonia (in the presence of the catalyst) is represented in Equation (1), as below:



[024] In some embodiments, the supply of anhydrous Ammonia may include a mixture of anhydrous Ammonia and air. By way of the above treatment, Nitrogen-based components may be removed from the flue gas, and as a result, a stream of a first treated gas may be generated. The first treated gas therefore may be substantially depleted of the Nitrogen-based components.

[025] The second treatment zone 222 may receive the stream of the first treated gas from the first treatment zone 220. As mentioned above, the second treatment zone 222 may be located vertically below the first treatment zone 220, and the third treatment zone 224 may be located vertically above the first treatment zone 220 and the second treatment zone 222. As such, the stream of the first treated gas may flow vertically downwards upon generation, owing to the high pressure of the flue gas from the emission source. The stream of the first treated gas exit the inner tower 204 through a bottom end of the inner tower 204 (as shown by arrows in FIG. 2). Further, upon exiting the inner tower 204, the stream of the first treated gas may flow vertically upwards towards the region defining the second treatment zone 222 and the third treatment zone 224.

[026] Therefore, upon exiting the inner tower 204, the stream of the first treated gas may be received by the second treatment zone 222. Upon receiving the stream of the first treated gas, the second treatment zone 222 may treat the stream of the first treated gas with aqueous Ammonia to

remove Sulphur-based components from the first treated gas. To this end, a first supply of low-temperature aqueous Ammonia may be dispensed by the second set of dispensers 210 positioned in the region defining the second treatment zone 222, to treat the stream of the first treated gas received in the second treatment zone 222.

[027] It should be noted that the second treatment zone may be maintained at a temperature within a range of 30-80 degrees Celsius. Since the first treatment zone is maintained at a high temperature (within the range of 300-410 degrees Celsius) and the stream of first treated gas is at high temperature, therefore, in order to maintain the second treatment zone at the above temperature (i.e. within the range of 30-80 degrees Celsius), chilled (i.e. low-temperature) aqueous Ammonia is dispensed in the second treatment zone 222. The first supply of low-temperature aqueous Ammonia therefore causes to cool the high temperature-first treated gases to therefore allow the reaction of the first treated gases with the aqueous Ammonia to take place at a temperature within the range of 30-80 degrees Celsius.

[028] A reaction of the first treated gases with the low temperature aqueous Ammonia may take place that may result in the removal of Sulphur-based components from the first treated gas flue gas. The reaction of the first treated gas with aqueous Ammonia is represented in Equation (2), as below:



[029] As a result, a stream of a second treated gas may be generated in the second treatment zone 222. The second treated gas may be substantially depleted of the Sulphur-based components.

[030] During the treatment of the first treated gas with aqueous Ammonia in the second treatment zone 222, some by-products may be generated. The by-products may include Ammonium Sulphate and Ammonium Bi-Sulphate. In order to the remove these by-products, the system 200 may further include a first drain outlet 214. The first drain outlet 214 may be provided in the outer tower 202 and positioned near a bottom end of the outer tower 202. The second drain outlet 216 may drain by-products generated during treatment of the stream of the first treated gas received in the second treatment zone 222 with aqueous Ammonia. The stream of the second treated gas generated in the second treatment zone 222 may flow further vertically upwards in order to enter the region defining the third treatment zone 224. In some embodiments, one or more filter meshes 228 may be provided in a region vertically above the second treatment zone 222. The stream of second treated gas while flowing vertically upwards may pass through these one or more filter meshes 228. The one or more

filter meshes 228 may cause the stream of the second treated gas to separate and shed the by-products, which can then be removed from the system 200 via the second drain outlet 216.

[031] As mentioned above, the stream of the second treated gas generated in the second treatment zone 222 may flow further vertically upwards in order to enter the region defining the third treatment zone 224. In an embodiment, the system 200 may further include a flow-bend 232 defined vertically above the region defining the second treatment zone 222, along the flow path of the second treated gas. As shown in FIG. 2, the flow-bend 232 may be configured to cause flow of stream of the second treated gas to undergo an upwards to downwards turn. It should be noted that flue gases may be received in the system 200 at a high pressure, owing to the flue gases being emitted at high pressure from the emission source. The flow bend 232 may cause to reduce the pressure of the stream of the first treated gas which may also be at high pressure owing to the high pressure flue gases from the emission source. Further, the flow bend 232 may cause the stream of the first treated gas to shed any by-products that it may still be carrying. These by-products, as will be explained later, may then be removed via the second drain outlet 216.

[032] The third treatment zone 224 may receive the stream of the second treated gas from the second treatment zone 222. As mentioned above, the third treatment zone 224 may be located vertically above the first treatment zone 220 and the second treatment zone 222. Therefore, the stream of the second treated gas (generated in the second treatment zone 222) may flow vertically upwards to enter the third treatment zone 224.

[033] Upon receiving the stream of the second treated gas, the third treatment zone 224 may treat the stream of the second treated gas with aqueous Ammonia to remove Carbon-based components from the second treated gas. To this end, the third set of dispensers 212 positioned in the region defining the third treatment zone 224 may dispense the aqueous Ammonia in the third treatment zone 224. For example, the second supply of low-temperature aqueous Ammonia comprises aqueous Ammonia in a range of 25-30 percent weight/volume solution.

[034] It should be noted that the third treatment zone 224 may be maintained at a temperature within a range of 0-10 degrees Celsius. Since the second treatment zone is maintained at a higher temperature (within the range of 30-80 degrees Celsius) and therefore the stream of second treated gas may also be at higher temperature, therefore, in order to maintain the third treatment zone at the above temperature (i.e. within the range of 0-10 degrees Celsius), chilled (i.e. low-temperature) aqueous Ammonia is dispensed in the third treatment zone 224. The second supply of low-temperature aqueous Ammonia therefore causes to cool the second treated gases to therefore allow

the reaction of the second treated gases with the aqueous Ammonia to take place at a temperature within the range of 0-10 degrees Celsius.

[035] The outer tower 102 may further be configured to receive the stream of the second treated gas from the second treatment zone 122 and treat the stream of the second treated gas received in the third treatment zone 124 with aqueous Ammonia to remove Carbon-based components from the second treated gas to generate a stream of a third treated gas.

[036] A reaction of the second treated gases with the low temperature aqueous Ammonia may take place that may result in the removal of Carbon-based components from the second treated gas flue gas to generate a stream of a third treated gas. The reaction of the second treated gas with aqueous Ammonia is represented in Equation (3), as below:



[037] As a result, a stream of a third treated gas may be generated in the third treatment zone 224. The third treated gas may be substantially depleted of the Carbon-based components. The third treated gas (i.e. the treated flue gas) generated in the third treatment zone 224 may be released into the atmosphere via the outlet 218. In some embodiments, the outlet 218 may be provided at the top end of the outer tower 202.

[038] During the treatment of the second treated gas in the third treatment zone 224, by-products may be generated. The by-products may include crystals, for example, Ammonium Carbonate-type crystals, Ammonium Bicarbonate-type crystals, or Ammonium Carbamate-type crystals. In order to collect and remove these by-products, the system 200 may further include one or more perforated trays 230 positioned inside the outer tower 102 in a region defining the third treatment zone 124. As shown in FIG. 2, a number of perforated trays 230 may be provided in the region defining the third treatment zone 224, such that the perforated trays 230 may be removable. The perforated trays 230 may be removed to remove the by-products periodically or once the perforated trays 230 are not able to collect the by-products anymore. For example, the inner periphery of the outer tower 102 may include one or more slots formed onto it which allow the perforated trays 230 to be slidably receiving into them.

[039] It should be noted that it is possible that the entire volume of the by-products generated in the third treatment zone 224 may not be collected by the perforated trays 230. Some by-product crystals may fall outside the span of the perforated trays 230 or through the perforated trays 230 (e.g. due to small size of the crystals). In order to the remove these by-product crystals, the system 200

may further include a second drain outlet 216. The second drain outlet 216 may be provided in the outer tower 202 and may be positioned vertically above the region defining the second treatment zone 222. The second drain outlet 216 therefore may drain crystals of Ammonium Carbonate-type crystals, Ammonium Bicarbonate-type crystals, and Ammonium Carbamate-type crystals, generated upon treatment of the stream of the second treated gas with aqueous Ammonia and uncollected in the one or more perforated trays. For example, the by-product crystals not collected in the perforated trays 230 may subsequently be collected on a substantially horizontal surface 234 defined above the region defining the second treatment zone 222. These by-product crystals may be led out of the system 200 through the second drain outlet 216.

[040] Referring now to **FIG. 3**, a flowchart for a method 300 of refining flue gases is illustrated, in accordance with an embodiment of the present disclosure. the method 300 may be performed via the system 100 or the system 200, as explained above.

[041] At step 302, the stream of flue gas may be received in the first treatment zone 120 defined in an inner tower 104. At step 304, the stream of the flue gas received in the first treatment zone 120 may be treated with anhydrous Ammonia to remove Nitrogen-based components from the flue gas, and to generate the stream of the first treated gas. In order to treat the stream of the flue gas received in the first treatment zone 120 with anhydrous Ammonia, a supply of anhydrous Ammonia may be dispensed by the first set of dispensers 108 which may be positioned in a region defining the first treatment zone 120. The supply of anhydrous Ammonia may include a mixture of anhydrous Ammonia and air. The first treatment zone 120 may be maintained at a temperature within a range of 300-410 degrees Celsius.

[042] At step 306, the stream of the first treated gas may be received from the first treatment zone 120 in the second treatment zone 122 defined in a region between inner periphery of the outer tower 102 and outer periphery of the inner tower 104. The inner tower 104 may be positioned inside the outer tower 102. At step 308, the stream of the first treated gas received in the second treatment zone 122 may be treated with aqueous Ammonia to remove Sulphur-based components from the first treated gas to generate the stream of the second treated gas. In order to treat the stream of the first treated gas received in the second treatment zone 122 with aqueous Ammonia, a first supply of low-temperature aqueous Ammonia may be dispensed by the second set of dispensers 110 which may be positioned in the second treatment zone 122. The first supply of low-temperature aqueous Ammonia may cause to maintain the second treatment zone 122 at a temperature within a range of 30-80 degrees Celsius.

[043] In some embodiments, the method 300 may further include draining by-products generated during treatment of the stream of the first treated gas received in the second treatment zone 122 with aqueous Ammonia. The first drain outlet 214 may be positioned in the outer tower 102 near a bottom end of the outer tower 102. The by-products may include Ammonium Sulphate and Ammonium Bi-Sulphate.

[044] At step 310, the stream of the second treated gas may be received from the second treatment zone 122 in the third treatment zone 124 defined in the outer tower 102. At step 312, the stream of the second treated gas received in the third treatment zone 124 may be treated with aqueous Ammonia to remove Carbon-based components from the second treated gas to generate a stream of a third treated gas. In order to treat the stream of the second treated gas with aqueous Ammonia, a second supply of low-temperature aqueous Ammonia may be dispensed by the third set of dispensers 112 positioned in a region defining the third treatment zone 124. The second supply of low-temperature aqueous Ammonia is to maintain the third treatment zone 124 at a temperature within a range of 0-10 degrees Celsius. In some embodiments, the second supply of low-temperature aqueous Ammonia may include aqueous Ammonia in a range of 25-30 percent weight/volume solution.

[045] In some embodiments, the method 300 may further include collecting by-product crystals (of Ammonium Carbonate-type crystals, Ammonium Bicarbonate-type crystals, and Ammonium Carbamate-type crystals) generated upon treatment of the stream of the second treated gas received with aqueous Ammonia, using one or more perforated trays 230 which may be positioned inside the outer tower 102 in a region defining the third treatment zone 124. The method 200 may further include draining crystals generated upon treatment of the stream of the second treated gas with aqueous Ammonia and uncollected in the one or more perforated trays 230, via the second drain outlet 216. The second drain outlet 216 may be positioned in the outer tower 102 vertically above the region defining the second treatment zone 122.

[046] It is intended that the disclosure and examples be considered as exemplary only, with a true scope and spirit of disclosed embodiments being indicated by the following claims.

CLAIMS

We Claim:

1. A system (100) for refining flue gases, the system (100) comprising:

an inner tower (104) defining:

a first treatment zone (120) configured to:

receive a stream of flue gas; and

treat the stream of flue gas received in the first treatment zone (120) with anhydrous Ammonia to remove Nitrogen-based components from the flue gas, to generate a stream of a first treated gas; and

an outer tower (102), wherein the inner tower (104) is positioned inside the outer tower (102), the outer tower (102) defining:

a second treatment zone (122) in a region between inner periphery of the outer tower (102) and outer periphery of the inner tower (104), wherein the second treatment zone (122) is configured to:

receive the stream of the first treated gas from the first treatment zone (120); and

treat the stream of the first treated gas received in the second treatment zone (122) with aqueous Ammonia to remove Sulphur-based components from the first treated gas to generate a stream of a second treated gas; and

a third treatment zone (124) configured to:

receive the stream of the second treated gas from the second treatment zone (122); and

treat the stream of the second treated gas received in the third treatment zone (124) with aqueous Ammonia to remove Carbon-based components from the second treated gas to generate a stream of a third treated gas.

2. The system (100) as claimed in claim 1 further comprising:

a first set of dispensers (108) positioned in a region defining the first treatment zone (120), wherein the first set of dispensers (108) is configured to dispense a supply of anhydrous Ammonia to treat the stream of flue gas received in the first treatment zone (120),

wherein the first treatment zone (120) is maintained at a temperature within a range of 300-410 degrees Celsius;

a second set of dispensers (110) positioned in a region defining the second treatment zone (122), wherein the second set of dispensers (110) is configured to dispense a first supply of low-temperature aqueous Ammonia to treat the stream of the first treated gas received in the second treatment zone (122),

wherein the first supply of low-temperature aqueous Ammonia is to maintain the second treatment zone (122) at a temperature within a range of 30-80 degrees Celsius; and a third set of dispensers (112) positioned in a region defining the third treatment zone (124), wherein the third set of dispensers (112) is configured to dispense a second supply of low-temperature aqueous Ammonia to treat the stream of the second treated gas received in the third treatment zone (124),

wherein the second supply of low-temperature aqueous Ammonia is to maintain the third treatment zone (124) at a temperature within a range of 0-10 degrees Celsius.

3. The system (100) as claimed in claim 1, wherein the second supply of low-temperature aqueous Ammonia comprises aqueous Ammonia in a range of 25-30 percent weight/volume solution.

4. The system (100) as claimed in claim 1 further comprising:

a set of catalytic grids (226) positioned in the inner tower (104), wherein the set of catalytic grids (226) comprises a catalyst for expediting treatment of the stream of the flue gas received in the first treatment zone (120) with anhydrous Ammonia.

5. The system (100) as claimed in claim 1, wherein the supply of anhydrous Ammonia comprises a mixture of anhydrous Ammonia and air.

6. The system (100) as claimed in claim 1, further comprising one or more perforated trays (230) positioned inside the outer tower (102) in a region defining the third treatment zone (124),

wherein the one or more perforated trays (230) are configured to collect crystals generated upon treatment of the stream of the second treated gas received with aqueous Ammonia, and

wherein the crystals comprises at least one of Ammonium Carbonate-type crystals, Ammonium Bicarbonate-type crystals, and Ammonium Carbamate-type crystals.

7. The system (100) as claimed in claim 6, further comprising a second drain outlet (216) in the outer tower (102), positioned vertically above the region defining the second treatment zone (122), wherein the second drain outlet (216) is configured to drain crystals generated upon treatment of the stream of the second treated gas with aqueous Ammonia and uncollected in the one or more perforated trays (230).

8. The system (100) as claimed in claim 1, further comprising a flow-bend (232) defined in a region vertically above the region defining the second treatment zone (122), wherein the flow-bend (232) is configured to cause flow of stream of the second treated gas to undergo an upwards to downwards turn.

9. The system (100) as claimed in claim 1, wherein:

the region defining the second treatment zone (122) is vertically below the region defining the first treatment zone (120); and

the region defining the third treatment zone (124) is vertically above the region defining the first treatment zone (120) and the region defining the second treatment zone (122).

10. The system (100) as claimed in claim 9, wherein:

the stream of the flue gas is to flow vertically downwards inside the inner tower (104),

the stream of the first treated gas is to:

flow vertically downwards upon generation to exit the inner tower (104) through a bottom end of the inner tower (104), and

upon exiting the inner tower (104), flow vertically upwards in the region defining the third treatment zone (124), and

the stream of the second treated gas is to flow vertically upwards to enter the region defining the third treatment zone (124).

11. The system (100) as claimed in claim 1, further comprising a first drain outlet (214) in the outer tower (102), positioned near a bottom end of the outer tower (102), wherein the first drain outlet (214) is configured to drain by-products generated during treatment of the stream of the first treated gas received in the second treatment zone (122) with aqueous Ammonia, wherein the by-products comprise Ammonium Sulphate and Ammonium Bi-Sulphate.

12. A method (300) of refining flue gases, the method (300) comprising:

receiving (302) a stream of flue gas in a first treatment zone (120) defined in an inner tower (104);

treating (304) the stream of the flue gas received in the first treatment zone (120) with anhydrous Ammonia to remove Nitrogen-based components from the flue gas, to generate a stream of a first treated gas;

receiving (306) the stream of the first treated gas from the first treatment zone (120) in a second treatment zone (122) defined in a region between inner periphery of an outer tower (102) and outer periphery of the inner tower (104), wherein the inner tower (104) is positioned inside the outer tower (102);

treating (308) the stream of the first treated gas received in the second treatment zone (122) with aqueous Ammonia to remove Sulphur-based components from the first treated gas to generate a stream of a second treated gas;

receiving (310) the stream of the second treated gas from the second treatment zone (122) in a third treatment zone (124) defined in the outer tower (102); and

treating (312) the stream of the second treated gas received in the third treatment zone (124) with aqueous Ammonia to remove Carbon-based components from the second treated gas to generate a stream of a third treated gas.

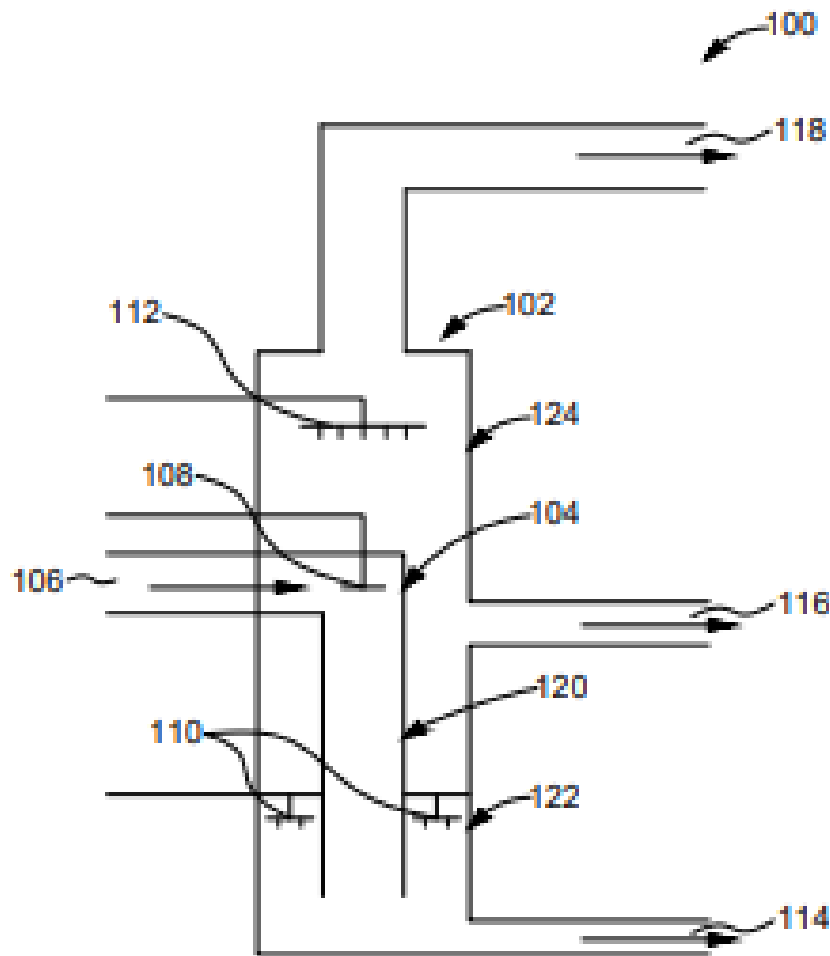
Dated this 11th Day of March 2022

Robin Koshy Varghese (INPA No: 3705)
Head, IPR Dept.
L&T Technology Services Ltd.
DLF 3rd Block, 2nd Floor,
Manapakkam, Chennai - 600089.

A SYSTEM AND METHOD FOR REFINING FLUE GASES

ABSTRACT

A system (100) for refining flue gases is disclosed that may include an inner tower (104) defining a first treatment zone (120) configured to treat a stream of flue gas with anhydrous Ammonia, to remove Nitrogen-based components from the flue gas to generate a stream of a first treated gas. The system (100) may further include an outer tower (102), such that the inner tower (104) is positioned inside the outer tower (102). The outer tower (102) may define a second treatment zone (122) configured to treat the stream of the first treated gas with aqueous Ammonia to remove Sulphur-based components and generate a stream of a second treated gas. The outer tower (102) may further define a third treatment zone (124) configured to treat the stream of the second treated gas with aqueous Ammonia to remove Carbon-based components.



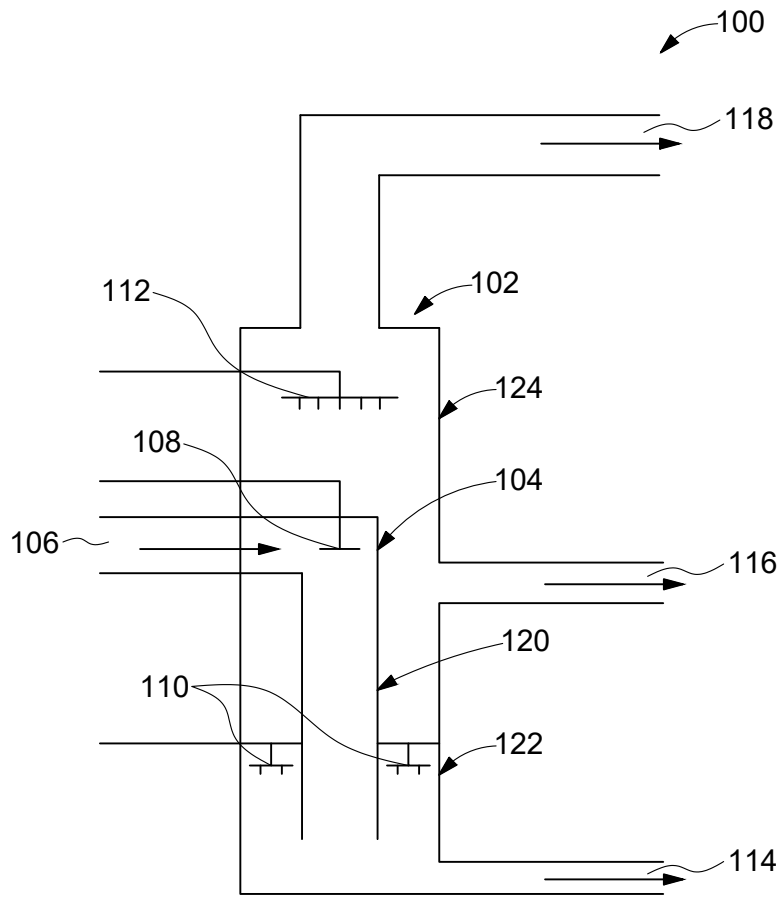


FIG. 1

ROBIN KOSHY VARGHESE (INPA No.: 3705)
Head, IPR Dept.,
L&T Technology Services Limited,
DLF 3rd Block, 2nd Floor,
Manapakkam, TN, Chennai - 600 089.

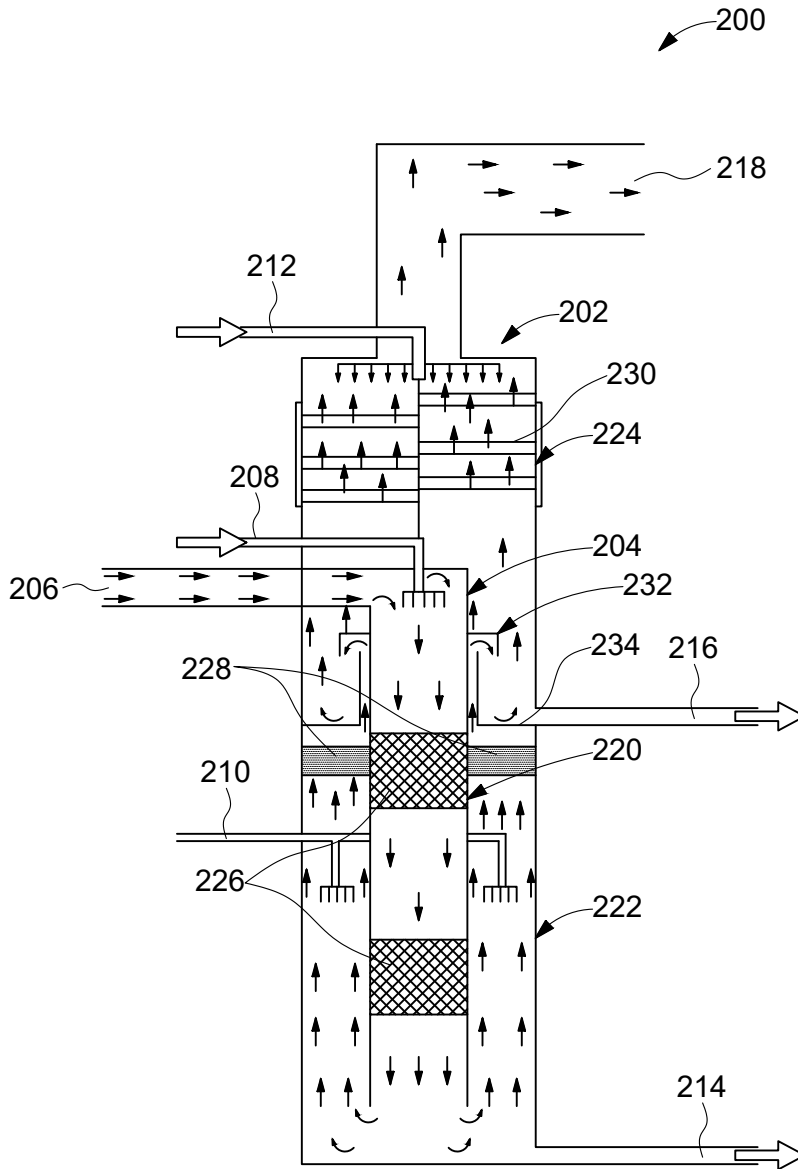


FIG. 2

ROBIN KOSHY VARGHESE (INPA No.: 3705)
Head, IPR Dept.,
L&T Technology Services Limited,
DLF 3rd Block, 2nd Floor,
Manapakkam, TN, Chennai - 600 089.

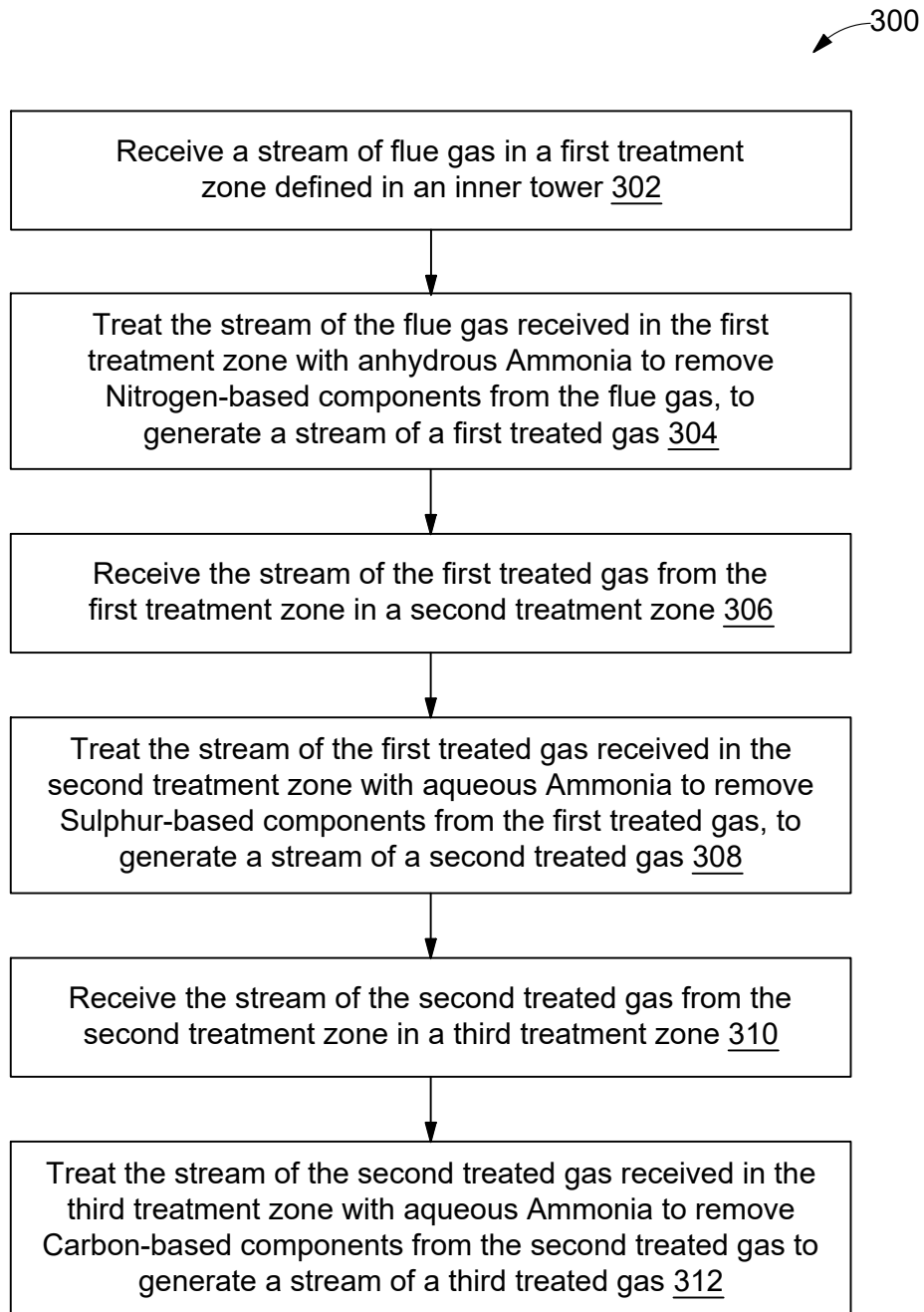


FIG. 3

ROBIN KOSHY VARGHESE (INPA No.: 3705)
Head, IPR Dept.,
L&T Technology Services Limited,
DLF 3rd Block, 2nd Floor,
Manapakkam, TN, Chennai - 600 089.