

METHOD AND SYSTEM FOR CARBON DIOXIDE EXTRACTION

TECHNICAL FIELD

This invention relates generally to a method and system for carbon dioxide extraction.

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Background

Processes currently used for removing carbon dioxide (CO₂) from gas streams, for example industrial exhaust gas, include pressure Swing adsorption (PSA) where the CO₂, removed from the gas stream is vented to the ambient, conventional membrane processes, and
10 conventional absorption processes using either packed columns with amine or other absorbents. However, these processes are generally too expensive for the small flow rates of biogas available at wastewater treatment plants and industrial facilities. There is a need for an approach to extracting CO₂ from exhaust gas

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Summary

In accordance with a first aspect of the invention, there is disclosed a carbon dioxide (CO₂) extraction system comprising a chamber defining a water inlet, a water outlet and a gas inlet where exhaust gas containing CO₂ is introduced, an atomizer coupled to the water inlet and
20 disposed adjacent the gas inlet for atomizing water and directing the atomized water substantially towards the exhaust gas introduced into the chamber at the gas inlet, and a wheel received within and rotatably coupled to the chamber, the wheel defining a rotational axis and comprising a plurality of paddles with each thereof defining a paddle plane being substantially parallel the rotational axis and defining a plurality of pores therein. The wheel
25 is disposed to position at least one of the plurality of paddles between the gas inlet and the water outlet, the atomized water absorbing a portion of the CO₂ in the exhaust gas when discharged from the atomizer and being caught by at least one of the plurality of paddles disposed between the gas inlet and the water outlet to thereby displaced the at least one of the plurality of paddles about the rotational axis and towards the water outlet. Wherein the water
30 on the at least one of the plurality of paddles draining through the plurality of pores and

sliding from the at least one of the plurality of paddles for discharged from the chamber through the water outlet during displacement of the paddles about the rotational axis, and wherein the CO₂ content in the exhaust gas introduced into the chamber is reduced.

- 5 In accordance with a second aspect of the invention, there is disclosed a CO₂ extraction method comprising introducing exhaust gas containing CO₂ into a chamber defining a water inlet, a water outlet and a gas inlet, directing atomized water by an atomizer substantially towards the exhaust gas introduced into the chamber at the gas inlet, the atomizer being coupled to the water inlet and disposed adjacent the gas inlet, and positioning at least one of a
- 10 plurality of paddles of a wheel between the gas inlet and the water outlet. The wheel is received within and rotatably coupled to the chamber, the wheel defining a rotational axis and comprising the plurality of paddles with each thereof defining a paddle plane being substantially parallel the rotational axis and defining a plurality of pores therein, the atomized water absorbing a portion of the CO₂ in the exhaust gas when discharged from the atomizer
- 15 and being caught by at least one of the plurality of paddles disposed between the gas inlet and the water outlet to thereby displaced the at least one of the plurality of paddles about the rotational axis and towards the water outlet. The CO₂ extraction method further comprises discharging the water draining through the plurality of pores and sliding from the at least one of the plurality of paddles through the water outlet and from the chamber during
- 20 displacement of the paddles about the rotational axis, wherein the CO₂ content in the exhaust gas introduced into the chamber is reduced.

Brief Description of the Drawings

- FIG. 1 shows an exemplary illustrative sectional view of a carbon dioxide (CO₂) extraction system in accordance with an aspect of the invention; and
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FIG. 2 shows an exemplary process flow diagram of a carbon dioxide (CO₂) extraction method for implementing the carbon dioxide (CO₂) extraction system of FIG. 1.

Detailed Description

An exemplary embodiment of the present invention, a carbon dioxide (CO₂) extraction system 20, implementable with a carbon dioxide (CO₂) extraction method 100, is described
5 hereinafter with reference to FIG. 1 to FIG. 2.

The CO₂ extraction system 20 comprises a chamber 22 defining a water inlet 24, a water outlet 26 and a gas inlet 28 where exhaust gas 30 containing CO₂ is introduced. The CO₂ extraction system 20 further comprises an atomizer 32 coupled to the water inlet 24 and
10 disposed adjacent the gas inlet 28 for atomizing water 33 supplied thereto and for directing the atomized water 33 substantially towards the exhaust gas 30 introduced into the chamber 22 at the gas inlet 28.

The CO₂ extraction system 20 further comprises a wheel 34 received within and rotatably
15 coupled to the chamber 22. The wheel 34 defines a rotational axis 36 and comprising a plurality of paddles 38 with each thereof defining a paddle plane 40 being substantially parallel the rotational axis 36 and defining a plurality of pores therein.

The wheel is disposed to position at least one of the plurality of paddles 38 between the gas
20 inlet 28 and the water outlet 26. The atomized water 33 absorbs a portion of the CO₂ in the exhaust gas 30 when discharged from the atomizer 32 and is caught by at least one of the plurality of paddles 38 disposed between the gas inlet 28 and the water outlet 26 to thereby displaced the at least one of the plurality of paddles 38 about the rotational axis 36 and towards the water outlet 26. Preferably, the water inlet 24 and atomizer 32 is positioned
25 higher to and substantially over the water outlet 26 to enable gravitationally assisted flow of water from the atomizer 32 to the water outlet 26, and from the at least one of the plurality of paddles 38 to the water outlet 26.

The water 33 on the at least one of the plurality of paddles 38 draining through the plurality
30 of pores and sliding from the at least one of the plurality of paddles 38 for discharged from

the chamber 22 through the water outlet 26 during displacement of the paddles 38 about the rotational axis 36 to thereby reduce the CO₂ content in the exhaust gas 30 introduced into the chamber 22.

- 5 As the wheel 34 rotates, a new one of the plurality of paddles 38 is introduced into the space between the gas inlet 28 and the water outlet 26 on a down-turn for capturing the atomized water 33 and for absorbing the CO₂ in the exhaust gas 30 by the capture atomized water 33. The water 33 then slides off the respective one of the plurality of paddles 38 at least one of across and through the plurality of pores before be gravitationally directed towards the water
10 outlet 26. The respective one of the plurality of paddles 38 the rotates on an up-turn away from the space between the gas inlet 28 and the water outlet 26 before re-entering the said space on a down-turn again. The use of the plurality of paddles 38 prolongs the exposure of the water 33 to the exhaust gas 30 to improve or optimize CO₂ absorption thereby.
- 15 The chamber 22 further defines a gas outlet 44 for discharging the CO₂-reduced exhaust gas 30 from the chamber 22. Preferably, each of the plurality of paddles 38 being formed from at least metal foam defining the plurality of pores. Further, each of the plurality of paddles 38 being a substantially planar structure for defining the paddle plane 40.
- 20 The CO₂ extraction system 20 further comprises a circulatory pathway 46 for returning water 33 directing at least a portion of the water 33 drained from the water outlet 26 back to the water inlet 24 and a pump 48 formed integral with the circulatory pathway 46 for displacing the water 33 in the circulatory pathway 46 from the water outlet 26 to the water inlet 24.
- 25 The CO₂ extraction system 20 further comprises a decarbonator 50 formed integral the circulatory pathway 46 for extracting and exhausting a portion of the CO₂ from the water 33 displaced along the circulatory pathway 46. Preferably, the circulatory pathway 46 comprising at least one pipe structure for the transport of water 33 therealong.

Preferably, the atomizer 32 is one of at least one nozzle-shaped for and an ultrasonic atomizer 32 for atomizing water 33 introduced at the water inlet 24 into the chamber 22. Further preferably, the plurality of paddles 38 extends substantially radially from the rotational axis 36 of the wheel 34.

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The CO₂ extraction method 100 comprises a step 110 of introducing the exhaust gas 30 containing CO₂ into the chamber 22 and a step 112 of directing the atomized water 33 by the atomizer 32 substantially towards the exhaust gas 30 introduced into the chamber 22 at the gas inlet 28. The CO₂ extraction method 100 further comprises a step 114 of positioning at
10 least one of the plurality of paddles 38 of a wheel 34 between the gas inlet 28 and the water outlet 26 to displace the at least one of the plurality of paddles 38 about the rotational axis 36 and towards the water outlet 26 when the at least one of the plurality of paddles 38 disposed between the gas inlet 28 and the water outlet 26 catches the atomized water 33.

15 The CO₂ extraction method 100 further comprises a step 116 of discharging the water 33 draining through the plurality of pores and sliding from the at least one of the plurality of paddles 38 through the water outlet 26 and from the chamber 22 during displacement of the paddles 38 about the rotational axis 36 to thereby reduce the CO₂ content in the exhaust gas 30 introduced into the chamber 22. The CO₂ extraction method 100 further comprises a step
20 118 of discharging the CO₂-reduced exhaust gas from the chamber through a gas outlet defined by the chamber 22. Preferably, the chamber 22 is a vessel made from heat resistant and high strength material such as steel.

Aspects of particular embodiments of the present disclosure address at least one aspect,
25 problem, limitation, and/or disadvantage associated with existing CO₂ extraction system and approaches. While features, aspects, and/or advantages associated with certain embodiments have been described in the disclosure, other embodiments may also exhibit such features, aspects, and/or advantages, and not all embodiments need necessarily exhibit such features, aspects, and/or advantages to fall within the scope of the disclosure. It will be
30 appreciated by a person of ordinary skill in the art that several of the above-disclosed

structures, components, or alternatives thereof, can be desirably combined into alternative structures, components, and/or applications. In addition, various modifications, alterations, and/or improvements may circulatory be made to various embodiments that are disclosed by a person of ordinary skill in the art within the scope of the present disclosure, which is limited only by the following claims.

Claims

1. A carbon dioxide (CO₂) extraction system comprising:

a chamber defining a water inlet, a water outlet and a gas inlet where exhaust gas containing CO₂ is introduced;

an atomizer coupled to the water inlet and disposed adjacent the gas inlet for atomizing water and directing the atomized water substantially towards the exhaust gas introduced into the chamber at the gas inlet; and

a wheel received within and rotatably coupled to the chamber, the wheel defining a rotational axis and comprising a plurality of paddles with each thereof defining a paddle plane being substantially parallel the rotational axis and defining a plurality of pores therein, the wheel being disposed to position at least one of the plurality of paddles between the gas inlet and the water outlet, the atomized water absorbing a portion of the CO₂ in the exhaust gas when discharged from the atomizer and being caught by at least one of the plurality of paddles disposed between the gas inlet and the water outlet to thereby displaced the at least one of the plurality of paddles about the rotational axis and towards the water outlet,

wherein the water on the at least one of the plurality of paddles draining through the plurality of pores and sliding from the at least one of the plurality of paddles for discharged from the chamber through the water outlet during displacement of the paddles about the rotational axis, and

wherein the CO₂ content in the exhaust gas introduced into the chamber is reduced.

2. The carbon dioxide (CO₂) extraction system as in claim 1, the chamber further defining a gas outlet for discharging the CO₂-reduced exhaust gas from the chamber.

3. The carbon dioxide (CO₂) extraction system as in claim 1, each of the plurality of paddles being formed from at least metal foam defining the plurality of pores.

4. The carbon dioxide (CO₂) extraction system as in claim 1, each of the plurality of paddles being a substantially planar structure for defining the paddle plane.
5. The carbon dioxide (CO₂) extraction system as in claim 1, further comprising:
5 a circulatory pathway for returning water directing at least a portion of the water drained from the water outlet back to the water inlet.
6. The carbon dioxide (CO₂) extraction system as in claim 5, further comprising:
10 a pump formed integral with the circulatory pathway for displacing the water in the circulatory pathway from the water outlet to the water inlet.
7. The carbon dioxide (CO₂) extraction system as in claim 5, further comprising:
15 a decarbonator formed integral the circulatory pathway for extracting and exhausting a portion of the CO₂ from the water displaced along the circulatory pathway.
8. The carbon dioxide (CO₂) extraction system as in claim 1, the circulatory pathway comprising at least one pipe structure for the transport of water therealong.
- 20 9. The carbon dioxide (CO₂) extraction system as in claim 1, the atomizer being one of at least one nozzle-shaped for and an ultrasonic atomizer for atomizing water introduced at the water inlet into the chamber.
10. The carbon dioxide (CO₂) extraction system as in claim 1, the plurality of paddles
25 extends substantially radially from the rotational axis of the wheel.
11. A carbon dioxide (CO₂) extraction method comprising:
introducing exhaust gas containing CO₂ into a chamber defining a water inlet, a water outlet and a gas inlet;

directing atomized water by an atomizer substantially towards the exhaust gas introduced into the chamber at the gas inlet, the atomizer being coupled to the water inlet and disposed adjacent the gas inlet; and

positioning at least one of a plurality of paddles of a wheel between the gas inlet and the water outlet, the wheel being received within and rotatably coupled to the chamber, the wheel defining a rotational axis and comprising the plurality of paddles with each thereof defining a paddle plane being substantially parallel the rotational axis and defining a plurality of pores therein, the atomized water absorbing a portion of the CO₂ in the exhaust gas when discharged from the atomizer and being caught by at least one of the plurality of paddles disposed between the gas inlet and the water outlet to thereby displaced the at least one of the plurality of paddles about the rotational axis and towards the water outlet; and

discharging the water draining through the plurality of pores and sliding from the at least one of the plurality of paddles through the water outlet and from the chamber during displacement of the paddles about the rotational axis,

wherein the CO₂ content in the exhaust gas introduced into the chamber is reduced.

12. The carbon dioxide (CO₂) extraction method as in claim 11, further comprising:

discharging the CO₂-reduced exhaust gas from the chamber through a gas outlet defined by the chamber.

13. The carbon dioxide (CO₂) extraction method as in claim 11, each of the plurality of paddles being formed from at least metal foam defining the plurality of pores.

14. The carbon dioxide (CO₂) extraction method as in claim 11, each of the plurality of paddles being a substantially planar structure for defining the paddle plane.

15. The carbon dioxide (CO₂) extraction method as in claim 11, further comprising:

a circulatory pathway for returning water directing at least a portion of the water drained from the water outlet back to the water inlet.

16. The carbon dioxide (CO₂) extraction method as in claim 15, further comprising:
5 a pump formed integral with the circulatory pathway for displacing the water in the circulatory pathway from the water outlet to the water inlet.
17. The carbon dioxide (CO₂) extraction method as in claim 15, further comprising:
10 a decarbonator formed integral the circulatory pathway for extracting and exhausting a portion of the CO₂ from the water displaced along the circulatory pathway.
18. The carbon dioxide (CO₂) extraction method as in claim 11, the circulatory pathway comprising at least one pipe structure for the transport of water therealong.
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19. The carbon dioxide (CO₂) extraction method as in claim 11, the atomizer being one of at least one nozzle-shaped for and an ultrasonic atomizer for atomizing water introduced at the water inlet into the chamber.
20. The carbon dioxide (CO₂) extraction method as in claim 11, the plurality of paddles extends substantially radially from the rotational axis of the wheel.
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