WHAT IS CLAIMED IS:

1. A gas conditioning system for removing contaminants comprising carbon dioxide from flue gas, the system comprising:

a rotating packed bed assembly fluidly connected to an exhaust port of an engine, the rotating packed bed assembly configured to receive a flue gas from the exhaust port, the rotating packed bed assembly comprising:

a first rotating packed bed comprising an absorption agent configured to absorb a portion of the carbon dioxide from the flue gas, and

a second rotating packed bed configured to receive the absorption agent from the first rotating packed bed and desorb at least some of the portion of the carbon dioxide from the absorption agent.

2. The gas conditioning system of claim 1, wherein the absorption agent comprises a liquid solvent.

3. The gas conditioning system of claim 2, wherein the liquid solvent comprises an amine solvent.

4. The gas conditioning system of any preceding claim, wherein the rotating packed bed assembly further comprises a water wash station fluidly connected to the first rotating packed bed, the water wash station configured to wash the flue gas from the first rotating packed bed with water.

5. The gas conditioning system of claim 4, wherein the water wash station comprises a packed cylinder or a rotating packed bed.

6. The gas conditioning system of any preceding claim, wherein the rotating packed bed assembly further comprises a third rotating packed bed in series with the first rotating packed bed, the third rotating packed bed comprising a second portion of the absorption agent, the third

rotating packed bed configured to absorb a second portion of the carbon dioxide from the flue gas.

7. The gas conditioning system of claim 6, wherein the rotating packed bed assembly further comprises an intercooler fluidly coupled to the first rotating packed bed and the third rotating packed bed, the intercooler configured to cool the second portion of the absorption agent and direct the second portion of the absorption agent to the first rotating packed bed.

8. The gas conditioning system of claim 6, wherein the rotating packed bed assembly further comprises an intercooler fluidly coupled to the first rotating packed bed and the third rotating packed bed, the intercooler configured to cool the first portion of the absorption agent and direct the first portion of the absorption agent to the third rotating packed bed.

9. The gas conditioning system of any preceding claim, wherein the rotating packed bed assembly further comprises a third rotating packed bed in parallel with the first rotating packed bed, the first rotating packed bed configured to receive a first portion of the flue gas and the third rotating packed bed configured to receive a second portion of the flue gas, the third rotating packed bed comprising a second portion of the absorption agent.

10. The gas conditioning system of any preceding claim, wherein the rotating packed bed assembly further comprises a fourth rotating packed bed in series with the second rotating packed bed, the fourth rotating packed bed configured to receive the absorption agent from the second rotating packed bed and desorb at least some of the carbon dioxide from the absorption agent.

11. The gas conditioning system of claim 10, wherein the rotating packed bed assembly further comprises an interheater fluidly coupled to the second rotating packed bed and the fourth rotating packed bed, the interheater configured to heat the absorption agent from the second rotating packed bed and direct the absorption agent to the fourth rotating packed bed.

12. The gas conditioning system of any preceding claim, wherein the rotating packed bed assembly further comprises a fourth rotating packed bed in parallel with the second rotating packed bed, the second rotating packed bed configured to receive a first portion of the absorption agent and the fourth rotating packed bed configured to receive a second portion of the absorption agent.

13. The gas conditioning system of any one of claims 1 to 12, further comprising:

an oxidizer unit comprising a fluid inlet fluidly connected to the exhaust flue gas from the engine and a fluid outlet fluidly connected to the rotating packed bed assembly, the oxidizer unit configured to receive the exhaust flue gas from the engine through the fluid inlet and convert at least a portion of nitrogen oxides in the flue gas into nitrogen dioxide and at least a portion of sulfur oxides in the flue gas into sulfur dioxide.

14. The gas conditioning system of any one of claims 1 to 13, further comprising:

a direct contact cooler positioned upstream of the rotating packed bed assembly and fluidly between the exhaust port and the rotating packed bed assembly, the direct contact cooler comprising a fluid inlet fluidly connected to the exhaust port, a housing enclosing a cooling chamber, and a fluid outlet, the direct contact cooler configured to direct the flue gas into contact with seawater residing in the cooling chamber and cool the flue gas to a temperature less than or equal to 60 degrees Celsius.

15. The gas conditioning system of claim 14, wherein the direct contact cooler is configured to direct the flue gas into contact with seawater residing in the cooling chamber and cool the flue gas to a temperature less than or equal to 50 degrees Celsius.

16. The gas conditioning system of claim 14 or claim 15, wherein the direct contact cooler comprises a third rotating packed bed comprising:

the housing enclosing the cooling chamber,

a rotor drum disposed within the housing and rotatable about a rotational axis,

a seawater inlet fluidly connected to the rotor drum,

a seawater outlet fluidly connected to the housing,

the fluid inlet fluidly connected to the housing, and

the fluid outlet fluidly connected to the rotor drum,

wherein the flue gas is directed from the fluid inlet to the fluid outlet, and the seawater is directed from the seawater inlet to the seawater outlet.

17. The gas conditioning system of claim 16, wherein the flue gas is disposed in countercurrent flow with the seawater within in the rotor drum when the third rotating packed bed is in use.

18. The gas conditioning system of any one of claims 14 to 17, wherein the direct contact cooler comprises a seawater inlet to direct the seawater into the cooling chamber, the seawater configured to remove at least a portion of sulfur dioxides and nitrogen dioxides from the flue gas in the cooling chamber.

19. The gas conditioning system of any one of claims 1 to 18, further comprising:

an adsorption unit positioned upstream of the rotating packed bed assembly and fluidly between the exhaust port and the rotating packed bed assembly, the adsorption unit comprising a fluid inlet fluidly connected to the exhaust port, the adsorption unit configured to receive the flue gas from the exhaust port and remove at least a portion of nitrogen oxides from the flue gas;

wherein the adsorption unit comprises at least one adsorption bed, the gas conditioning system is configured to direct the flue gas from the fluid inlet through the at least one adsorption bed, and the adsorption bed is configured to reduce a nitrogen oxide content from the flue gas to less than 50 parts per million.

20. The gas conditioning system of any one of claims 1 to 19, wherein the rotating packed bed assembly is fluidly connected to the exhaust port of a marine engine of a marine vessel.

21. A method for conditioning flue gas, the method comprising:

directing a flue gas from an exhaust port to a rotating packed bed assembly, the rotating packed bed assembly comprising a first rotating packed bed and a second rotating packed bed;

absorbing, with an absorption agent in the first rotating packed bed, at least a portion of the carbon dioxide from the flue gas;

directing the absorption agent with the absorbed carbon dioxide from the first rotating packed bed to the second rotating packed bed; and

desorbing, in the second rotating packed bed, the carbon dioxide from the absorption agent.

22. The method of claim 21, further comprising:

directing the flue gas from the first rotating packed bed to a water wash station; and

washing, in a wash chamber of the water wash station, the flue gas with water.

23. The method of any one of claims 21 to 22, wherein the rotating packed bed assembly further comprises a third rotating packed bed in series with the first rotating packed bed and comprising a second portion of the absorption agent, the method further comprising:

directing the flue gas from the first rotating packed bed to the third rotating packed bed; and

absorbing, with the second portion of the absorption agent in the third rotating packed bed, a second portion of the carbon dioxide from the flue gas.

24. The method of claim 23, further comprising:

directing the second portion of the absorption agent from the third rotating packed bed to an intercooler fluidly coupled to the first rotating packed bed and the third rotating packed bed;

cooling, with the intercooler, the second portion of the absorption agent; and

directing the cooled second portion of the absorption agent to the first rotating packed bed.

25. The method of claim 23, further comprising:

directing the first portion of the absorption agent from the first rotating packed bed to an intercooler fluidly coupled to the first rotating packed bed and the third rotating packed bed;

cooling, with the intercooler, the first portion of the absorption agent; and

directing the cooled first portion of the absorption agent to the third rotating packed bed.

26. The method of any one of claims 21 to 25, wherein the rotating packed bed assembly further comprises a fourth rotating packed bed in series with the second rotating packed bed, the method further comprising:

directing the absorption agent from the second rotating packed bed to the fourth rotating packed bed; and

desorbing, in the fourth rotating packed bed, at least some of the carbon dioxide from the absorption agent.

27. The method of claim 26, wherein directing the absorption agent from the second rotating packed bed to the fourth rotating packed bed comprises:

directing the absorption agent from the second rotating packed bed to an interheater fluidly coupled to the second rotating packed bed and the fourth rotating packed bed;

heating, with the interheater, the absorption agent; and

directing the heated absorption agent to the fourth rotating packed bed.

28. The method of any one of claims 21 to 27, further comprising:

receiving, at a chamber of an oxidizer unit disposed fluidly between the exhaust port and the rotating packed bed assembly, the flue gas from the exhaust port at a temperature between 150 degrees Celsius and 550 degrees Celsius; and

converting, with a reactant in the chamber of the oxidizer unit, a portion of nitrogen oxides in the flue gas into at least one of nitrogen gas or nitrogen dioxide at a temperature between 150 degrees Celsius and 550 degrees Celsius.

29. The method of any one of claims 21 to 28, further comprising:

receiving, at a direct contact cooler disposed fluidly between the exhaust port and the rotating packed bed assembly, the flue gas from the exhaust port; and

cooling, with direct contact of the flue gas with seawater in the direct contact cooler, the flue gas to a temperature less than or equal to 60 degrees Celsius.

30. The method of claim 29, further comprising:

receiving, at an adsorption unit, the flue gas from the direct contact cooler; and

removing, at the adsorption unit, at least a portion of remaining nitrogen oxides from the cooled flue gas;

wherein removing at least a portion of remaining nitrogen oxides from the cooled flue gas comprises directing the cooled flue gas through at least one adsorption bed of the adsorption unit to reduce a nitrogen oxide content of the flue gas to less than 50 parts per million.

31. The method of any one of claims 21 to 30, wherein directing a flue gas from an exhaust port to a rotating packed bed assembly comprises directing the flue gas from a marine engine of a marine vessel to the rotating packed bed assembly.