Improved methods and systems are needed for removing contaminants comprising carbon dioxide from flue gas onboard of ships. Improved systems are needed that remove flue gas contaminants more efficiently.

Previous attempts at removing contaminants from flue gas have targeted SOx removal on ships is an open system utilizing seawater that is discharged back into the ocean. Amines or other commercially produced chemical solvents are harmful and can not be discharged at sea. Further attempts at removing CO2 from feed gas have targeted natural gas and the like that are available at much higher pressures than flue gas. A system or process to capture CO2 that avoids discharge of harmful chemical solvents into the ocean and addresses the ambient pressure of flue gas is needed and described herein.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided a method for removing carbon dioxide from a flue gas, on a ship or marine vessel generating flue gas including: (a) feeding CO2 containing flue gas to a Venturi Quencher to treat the hot flue gas from a ship and cool it down, (b) feeding the cooled flue gas into a rotating packed bed (RPB) device and (c) contacting with a scrubbing fluid to form a spent fluid with bound CO2.

According to a second aspect of the present invention, there is provided an integrated system for onboard scrubbing of a marine exhaust gas on a ship, including: i) a hot exhaust gas entry that feeds the marine exhaust gas, having a temperature greater than 180 °C, from an engine on the ship; and ii) a rotating packed bed device, having: iii) a stationary gas distributor, placed along an outer circumference of the rotating packed bed device, connected to a Venturi quencher, wherein the stationary gas distributor is configured to receive the cooled exhaust gas and uniformly distribute the quenched marine exhaust gas along the outer circumference of the rotating packed bed device; and iv) a stationary liquid distributor, with multiple liquid rings, that is centrally positioned within the rotating packed bed device, wherein the multiple liquid rings are fitted with spray nozzles that spray a liquid absorbent as a co-feed with the cooled exhaust gas into the annulus of the rotating packed bed device.

An embodiment of the invention is a closed loop process for removing CO2 from a flue gas comprising a Venturi Quencher to treat the hot flue gas from a ship and cool it down.

Another embodiment is feeding the cooled flue gas into one or more rotating packed bed (RPB) devices and contact with a scrubbing fluid that is selective for CO2 capture such as conventional amines (MEA, DEA and MDEA), advanced amines comprising activated MDEA, combination of piperazine and MDEA, ionic liquids or switchable polarity fluids (SPS).

Another embodiment is an integrated system for the scrubbing fluid containing two tanks, one for holding the fresh liquid and another to collect the spent fluid that has reacted with CO2.

A further embodiment is one or more RPB devices located in a hull or the funnel of the marine ship, comprising of a rotating shaft and a porous media and configured to mix the flue gas with the CO2 capture liquid in an outwardly direction at a sufficient gas/liquid ratio to reduce the CO2 concentration in the flue gas to the desired level. The outwardly flue gas/liquid feeding of the RPB may be co current and will allow for a pressure increase of up to 50 kPa from the interior region to the exterior region of the RPB and to overcome the pressure limitation of the flue gas.

Another embodiment of this invention is to add another RPB to regenerate the spent fluid onboard and store the desorbed CO2 in tanks onboard. Another option is to regenerate the spent fluid at an onshore facility during a port stay.