is generally considered as equivalent to "soapy water" and is classified as non-hazardous and non-corrosive. The device is preferably designed so that there is no standing seawater/quenching/pre-treating/washing fluid in order to reduce and/or prevent corrosion of the stainless steel.

With reference to Figure 1, the marine exhaust gas scrubbing device 100 contains an exhaust inlet 110, an exhaust outlet 120, a quencher 500 to cool the incoming hot exhaust gas 111, a pre-treater 600 to pre-treat the quenched exhaust gas 112, a convergent-divergent venturi 300 , having a convergent zone 301, a divergent zone 302, and a convergent-divergent passageway 303. The convergent zone 301 contains a washer 320 further to mix the pre-treated exhaust gas 113 and a venturi washdown 310 to remove soot and solid material from the venturi, an impingement basket 700 for further mixing allowing for the separation and collapse of the bubbles formed during operation of the marine exhaust gas scrubbing device 100, a demister 420 to remove fluid droplets from the treated exhaust and an exit space washdown 410. Excess quenching, pre-treating and washing fluid is collected by the drain 200. The unit also includes a demister soot cleaning washdown nozzle 400.

With reference to Figure 2, an alternate embodiment of the marine exhaust gas scrubbing device 100 contains an exhaust inlet 110, and exhaust outlet 120, a quencher/pre-treater 550, a butterfly valve 130, a venturi 300 having a conical reducer 330 and containing a washer 320 and a demister ~~400~~420. Excess quenching, pre-treating and washing fluid and washed solids are collected by the drains 200 which empty into sump 250.

With reference to Figures 3, 3 A-A and 3 B-B, a marine exhaust gas scrubbing device 100 is shown having two venturi components 300 in parallel. Figure 3 A-A provides the flowpath of the exhaust gas from the exhaust gas inlet 110, up the inlet side 121 of the device 100 into the two venturi components 300 out the venturi outlet 304, up the outlet side 122 and out the treated exhaust gas outlet 120.

With reference to Figure 4, the convergent zone 301 is shown with rotational flow blades 800 along the inside wall of the upper portion of the convergent zone 301. The flow blades 800 are angled (helical in configuration) to promote rotational flow of the exhaust gas into the convergent-divergent passageway 303. Although helical blades are shown herein, the rotational flow may be any surface structure along the inside of the convergent zone 301 that will promote rotational flow. Examples include but are not limited to, surface beads, surface impressions, surface etchings, ribs and combinations thereof.

With reference to Figure 5, there is provided top cutaway view of the exhaust gas inlet 110 modified such that the exhaust gas 111 is divided into two streams before entering the inlet side 121 of the scrubber device 100, resulting in a rotational flow of the exhaust gas and a turbulent zone in the scrubber.

Drains

The drain 200 from the marine exhaust gas scrubbing device 100 of the present disclosure is designed for gravity flow of 125% of the maximum pump flow through the nozzles of the device into the collector. In a most preferred embodiment the device has two separate compartments for the pre-treatment and primary treatment. Each compartment has its own drain (200 and 210 respectively) and is designed for maximum flow of the nozzles.

The marine exhaust gas scrubbing device of the present disclosure can also operate in "dry-mode" wherein no quenching, pre-treating, washing, mixing or demisting steps are employed. The device is constructed of a material that can resist in one embodiment an exhaust temperature of 265°C. The device, when in full operation, also has a backpressure less than about 150 mm (dry) and less than about 60 mm (wet). The complete unit including the exhaust piping and other equipment is below about 350 mm water column backpressure limit total for marine engines.

Optional Access for Inspection and Maintenance

Optionally included in the marine exhaust gas scrubbing device of the present disclosure are three external access panels in the side of the device and one internal access panel in the divider plate between the exhaust inlet 110 and exhaust outlet 120. Two of the external access panels are located above the demister ~~400~~ 420 for demister installation and access to the upper portion of the exhaust outlet end of the device. The third external access panel is located on the lower portion of the exhaust outlet of the device for access to the interior of the device, the impingement basket 700 and primary drain.

The exhaust inlet side 121 of the marine exhaust gas scrubbing device is accessed from the exhaust outlet side 122 by an access panel in the vertical divider 123 (See Fig. 3A-A) between the exhaust inlet and exhaust outlet sides of the device for access to the exhaust inlet elbow, the inlet drain and the nozzle headers. The spray nozzle lances are also accessible by removing the headers from flanged penetrations on the exhaust inlet side of the device. Inspection points are also provided in the access panel or the device body for visual inspection and temporary testing or sampling of the exhaust gas stream.

Soot Cleaning

Optionally, to insure minimal soot build-up in the device, the wetted portions of the internal walls of the device are continually washed through the pre-treatment 600 and primary 500 nozzle systems. In particular the nozzles 405 serve as soot cleaning nozzles as well. Additional washdown spray nozzles 310 are also provided in the top of the venturi component 300, below the demister 420 (see nozzle 400) and in the exhaust outlet 120 above the demister (see 410). These nozzles may be operated as needed to wash soot from these portions of the device.

Demister and Exhaust Outlet

Proximate the exhaust outlet 120 of the marine exhaust gas scrubbing device 100 of the present disclosure are three pass chevron-type demisters 420 designed to eliminate mist having a preferable diameter of about 25 microns. The demisters are preferably fabricated from 316L stainless steel and are installed in the device on a Z-shaped divider panel ~~420~~ approximately halfway up the exhaust outlet side 122. The demisters are installed through access panels in the sides of the device. The demisters are designed with a maximum velocity of about 5 metres per second and a maximum pressure drop of about 65 mm water column. The demister area is also fitted with an optional washdown spray system 400 to wash any soot or dried sodium hydroxide or salts from the demister vanes.

While the water droplets are largely eliminated by the demisters 420, the exhaust gas exiting the marine exhaust gas scrubbing device is generally saturated at a temperature range of from about 35°C to about 50°C. Some water vapour is expected to condense on the inside walls of the exhaust outlet compartment and elbow. The exhaust outlet and elbow are constructed from 316L stainless steel to prevent any problems with corrosion in these areas and any water condensed is expected to drain down through the demisters 420 and the demister support plates into the primary device drain 200. The saturated exhaust forms a white plume as the exhaust stream contacts the outside air.

Quenching, Pre-Treating and Washing Fluid

In one embodiment, the quenching, pre-treating and washing fluids are a mixture of seawater and aqueous sodium hydroxide. The sodium hydroxide is added to maintain maximum alkalinity between about pH 8 (0.1 mmol/l) and about pH 12 (10 mmol/l) and has a maximum sodium hydroxide concentration of about 0.04% by weight. The fluid solution at the maximum pH would be equivalent to "soapy water" and not considered hazardous to personnel or

equipment. By-products of the expected chemical reactions are not considered hazardous or

CLAIMS

1. A marine exhaust gas scrubbing device comprising:

a) an enclosure having a first end and a second end;

b) an exhaust gas inlet proximate said first end for accepting a high temperature exhaust gas comprising sulfur dioxide and particulate matter;

c) at least one quencher proximate the exhaust gas inlet for cooling the high temperature exhaust gas with at least one quenching fluid to give a cooled exhaust gas;

d) at least one pre-treater for pre-treating the cooled exhaust gas with at least one pre-treating fluid to give a pre-treated exhaust gas;

e) at least one venturi component comprising a venturi inlet for accepting the pre-treated exhaust gas and a venturi outlet for washing the pre-treated exhaust gas with at least one washing fluid to give a washed exhaust gas containing a plurality of washing fluid droplets and conveying the washed exhaust gas to the venturi outlet;

f) an impingement basket proximate the venturi outlet for providing additional mixing of the washed exhaust gas with the washing fluid;

g) at least one demister for removing the plurality of washing fluid droplets from the washed exhaust gas to form a demisted exhaust gas;

h) an exhaust gas outlet at said second end for exhausting said demisted exhaust gas; and

i) a receiver for receiving the at least one quenching fluid, the at least one pre-treating fluid and the at least one washing fluid.

2. The device of claim 1 wherein the at least one quenching fluid, the at least one pre-treating fluid and the at least one washing fluid are basic.

3. The device of claim ~~two~~ 2 wherein the at least one quenching fluid, the at least one pre-treating fluid and the at least one washing fluid comprise an aqueous alkali metal hydroxide solution, an aqueous alkaline earth metal hydroxide solution, and combinations thereof, wherein the aqueous alkali metal hydroxide solution is selected from the group consisting of lithium hydroxide, sodium hydroxide, potassium hydroxide, ~~an~~ the aqueous alkaline earth

metal hydroxide solution is selected from calcium hydroxide, magnesium hydroxide~~, and combinations thereof~~.

4. The device of claim 1 wherein the at least one venturi component is a concentric venturi further comprising a convergent-divergent passageway joining the venturi inlet with the venturi outlet.

5. The device of claim 3 wherein the alkali metal hydroxide is sodium hydroxide.

6. The device of claim 1 wherein the at least one quenching fluid, the at least one pre-treating fluid, and the at least one washing fluid have a pH of from about 8 to about 12.

7. The device of claim 1 wherein the enclosure, the at least one quencher, the at least one pre-treater, the at least one venturi, the impingement basket and the at least one demister are constructed of material resistant to a temperature of up to about 300°C.

8. The device of claim 1 further comprising a generator for generating the at least one quenching fluid, the at least one pre-treating fluid and the at least one washing fluid.

9. The device of claim 1 further comprising a distributor for distributing the at least one quenching fluid, the at least one pre-treating fluid and the at least one washing fluid.

10. The device of claim 1 further comprising a collecting receiver for receiving the at least one quenching fluid, the at least one pre-treating fluid and the at least one washing fluid.

11. The device of claim 1 further comprising a cooler for cooling the at least one quenching fluid, the at least one pre-treating fluid and the at least one washing fluid.

12. The device of claim 1 further comprising a cleaner for cleaning the at least one quenching fluid, the at least one pre-treating fluid and the at least one washing fluid.

13. A process for scrubbing marine exhaust gas comprising the steps of:

a) providing a high temperature exhaust gas comprising sulfur dioxide and particulate matter;

b) cooling the high temperature exhaust gas using a quenching fluid to give a cooled exhaust gas;

c) pre-treating the cooled exhaust gas using a pre-treating fluid to give a pre-treated exhaust gas;

d) washing the pre-treated exhaust gas using at least one venturi component comprising a venturi inlet for accepting the pre-treated exhaust gas and a venturi outlet for washing the pre-treated exhaust gas with a washing fluid to give a washed exhaust gas containing a plurality of washing fluid droplets and conveying the washed exhaust gas to the venturi outlet;

e) mixing the washed exhaust gas with the washing fluid using an impingement basket;

f) removing the plurality of washing fluid droplets from the washed exhaust gas to form a demisted exhaust gas;

g) exhausting the demisted exhaust gas; and

h) capturing the quenching fluid, the pre-treating fluid, and the washing fluid.

14. The process of claim 13 wherein the quenching fluid, pre-treating fluid and washing fluid are basic.

15. The process of claim 14 wherein the quenching fluid, pre-treating fluid and washing fluid comprises an aqueous alkali metal hydroxide, an aqueous alkaline earth metal hydroxide solution, and combinations thereof, wherein the aqueous alkali metal hydroxide solution is selected from the group consisting of lithium hydroxide, sodium hydroxide, potassium hydroxide, ~~an~~ the aqueous alkaline metal earth hydroxide is selected from calcium hydroxide, magnesium hydroxide.

16. The process of claim 15 wherein the alkali metal hydroxide is sodium hydroxide.

17. The process of claim 13 wherein the quenching fluid, the pre-treating fluid, and the washing fluid have a pH of from about 8 to about 12.

18. The process of claim 13 further comprising a process for generating the quenching fluid, the pre-treating fluid and the washing fluid.

19. The process of claim 13 further comprising a process for distributing the quenching fluid, the pre-treating fluid and the washing fluid.

20. The process of claim 13 further comprising a process for collecting the quenching fluid, the pre-treating fluid and the washing fluid.

21. The process of claim 13 further comprising a process for cooling the quenching fluid, the pre-treating fluid and the washing fluid.

22. The process of claim 13 further comprising a process for cleaning the quenching fluid, the pre-treating fluid and the washing fluid.

23. The device of claim 1 wherein said device is closed-loop.

24. The process of claim 13 wherein said process is closed-loop.