

CLAIMS

1. A wet inline scrubber (1) using alkali scrubber fluid for reducing the amount of SO_x in an exhaust gas produced by one or more engines of a marine vessel, comprising a vertically extending exhaust gas reaction tube (4), which comprises
- 5 - a lower scrubbing chamber (6) comprising
- a side inlet (2) for the exhaust gas produced by the one or more engines of the marine vessel,
- a plurality of scrubber fluid injectors (10) to inject alkali scrubber fluid in the exhaust gas present in the lower scrubbing chamber to partially scrub this exhaust gas, resulting in a
- 10 first used scrubber liquid,
- a drain (3) for used scrubber fluid at the bottom thereof,
- an upper scrubbing chamber (7) comprising
- an exhaust gas outlet (12) at the top thereof,
- a plurality of scrubber fluid injectors (10) to inject alkali scrubber fluid in the exhaust gas to
- 15 further scrub exhaust gas which has already partially been scrubbed in the lower scrubbing chamber, resulting in a second used scrubber fluid,
- wherein the lower scrubbing chamber (6) and the upper scrubbing chamber (7) are fluidically connected through a lower chamber exhaust gas outlet (8) guiding the partially scrubbed exhaust gas flowing from the lower scrubbing chamber (6) to the upper scrubbing chamber (7),
- 20 said lower chamber exhaust gas outlet (8) comprising a reverse funnel (30) extending from walls of the exhaust gas reaction tube (4) upwards and towards a central opening (8a), characterized in that along the circumferential border where the reverse funnel (30) is attached to the exhaust gas reaction tube (4), one or more slit-shaped openings (20) are provided that allow the second used scrubber fluid to flow from the upper scrubbing chamber
- 25 (7) to the lower scrubbing chamber (6) and that allow the second used scrubber fluid to flow over the side inlet (2) for the exhaust gas present in the lower scrubbing chamber (6).
2. A scrubber (1) according to claim 1, wherein the one or more slit-shaped openings (20) cover between 40% and 60% of the circumferential border where the reverse funnel (30) is attached to the
- 30 exhaust gas reaction tube (4).

3. A scrubber (1) according to claim 2, wherein the one or more slit-shaped openings (20) cover 50% of the circumferential border where the reverse funnel (30) is attached to the exhaust gas reaction tube (4).
- 5 4. A scrubber (1) according to any one of claims 1 to 3, wherein the lower chamber exhaust gas outlet (8) comprises two slit-shaped openings.
5. A scrubber (1) according to claim 4, wherein the lower chamber exhaust gas outlet (8) comprises a first slit-shaped opening (20) arranged at the side of the exhaust gas reaction tube (4) where the exhaust gas side inlet (2) is arranged and a second slit-shaped opening (20) is arranged at the opposite side thereof.
- 10 6. A scrubber (1) according to any one of claims 1 to 5, wherein the scrubber comprises a side tube (9) which is connected to the lower scrubber chamber (6) via the side inlet (2), wherein this side tube (9) is arranged with one or more alkali scrubber fluid injectors (10) to inject scrubber fluid in the exhaust gas coming from the one or more engines of the marine vessel.
- 15 7. A scrubber (1) according to any one of claims 1 to 6, wherein the upper scrubbing chamber (7) comprises a deflection body (11) which is arranged above the central opening (8a) of the lower chamber exhaust gas outlet (8).
- 20 8. A scrubber (1) according to claim 7, wherein the one or more scrubber fluid injectors (10) of the upper scrubbing chamber (7) are arranged above the deflection body (11).
- 25 9. A scrubber (1) according to any one of claims 1 to 8, wherein the lower scrubbing chamber (6) comprises only one drain (3) for used scrubber fluid arranged at the bottom thereof.
10. A scrubber (1) according to any one of the preceding claims, wherein the height of the scrubber (1) is between 8 m and 18 m, depending upon the size of the one or more engines of the marine vessel.
- 30 11. A method for scrubbing of exhaust gas produced by one or more engines of a marine vessel, wherein the exhaust gas is introduced into a wet inline scrubber (1) where the exhaust gas is scrubbed

in contact with alkali scrubber fluid for reduction of SO_x in the exhaust gas, the method comprising the steps of:

- introducing the exhaust gas from the one or more engines of the marine vessel via a side inlet (2) in a lower scrubbing chamber (6) of a vertically extending exhaust gas reaction tube (4);
- 5 - injecting alkali scrubber fluid in the exhaust gas present in the lower scrubbing chamber (6), thereby partially scrubbing the exhaust gas, and obtaining a first used scrubber liquid;
- withdrawing the partially scrubbed exhaust gas from the lower scrubbing chamber (6) and letting it flow into an upper scrubbing chamber (7) by passing it through a reverse funnel (30) extending from walls of the exhaust gas reaction tube (4) upwards and towards a central opening (8a);
- 10 - injecting alkali scrubber fluid in the partially scrubbed exhaust gas present in the upper scrubbing chamber (7), thereby further scrubbing the partially scrubbed exhaust gas, and obtaining a second used scrubber liquid;
- withdrawing the scrubbed exhaust gas from the upper scrubbing chamber (7) via an exhaust gas outlet (12) arranged at the top of the upper scrubbing chamber (7);
- 15 - flowing of the second used scrubber fluid from the upper scrubbing chamber (7) through one or more slit-shaped openings (20) arranged along the circumferential border where the reverse funnel (30) is attached to the exhaust gas reaction tube (4b);
- flowing of the second used scrubber fluid over the exhaust gas side inlet (2) present in the lower scrubbing chamber (6);
- 20 - withdrawing the used scrubber fluid from the lower scrubbing chamber (6) via a drain (3) for used scrubber fluid at the bottom of the lower scrubbing chamber (6).

12. A method according to claim 11, wherein the method further comprises the step of injecting alkali scrubber fluid in the exhaust gas from the one or more engines of the marine vessel which is flowing in a side tube (9) which is connected to the lower scrubbing chamber (6) via the side inlet (2).

13. A method according to claim 11 and 12, wherein the method comprises the step of injecting alkali scrubber fluid in the upper scrubbing chamber (7) above a deflection body (11).

14. A method according to any one of claims 11 to 13, wherein the method comprises the step of withdrawing the used scrubber fluid via only one drain (3) for used scrubber liquid at the bottom of the lower scrubbing chamber (6).

15. A method according to any one of claims 11 to 14, wherein a wet inline scrubber (1) is used which comprises:
- a lower scrubbing chamber (6) comprising
 - 5 ○ a side inlet (2) for the exhaust gas produced by the one or more engines of the marine vessel,
 - a plurality of scrubber fluid injectors (10) to inject alkali scrubber fluid in the exhaust gas present in the lower scrubbing chamber (6) to partially scrub this exhaust gas, resulting in a first used scrubber liquid,
 - 10 ○ a drain (3) for used scrubber fluid at the bottom thereof,
 - an upper scrubbing chamber (7) comprising
 - an exhaust gas outlet (12) at the top thereof,
 - a plurality of scrubber fluid injectors (10) to inject alkali scrubber fluid in the exhaust gas to further scrub exhaust gas which has already partially been scrubbed in the lower scrubbing
 - 15 chamber (6), resulting in a second used scrubber fluid,
- wherein the lower scrubbing chamber (6) and the upper scrubbing chamber (7) are fluidically connected through a lower chamber exhaust gas outlet (8) guiding the partially scrubbed exhaust gas flowing from the lower scrubbing chamber (6) to the upper scrubbing chamber (7), said lower chamber exhaust gas outlet (8) comprising a reverse funnel (30) extending from walls of the exhaust gas reaction tube (4)
- 20 upwards and towards a central opening (8a),
- wherein along the circumferential border where the reverse funnel (30) of the lower chamber exhaust gas outlet (8) is attached to the exhaust gas reaction tube (4), one or more slit-shaped openings (20) are provided that allow the second scrubber fluid to flow from the upper scrubbing chamber (7) to the lower scrubbing chamber (6) and that allow the second used scrubber fluid to flow over the inlet side (2)
- 25 for the exhaust gas present in the lower scrubbing chamber (6).
16. A method according to claim 15, wherein a scrubber according to any one of claims 2 to 10 is used.