

Method and Device for Engine Exhaust Gas Scrubbing

The invention relates to a method and device for engine exhaust gas scrubbing, in particular of a large engine, preferably a two stroke large Diesel engine.

From EP 1 230 969 A1, a method and device for exhaust gas scrubbing of a vehicle engine are known where the exhaust gas to be scrubbed is introduced into an oil bath without pretreatment by means of a perforated tube above which bath a perforated cover is located as a splash guard. Thus, a comparatively short contact time of the exhaust gas with the scrubbing liquid formed here by oil occurs which may have an unfavourable effect for take-over of the contaminants contained in the exhaust gas by the scrubbing liquid. Moreover, comparatively large gas bubbles occur in the oil bath, which only on its surface get into contact with the scrubbing liquid, but include a comparatively large gas volume which still increases the above mentioned disadvantage. Therefore, only a comparatively small cleaning effect is to be achieved.

Therefore, it is the object of the present invention to provide a method of the above type which ensures a high degree of scrubbing. It is another object of the present invention to provide a device for performance of the method according to the invention, which is of simple design and permits achievement of optimum process results.

These objects are achieved by the features of the independent claims 1 and 11.

The fine droplets of the scrubbing liquid introduced into the exhaust gas capture and bind the solid particles contained in the exhaust gas and the gases to be scrubbed from the exhaust gas, with a comparatively lot of time being available for these processes due to an early central admission of dispersed scrubbing liquid into the exhaust gas so that the contaminants contained in the exhaust gas are

reliably absorbed by the scrubbing liquid. In the subsequent passage of the aerosol flow comprised of exhaust gas and dispersed scrubbing liquid through the scrubbing liquid bath, the liquid portion of the aerosol introduced is already largely absorbed, with the particles absorbed by it and the scrubbed gases passing over
5 to the scrubbing liquid in the scrubbing liquid bath, and being discharged with it. The receptacle taking the scrubbing liquid bath gets permanent liquid supply by the dispersed scrubbing liquid introduced into the gas to be scrubbed, so that the contents of the receptacle are permanently renewed and the contaminants collected from it are reliably discharged. A high degree of scrubbing can therefore
10 be expected from the measures according to the invention.

Advantageous embodiments and adequate further embodiments of the generic measures are indicated in the dependent claims and are described more in detail in the subsequent description of an example by means of the drawing.

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In the accompanying drawing:

- Figure 1 shows a longitudinal sectional view of an exhaust gas scrubbing device according to the invention,
- 20 Figure 2 shows a section along line II/II in figure 1,
- Figure 3 shows a section of a sump provided for collecting a scrubbing liquid bath,
- Figure 4 shows the assembly according to figure 3 in operation,
- Figure 5 shows a sump assembly of a scrubbing device according to the
25 invention installed, for example, on a ship, which is inclined relative to the horizontal,
- Figure 6 shows a schematic view of a two stroke large Diesel engine with exhaust gas recirculation and scrubbing,
- Figure 7 shows a schematic view of a two stroke large Diesel engine with a
30 scrubbing device built into the exhaust pipe,

- Figure 8 shows an alternative of figure 1,
Figure 9 shows an example of a Venturi assembly assigned to a pipe socket,
Figure 10 shows an alternative of figure 9 with internal flow body,
Figure 11 shows an alternative of figure 10,
5 Figure 12 shows a vertical section of the bottom end of a pipe socket with assigned valve body and
Figure 13 shows a plan view of the valve body according to figure 12.

The main field of application of the present invention are large engines, in particular two stroke large Diesel engines, as they can be used, for example, as propulsion systems for ships or for stationary power stations or similar.

The exhaust gas scrubbing device, which is the object of figures 1 and 2, contains a barrel-type receptacle 1 which is received on a supporting frame 1a provided with feet. The receptacle 1 comprises an exhaust gas inlet 2 located on the front side and an exhaust gas outlet 3 discharging here towards the top, and is provided with a water outlet 4 on the lower side. The exhaust gas inlet 2 is connected with a supply line 50 chargeable with exhaust gas.

20 The barrel-type receptacle 1 is comprised of a cylindrical centre portion which is closed by two lids flanged on the front side. The exhaust gas inlet 2 is located here in the upper area of a frontal lid. The exhaust gas outlet 3 is located here approximately in the centre of the vertex area of the cylindrical centre portion. Advantageously, in the area of the centre portion and/or the lids at least one, preferably several portholes 5 are provided via which what happens inside the receptacle 1 can be observed from outside.

The inherent pressure of an exhaust gas leaving an engine and/or its exhaust turbo charger is supposed to be sufficient in the present example in order to flow through the receptacle 1. In the present example it is therefore defined as a pressure vessel which resists to the high exhaust gas pressure. Additional
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conveying means for the exhaust gas are not required here.

In the upper area of the internal space 6 of receptacle 1, an assembly with at least one horizontal distribution pipe 7 is provided, which extends approximately over
5 the length of the centre portion of receptacle 1 and communicates with the exhaust gas inlet 2. In the example shown, several, here three, parallel distribution pipes 7 adjacent to each other are provided, as can best be seen in figure 2, which are connected with the exhaust gas inlet 2 via a distributor piece 8 coupled to the exhaust gas inlet 2 and provided with a corresponding number of connecting
10 sockets. From each distribution pipe 7 several branch sockets 9 distributed over its length and defined by vertical pipe sockets branch off towards the bottom which each take up a partial flow of the exhaust gas volume flow fed to the associated distribution pipe 7. In the example shown, as can be seen in figure 2, the branch sockets 9 branching off towards the bottom from the three distribution pipes 7 are
15 located each in the form of rows extending transversely to the receptacle axis.

In the embodiment shown with division of the exhaust gas flow taking place within the receptacle 1 to the branch sockets 9, the distribution pipes 7 can advantageously act as heating elements which can release heat to a medium
20 passing by, for example the scrubbed exhaust gas flowing towards the exhaust gas outlet 3. But in many cases this is not desired or necessary. In such cases, division of the exhaust gas flow can also occur to the individual branch sockets 9 also outside receptacle 1. The distribution pipes 7 connected with the supply line 50 via the distributor piece 8 can be located outside the receptacle 1 in that case.
25 The branch sockets 9 branching off from the distribution pipes 7 are introduced into the internal space 6 of the receptacle 1 through a receptacle wall in that case.

The exhaust gas supplied to the branch sockets 9 is charged with a dispersed scrubbing liquid virtually creating a kind of mist or aerosol out of exhaust gas and
30 dispersed scrubbing liquid. In this way, a large surface of scrubbing liquid is

- created where the exhaust gas gets into contact with the scrubbing liquid which promotes the desired cleaning of the exhaust gas. Charging the exhaust gas with dispersed scrubbing liquid can, for example, occur centrally in the area of the supply line 50 close to the receptacle, or locally, for example in the area of the distribution pipes 7 and/or preferably in the area of the branch sockets 9. For central charging of the exhaust gas with dispersed scrubbing liquid, a feeding device 51 associated with the supply line 50 is proposed in figure 1 which includes here one or several spray nozzles 52 for spraying in scrubbing liquid.
- 10 The scrubbing liquid can advantageously be water but also salt water or brackish water with or without the addition of chemicals. In any case, the scrubbing liquid is such that during the entire scrubbing process only little or preferably no foam at all occurs.
- 15 In the example shown, in addition to the central feeding device 51, also local feeding devices 51a associated with the branch sockets 9 are provided, with part of the scrubbing liquid being introduced by means of the central feeding device 51 and the remainder by means of the local feeding devices 51a. In the example shown, spray nozzles 10 located in the upper region of the branch sockets 9 are associated with the branch sockets 9 which spray nozzles are chargeable with scrubbing liquid. The spraying direction of the spray nozzles 10 and/or 52 is coincident with the flow direction of the exhaust gas flowing past so that virtually a co-current or parallel flow treatment occurs. For formation of the spray nozzles 10 and/or 52, pressure spray nozzles can be provided which atomise the scrubbing liquid supplied into very fine, tiny droplets. The spray nozzles 10 and/or 52 can perhaps be arranged centrally in the correspondingly associated flow channel, i.e. in the branch sockets 9 and/or the supply line 50. But of course it would also be possible to provide several spray nozzles each distributed over the cross section.
- 30 The spray nozzle 52 located in the supply line 50 is mounted on an arm 53

extending into the supply line 50 which can advantageously be formed at the same time as a feed line for supplying the associated spray nozzle 52 with biased scrubbing liquid. The spray nozzles 10 located in the branch sockets 9 are each placed at the lower end of an injector 11 interpenetrating the associated distribution pipe 7 and extending into the upper region of the associated branch socket 9 and coaxial to the latter. The injectors 11 are likewise advantageously formed as feed lines associated with the nozzles 10 chargeable with biased scrubbing liquid.

10 In addition or alternatively to use of atomising nozzles, also by means of a Venturi assembly dispersion of scrubbing liquid in the exhaust gas can be achieved. For this purpose, the supply pipe 50, as is shown in figure 8, can be provided with a flow throttle 54 accelerating the exhaust gas flow which flow throttle is associated with a supply device 55 located above the throttle for feeding scrubbing liquid.

15 Said supply device 55 can be provided with nozzles or formed without nozzles. For formation of the flow throttle 54, the supply line 50 is provided with a corresponding wall neck-in 56. As a result of the change of direction and acceleration of the exhaust gas occurring in the area of the flow throttle 54, a very good distribution of the scrubbing liquid supplied is obtained.

20 In a similar way, the pipe sockets forming the branch sockets 9 can each also be associated with a Venturi assembly. As is shown in figure 9, the branch sockets 9 can also be provided with a flow throttle 54 for this purpose which is associated with a supply device located above for feeding scrubbing liquid. For formation of the supply devices associated with the branch sockets 9, injectors 11 of the type already mentioned in connection with figure 1 and provided with a central supply duct 57 are used. The injectors 11, however, are not provided with a nozzle 10 here at their lower end. Rather, the supply duct 57 of the injectors 11 is open at the bottom. In the example, which is the basis of figure 9, the flow throttle 54 is

30 formed by a wall neck-in 56 similar to the embodiment according to figure 8.

An alternative embodiment is shown in figure 10. Here, a flow body 58 preferably centrally located in the flow channel, here in the branch socket 9, is used for formation of a flow throttle 54a. Said flow body has advantageously the form of a streamlined arrow directed towards the bottom. By means of the flow body 58 likewise a deflection and acceleration of the exhaust gas flowing past can be obtained. The flow body 58 can advantageously be mounted at the lower end of an injector 11 extending into the associated branch socket 9. Said injector is advantageously provided with outlet ports 59 adjacent to the flow body 58 and radially extending from its central supply duct 57. In the embodiment according to figure 10, the outlet ports 59 are located in the area of the lower end of injector 11. Of course, it would also be imaginable to provide the outlet ports 59 in the area of the flow body 58. Such an embodiment is shown in figure 11. The supply duct 57 of course extends here up to the outlet ports 59 and into the flow body 58. Moreover, the embodiment according to figure 11 corresponds to the arrangement according to figure 10.

The flow body 58 can be formed in one part or several parts. The flow body 58 can also be formed in one part with the associated injector 51 or attached to it. The surface of the flow body 58 can advantageously be provided with a wear resistant protective layer which can be a welded-on or melted-on layer. The protective layer can advantageously be composed of glass so that a very low flow resistance occurs. An internal Venturi assembly of the type shown in figures 10 and 11 can of course also be provided for formation of a central feeding device 51 in the area of the supply line 50.

Below the branch sockets 9 at least one sump 12 is located into which the branch sockets extend with their lower open ends as can be seen best in figure 2. Advantageously, an own sump 12 each is allocated to each branch socket 9, with the sumps 12 allocated to the adjacent branch sockets 9 forming a row of the

above mentioned type being able to be connected into a continuous cassette 13 over the width of the internal space 6. Continuous cassettes 13 in longitudinal direction can be provided as well.

- 5 One valve body 14 each is allocated to the open lower end of the branch sockets 9 which valve body can be adequately adjusted. By it, the clearance between the valve body 14 and the lower end of the associated branch socket 9, and thus the available cross-sectional flow area can be adjusted. Adjustment is advantageously made such that the exhaust gas volume flow through all branch sockets 9 is
10 identical. As is best shown in figure 3, the adjustable valve body 14 is received on a rod 15 coaxially to the associated branch socket 9 which rod is fixed with its upper end on at least one strut 16 attached to the inner wall of the associated branch socket 9. Of course, also several struts offset from each other in height and/or circumferentially can be provided. The rod 15 can be formed as a threaded
15 rod onto which nuts 17 fixing the associated valve body 14 can be screwed by means of which adjustment of the valve body 14 is possible.

The valve bodies 14 associated with the open lower end of the branch sockets 9 cause a radial flow deflection, i.e. the volume flow arriving in the direction of the
20 axis of the branch sockets 9 is distributed radially in all directions. As is shown in figure 12, the valve bodies 14 comprise a conoid core 14a the upper side of which is formed by a surface of revolution formed by a generatrix bent concavely towards the bottom. This results in a curved transition from the axial, here vertically extending direction to the radial, here horizontally extending direction. The upper
25 side of the core 14a is advantageously occupied with radially extending blades which are equidistantly spaced from each other in circumferential direction so that a uniform distribution around the circumference occurs.

As is shown further in figure 12, the upper edge 61 of the blade 60 extends
30 starting from the peak of the conoid core 14a horizontally or here slightly inclined

towards the outside so that the height of the blades 60 increases from radially inside to radially outside. As is shown in figure 13, the blades 60 can be bent across their length. In this way, an especially good swirl of the volume flow deflected into the radial direction can be obtained.

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The inert forces imposing on the mass-carrying droplets, which are accelerated in radial direction on the deflection caused by the valve body 14, counteract a change of direction and result here already in a separation of droplets from the deflected volume flow. This concerns in particular the heavy droplets. The
10 separated droplets are virtually absorbed by the circumfluent scrubbing liquid in the sump 12.

The sumps 12 are each divided by an intermediate bottom 18 penetrated by each associated branch socket 9 into a lower compartment 19 into which the associated
15 branch socket 9 leads with its lower, open end, and in which the valve body 14 is located, and into an upper compartment 20. In operation, not only in the lower compartment 19 but also in the upper compartment 20 scrubbing liquid exists. Each sump 12 contains accordingly a scrubbing liquid bath split by the intermediate bottom 18. The intermediate bottom 18 is formed as a gas and liquid
20 permeable, extensive retaining element which contains a large number of narrow passages distributed over its surface between the lower compartment 19 and the upper compartment 20 and accordingly between the lower and upper part of the scrubbing liquid bath. For this, the retaining element forming the intermediate bottom 18 can be formed as a single or multiple layer grid and/or network of a
25 close-meshed grid or mesh or wire cloth or expanded metal or as a similar permeable structural element and/or structural element package assembly, e.g. out of metal and/or plastic foam. As is further shown in figure 3, the intermediate bottom 18 is supported on the border upon sump-fix supporting strips 21 and fixed from the top by means of a box or bushing 23 encompassing the associated
30 branch socket 9 and fixable to it by screws 22.

Between the intermediate bottom 18 and the supporting strips 21 a spacing element assembly 21a of adequate height, e.g. in the form of strips resting upon the supporting strips 21 or a frame etc. resting upon the supporting strips 21, can be provided. By means of the spacing element assembly the position of the intermediate bottom 18 relative to the lower end of the associated branch socket 9 can be finely adjusted.

In operation, the device according to the invention is charged with exhaust gas which can be more or less pressured and which is distributed onto the branch sockets 9 and flows through all scrubbing stations under the effect of its inherent pressure. At the same time the liquid feeding devices 51, 51a are charged with a hardly foaming or preferably non-foaming scrubbing liquid, advantageously in the form of water, which is dispersed by atomising nozzles and/or Venturi effect so that very fine droplets are formed, and a mist and/or aerosol is created in the end area of the supply line 50 close to the receptacle and in the branch sockets 9. By these spray treatments in a first treatment step the solid contaminants contained in the exhaust gas, which form condensation nuclei, are captured by the scrubbing liquid droplets, here the water droplets, and entrained by them. Likewise, the gases contained in the exhaust gas and removable by scrubbing are removed by the water droplets and entrained by these.

The volume flow discharged from the branch sockets 9 in the form of the exhaust gas-water-mixture and/or aerosol formed is introduced into the scrubbing liquid bath contained in the associated sump 1. As can be seen from the flow arrows in figure 4, a radical deflection from the vertical direction to the horizontal direction results here by the valve body 14, with the scrubbing liquid contained in the lower compartment 19 being displaced from the area adjacent to the intermediate

bottom 18 as is suggested in figure 4 by an irregular surface 24. Simultaneously, a larger part of the droplets penetrates into the scrubbing liquid contained in the lower compartment 19 and is absorbed by it. The exhaust gas with the remainder of the water droplets is present at the lower side of the retaining element formed by the intermediate bottom 18 in the form of a cushion 25 and gets into the upper compartment 20 via the fine passages of the retaining element, with the water droplets still getting through being absorbed by the scrubbing liquid present there, and the exhaust gas in the form of fine, small bubbles and/or beads 26 bubbling towards the top, with residual contaminants still contained in the exhaust gas being captured by the scrubbing liquid and passing over into it.

For filling the sumps 12 with scrubbing liquid, a feeding device (not shown) is advantageously associated with the sumps 12. In operation, the liquid filling of the sumps 12 in the form of the scrubbing liquid dispersed in the exhaust gas, is constantly being replenished resulting in a permanent renewal of the scrubbing liquid in the sumps 12. The sumps 12 are accordingly provided with a drain hole 27 on the bottom which is advantageously located at the lowest point in the inclined sump bottom. The drain hole 27 is dimensioned such that less scrubbing liquid can be discharged via it than is being replenished. The excess is discharged via the upper edges of the sumps 12, which accordingly form overflow edges 28, as is shown in figure 4. The scrubbing liquid flowing off from the sumps 12 towards the bottom and/or flowing over via the overflow edges 28 is collected in the lower area of the internal space 6 of the pressure vessel 1 and is flowing off via the outlet 4 exiting towards the bottom.

The exhaust gas bubbling through the upper compartment 20 and rising from said compartment can still entrain particles in the form of contaminants, water droplets and the like. In order to remove these particles to a large extent, another single-stage or multi-stage separation takes place above the sumps 12. In the example shown in figure 1, the separation is a single-stage separation. For this purpose, a

deflector shield 29 penetrated by the branch sockets 9 with degree of freedom of movement is provided, the lateral edges of which form gap-like, lateral flow passages 30 with the adjacent side walls of the pressure vessel 1. The exhaust gas rising from the sumps 12 is accordingly led alongside the lower side of the deflector shield 29 approximately horizontally and radially towards the outside and deflected there, resulting in a separation of mass-carrying particles by the effect of centrifugal force. To reinforce deflection, the lateral flanks of the deflector shield 29 can be bent towards the bottom, as is shown in figure 2. The deflector shield 29 is advantageously located on the average height of the barrel-type pressure vessel 1 where the greatest clearance exists, so that the exhaust gas subsequent to the lateral flow passages 30 mentioned is lead inside again through the wall of the pressure vessel 1 which even increases the deflection effect. Due to the deflection, water droplets entrained by the exhaust gas are centrifuged radially outside and are discharged towards the bottom alongside the pressure vessel 1 wall. In order to make sure that no water droplets can be entrained up to the exhaust gas outlet 3, above the flow passages 30, drop catch strips 31 projecting from the interior wall surface of the pressure vessel 1 towards the inside are provided which are advantageously inclined towards the bottom.

In the example shown in figure 8 a two-stage separation above the sumps 12 is intimated. For this purpose, a separating element 62 made out of a material permeable for exhaust gas is located upstream of the deflector shield 29. The separating element 62 can be a plate-shaped element as is shown in the example, and is advantageously located in the receptacle 1 without any gaps. For formation of the separating element 62, porous and/or crosslinked material can be used having irregular transit paths for the medium penetrating it so that there is a high probability that mass-carrying particles strike against edges etc. and are thus captured.

It would also be imaginable to provide a single-stage separation above the sumps

12 only by using one separating element 62. In that case, the deflector shield 29 provided above the separating element 62 could be omitted. But it would also be imaginable to arrange several separating elements 62 one after another with it being possible that at least one is formed as a deflector shield.

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The exhaust gas passing the flow passages 30 flows close to the walls past the distribution pipes 7 to the exhaust gas outlet 3 which is provided in figure 1 in the vertex area of the pressure vessel 1. But the exhaust gas outlet can also occur on the front as is intimated in figure 8 at 3a. The distribution pipes 7, which are
10 charged inside with fresh exhaust gas, can act as heating tubes on which the exhaust gas flowing past is heated. In order to increase this effect, the distribution pipes 7 can be provided with radiators on the outside. The exhaust gas discharged via the exhaust gas outlet 3, 3a can either be used for exhaust gas recirculation and/or supplied to an exhaust pipe.

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Large engines of the type mentioned above are often used as propulsion systems for ships. Ships lying in the water can tilt laterally, which may also result in tilting of the inventive device and in particular the sumps 12, as is intimated in figure 5. If an own sump 12 is associated with each branch socket 9, as is shown in the
20 example, there will be many, comparatively small sumps 12 so that even in the event of a comparatively large tilt, the lower, open end of each branch socket 9 normally is deep enough below the liquid level in the associated sump 12, as is clearly shown in figure 5. Insofar as this is no longer guaranteed and/or if the loss of scrubbing liquid is too great, the sumps 12 are replenished which is possible
25 rapidly and easily by means of the scrubbing liquid feeding device associated with the sumps 12.

To simplify the erection, the adjacent sumps associated with a row of branch sockets 9 located transversely to the receptacle axis, can be combined into a common cassette 13, as already mentioned above, which cassette is divided into
30 individual sumps by intermediate walls 32, as is best shown in figure 2. The

cassettes located one after another in the direction of the receptacle axis can advantageously be spaced apart from each other. But it would also be imaginable to combine the sumps located one after another in the direction of the receptacle axis into common cassettes continuous over the receptacle length and which are
5 laterally spaced apart from each other. The intermediate walls 32 are in any case advantageously provided with overflow orifices 33 in the area between the upper side of the intermediate bottom 18 and its upper edge. Via said overflow orifices a liquid exchange can occur between adjacent sumps. By this it is guaranteed that independent of the liquid replenishment, approximately the same liquid level is
10 achieved in all adjacent sumps. The position of the overflow orifices 33 is selected such that also in the event of the largest tilt, the intermediate bottom 18 acting as a retaining element is covered with scrubbing liquid over the entire surface and accordingly also the open, lower end of the branch sockets 9 is entirely overflowed, as is clearly shown in figure 5.

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As is further shown in figure 3, the cassettes 13 are provided with lateral support strips 34 which can be placed upon holding strips 35 provided on the receptacle. Advantageously, the support strips 34 and/or holding strips 35 can be located adjustable in height so that the immersion depth of the branch sockets 9 is
20 likewise adjustable.

Figures 6 and 7 show application examples of the multi-stage exhaust gas scrubbing device described above. As already mentioned, a preferred application is scrubbing of the exhaust gas used for exhaust gas recirculation, i.e. of exhaust
25 gas added again to the fresh charge air supplied to the engine for reduction of NO_x and/or SO_x -output of an engine. Such an application is shown in figure 6 where a large engine intimated in the form of a cylinder is shown in the form of a two stroke large Diesel engine 36. The exhaust connection 37 extending from the working area of the cylinder and controllable by an exhaust valve opens out into an
30 exhaust gas header 38 passing via all cylinders. In the bottom area of the cylinder

barrel, inlet slots 39 are provided via which charge air is supplied to the working area at lowered piston. An exhaust gas turbo charger 40 is associated with the engine, the turbine of which is operated with exhaust gas and the compressor of which supplies the precompressed charge air. Accordingly, the turbine of the exhaust gas turbo charger 40 is connected with the exhaust gas header 38 via an exhaust gas pipe 41. From the compressor outlet a charge air pipe 42 is leading to the inlet slots 39. Exhaust gas is added to the charge air. For this purpose, a recirculation line 43 branches off from the exhaust gas pipe 41 which opens out into the charge air pipe 42 or, as is intimated by means of a dashed line, into the intake socket of the compressor of the exhaust gas turbo charger 40. The exhaust gas scrubbing device, intimated by the pressure vessel 1, is integrated into the recirculation line 43 for scrubbing of the exhaust gas. Here, only that portion of the exhaust gas is scrubbed which is used for recirculation.

But it would also be imaginable to scrub the entire exhaust gas prior to emission into the environment. Such an embodiment is shown in figure 7. Here, the exhaust gas scrubbing device intimated by the pressure vessel 1 is built into an exhaust pipe 44 extending from the turbine outlet of the exhaust gas turbo charger 40 and opening out into the environment. Moreover, the engine layout corresponds to the arrangement of figure 6.

In the examples shown in figures 6 and 7 an individual, own, inventive device for exhaust gas scrubbing is each associated with each internal combustion engine. But it would also be imaginable to associate one common inventive device for exhaust gas scrubbing with an arrangement of several internal combustion engines. Likewise it would be imaginable to associate several inventive devices for exhaust gas scrubbing with one internal combustion engine. Another possibility is to use the scrubbed exhaust gas contrary to the embodiments of figures 6 and 7 only partly for exhaust gas recirculation and to discharge the remainder as exhaust gas. This applies not only to assemblies installed aboard a ship but also to

stationary assemblies.

Some embodiments and application examples are explained above in detail which are, however, non-limitative. Rather, a number of possibilities is available to the
5 person skilled in the art in order to adjust the general spirit of the invention to the conditions of the individual case.

CLAIMS

1. A method for engine exhaust gas scrubbing, in particular for at least one large engine, preferably a two stroke large Diesel engine, with an admission of dispersed scrubbing liquid into the exhaust gas taking place at first and subsequently a volume flow formed of exhaust gas and dispersed scrubbing liquid being sent through a scrubbing liquid bath contained in a receptacle (1) which is divided by a gas and liquid permeable retaining element (18), with the volume flow formed by the exhaust gas and dispersed scrubbing liquid being introduced into the area of the scrubbing liquid bath located below the retaining element (18) and bubbling through the area of the scrubbing liquid bath located above the retaining element (18) from here, **characterized in that** at least a part of the dispersed scrubbing liquid to be supplied to the exhaust gas is supplied to an overall exhaust gas flow not yet divided into partial flows.
2. A method according to claim 1, **characterized in that** the exhaust gas prior to introduction into the scrubbing liquid bath is divided into partial flows, and that part of the dispersed scrubbing liquid to be supplied to the exhaust gas is at least supplied to the exhaust gas partial flows.
3. A method according to any one of the preceding claims, **characterized in that** admission to the exhaust gas occurs at least with part of the dispersed scrubbing liquid by Venturi effect.
4. A method according to any one of the preceding claims, **characterized in that** each volume flow formed by exhaust gas and dispersed scrubbing liquid when being introduced into the scrubbing liquid bath is radially deflected with respect to the feeding direction.
5. A method according to any one of the preceding claims, **characterized in that** as a scrubbing liquid a non-foaming liquid, preferably water with or without chemicals is used.

6. A method according to any one of the preceding claims, **characterized in that**
above the scrubbing liquid bath, which absorbs the scrubbing liquid portion of
the introduced volume flow at least to a large extent, an at least single-stage
separation of liquid particles entrained by the exhaust gas rising from the
5 scrubbing liquid bath occurs.
7. A method according to claim 6, **characterized in that** the separation of liquid
particles taking place above the scrubbing liquid bath is carried out at least
partially by using a separating element (62) permeable for the exhaust gas.
8. A method according to claim 6 or 7, **characterized in that** the separation of
10 liquid particles taking place above the scrubbing liquid bath is carried out at
least partially by the effect of centrifugal force.
9. A method according to claim 8, **characterized in that** the separation by
centrifugal force effect takes place after the separation by means of the
separating element (62).
- 15 10. A method according to any one of the preceding claims, **characterized in that**
the scrubbed exhaust gas at least partially is used for exhaust gas recirculation
in an associated engine and/or is discharged into the environment.
11. A device for performance of the method according to at least any one of the
preceding claims,
20 comprising at least a feeding device (51, 51a) for charging the exhaust gas
flowing past with dispersed scrubbing liquid,
comprising at least a sump (12) open towards the top, located in a receptacle
(1) and containing a scrubbing liquid bath,
comprising at least an intermediate bottom formed as a gas and liquid
25 permeable retaining element (18) which divides the sump (12) into a lower
compartment (19) with scrubbing liquid and an upper compartment (20) with
scrubbing liquid, and
comprising at least a branch socket (9) chargeable with exhaust gas,

- extending into a sump (12) and penetrating the retaining element (18),
characterized in that at least a feeding device (51) chargeable with scrubbing
liquid for charging the exhaust gas flowing past with dispersed scrubbing liquid
is associated with a supply line (50) through which an overall exhaust gas flow
5 not yet divided into partial flows can pass.
- 12.A device according to claim 11, **characterized in that** each branch socket (9)
immersing into a sump (12) and chargeable with a partial exhaust gas flow is
associated at least with a feeding device (51a) chargeable with scrubbing liquid
10 for charging the exhaust gas flowing past with dispersed scrubbing liquid.
- 13.A device according to claim 11 or 12 **characterized in that** at least one feeding
device (51, 51a) for charging the exhaust gas with dispersed scrubbing liquid is
formed as a Venturi assembly which comprises a flow throttle (54, 54a)
accelerating the gas flow and comprises at least a supply device chargeable
15 with scrubbing liquid associated with it.
- 14.A device according to claim 13, **characterized in that** for formation of a flow
throttle (54) a neck-in on the circumference (56) of the associated flow channel
is provided.
- 15.A device according to claim 14, **characterized in that** for formation of a flow
20 throttle (54a) at least a flow body (58) circulated by the exhaust gas is located in
the associated flow channel.
- 16.A device according to claim 15, **characterized in that** the flow body (58) is
provided with a protective layer on its surface.
- 17.A device according to any one of the preceding claims 15 or 16, **characterized**
25 **in that** the flow body (58) is mounted on a coaxial injector (11) extending into
the associated flow channel.
- 18.A device according to any one of the preceding claims 13 to 17, **characterized**

- in that** the supply device associated with a flow throttle (54, 54a) and chargeable with scrubbing liquid is associated with an injector (11) extending into the associated flow channel and/or with a flow body (58) mounted on the injector (11).
- 5 19.A device according any one of the preceding claims 11 to 18 **characterized in that** a valve body (14) causing a radial flow deflection is associated with the bottom end of each branch socket (9) immersing into a sump (12).
- 20.A device according to claim 19, **characterized in that** the valve body (14) can be adjusted relative to the bottom end of the associated branch socket (9).
- 10 21.A device according to claim 19 or 20, **characterized in that** the valve body (14) on its upper side facing towards the associated branch socket (9) is provided with radially extending blades (60).
- 22.A device according to claim 21, **characterized in that** the blades (60) are bent across their length.
- 15 23.A device according to claim 21 or 22, **characterized in that** the height of the blades (60) increases from radially inside to radially outside.
- 24.A device according to any one of the preceding claims 21 to 23, **characterized in that** the valve body (14) comprises a conoid core (14a) which bears the blades (60) on its upper side.
- 20 25.A device according to any one of the preceding claims 11 to 24, **characterized in that** above each sump (12) a separating device for separating fluid particles entrained by the exhaust gas rising from the scrubbing bath is provided which comprises at least a separating element (62) out of a material permeable for exhaust gas located above an associated sump.
- 25 26.A device according to any one of the preceding claims 11 to 25, **characterized in that** a separating device provided above each sump comprises at least a

deflector shield (29) preferably downstream of a separating element (62) permeable for exhaust gas, the lateral edges of which form flow passages (30) with the adjacent receptacle walls.

27.A device according to claim 25 or 26, **characterized in that** at least one
5 separating element (62) is formed as a deflector shield.

28.A device according to claim 26 or 27, **characterized in that** the deflector shield (29) is located on an average receptacle height.

29.A device according to any one of the preceding claims 26 to 28, **characterized in that** on the lateral receptacle walls above the flow passages (30), drop catch
10 strips (31) extending inwardly are located.

30.A device according to any one of the preceding claims 25 to 29, **characterized in that** the separating element (62) is composed of a porous and/or crosslinked material.

31.A device according to any one of the preceding claims 11 to 30, **characterized in that** several branch sockets (9) chargeable with a partial exhaust gas flow
15 are provided which immerse into a sump (12).

32.A device according to claim 31, **characterized in that** several sumps (12) are provided into which each an associated branch socket (9) or an associated group of branch sockets (9) is immersed.

20 33.A device according to any one of the preceding claims 11 to 32, **characterized in that** sump cassettes (13) extending in longitudinal direction and/or transverse direction of the receptacle (1) and divided into individual sumps (12) by intermediate walls are provided.

25 34.A device according to claim 33, **characterized in that** the receptacle (1) is provided inside with holding strips (35) upon which the sump cassettes (13) can be supported, which are provided with lateral support strips (34), and that the

height distance between the support strips (34) and the holding strips (35) can be adjusted and fixed.

35.A device according to claim 33 or 34, **characterized in that** the intermediate walls in the area of the upper compartment (20) comprise overflow orifices (33).

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36.A device according to any one of the preceding claims 11 to 35, **characterized in that** a supply device for the supply of scrubbing liquid is associated at least with part of the sumps (12), preferably with each sump (12).

10 37.A device according to any one of the preceding claims 11 to 36, **characterized by** an assembly with at least one distribution pipe (7) communicating with the supply line (50) from which several branch pipes formed by a branch socket (9) branch off towards the bottom and extend into a sump (12).

15 38.A device according to claim 37, **characterized in that** several distribution pipes (7) located in parallel side by side are provided, from which branch pipes formed by a branch socket (9) each and located side by side in a row in transverse direction extend towards the bottom

39.A device according to claim 37 or 38, **characterized in that** the distribution pipe assembly comprising at least one distribution pipe (7) is located in the receptacle (1).

20 40.A device according to any one of the preceding claims 11 to 39, **characterized in that** the receptacle (1) is defined as a pressure vessel.

25 41.A device according to any one of the preceding claims 11 to 40, **characterized in that** the distribution pipe (7) and/or the distribution pipes (7) is and/or are located in the upper region of the receptacle (1) below the exhaust gas outlet (3) extending towards the top.

- 42.A device according to any one of the preceding claims 11 to 41, **characterized in that** the retaining element (18) is formed as a single or multiple layer network and/or grid or as a metal foam or plastic foam body.
- 5 43.A device according to any one of the preceding claims 11 to 42, **characterized in that** the retaining element (18) borders are supported on supporting strips (21) of the associated sump (12) and is held from the top by means of at least one bushing (23) fixable on the associated branch socket (9).
- 10 44.A device according to at least one of the preceding claims 11 to 43, **characterized in that** an own sump (12) is associated with each branch socket (9).
- 45.A device according to at least one of the preceding claims 11 to 44, **characterized in that** the sumps (12) comprise upper overflow edges (28) and/or a drain hole (27) provided on the bottom, and that the receptacle (1) is provided with a liquid outlet (4) discharging towards the bottom.
- 15 46.A device according to at least one of the preceding claims 11 to 45, **characterized in that** the receptacle (1) is integrated into an exhaust gas recirculation line (43) of a large engine provided with an exhaust gas recirculation device, in particular a two stroke large Diesel engine.
- 20 47.A device according to at least one of the preceding claims 11 to 45, **characterized in that** the receptacle (1) is integrated into an exhaust pipe (44) of a large engine, in particular a two stroke large Diesel engine, which opens out into the environment.
- 25 48.A device according to at least one of the preceding claims 11 to 47, **characterized in that** a receptacle (1) is associated with an assembly of several internal combustion engines.
- 49.A device according to at least one of the preceding claims 11 to 48,

characterized in that several receptacles (1) are associated with one internal combustion engine.

50.A device according to at least one of the preceding claims 11 to 49,
characterized in that the scrubbed exhaust gas is distributed to at least an
5 exhaust gas recirculation line (43) and at least an exhaust pipe (44).