



- (51) International Patent Classification:  
C02F 1/06 (2006.01)
- (21) International Application Number:  
PCT/DK2016/050243
- (22) International Filing Date:  
8 July 2016 (08.07.2016)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
PA 2015 70471 16 July 2015 (16.07.2015) DK
- (72) Inventor; and  
(71) Applicant : DJURHUUS, Hans Andrias [DK/DK];  
Fútalág 21, Tórshavn, 100 (FO).
- (74) Agent: PATRADE A/S; Fredens Torv 3A, 8000 Aarhus C (DK).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:  
— with international search report (Art. 21(3))

(54) Title: SYSTEM AND METHOD FOR PURIFICATION OF CONTAMINATED LIQUID

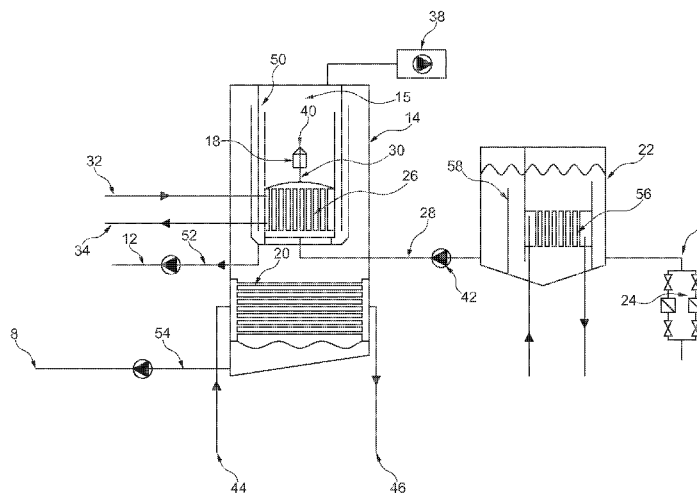


Fig. 1

(57) Abstract: A system or a method adapted to perform purification of contaminated liquid (4), which system performs at least an evaporation process of the contaminated liquid (4), which evaporation is performed in an under-pressure (15). A mostly perfect purification of contaminated liquid (4) is achieved. A further object is to avoid the formation of foam in the evaporation process. The object can be fulfilled if the system comprises at least one common process enclosure (14, 101), which process enclosure (14, 101) comprises a plurality of technical functions, such as a heater (26), an evaporator (18) and a condenser (20, 105). Hereby a compact system can be achieved in which most of the technical features are placed in the same enclosure (14, 101). This enclosure (14, 101) can then be partly evacuated by a pump (38, 102) so that a common under-pressure (15) is achieved in the enclosure (14, 101). Hereby heater evaporator and condenser can operate at an under-pressure (15).



## **System and method for purification of contaminated liquid**

### **Field of the Invention**

The present invention relates to a system or a method adapted to perform purification  
5 of contaminated liquid, primarily water, which system comprises at least an inlet for  
contaminated liquid, which system comprises at least an outlet for purified liquid and  
at least an outlet for waste water, which system performs at least an evaporation pro-  
cess of the contaminated liquid, which evaporation is performed in a sub-pressure.

### **10 Background of the Invention**

WO 2011/014107 relates to a method for purification of bilge and sludge water on a  
ship, especially at sea, using excess heat from the ship's engine(s) to a level of oil con-  
tamination of less than 15 ppm. Here is disclosed a plant for carrying out the method,  
and a vessel including such plant, as well as the use of the method and plant.

15

### **Object of the Invention**

It is the object of the present invention to perform an almost complete purification of  
contaminated liquid; a further object is to operate a process for purification of contam-  
inated liquid with low power consumption. A further object of the present invention is  
20 to avoid the formation of foam in the evaporation process.

### **Description of the Invention**

The object can be fulfilled by a system as disclosed in the opening paragraph and  
modified in that the system comprises at least one common process enclosure, which  
25 process enclosure comprises a plurality of technical functions, such as a heater, an  
evaporator and a condenser.

Hereby a relatively compact system can be achieved in which most of the technical  
features are placed in the same enclosure. This enclosure can then be partly evacuated  
30 by a pump so that a common sub-pressure is achieved in the enclosure in which com-  
mon sub-pressure the technical functions are in operation. Hereby heater evaporator

and condenser can operate at a sub-pressure. Hereby evaporation and condensation can take place in the same common enclosure simply because different temperatures are present. Evaporation is effected at a relatively higher temperature than is the condensation. By the correct forming of the common enclosure it can be achieved that only evaporated liquid can find its way to the condensing unit. The reduced pressure in the common process enclosure will reduce the boiling temperature of any liquid. Therefore, the purifying process can be performed with relatively low power consumption. Because the system as such operates at relatively low temperatures, in many situations it is possible to operate with a waste heat from processes such as engines. It is likely to raise the temperature of the liquid to maybe 60 or 70 degrees Celsius for operating the disclosed system.

In a preferred embodiment for the invention, the system can perform a pre-purification of the contaminated liquid. The pre-purification can for example be a pre-heating process and sending the liquid through a water seal and in that way a first purifying process can be performed. The water seal can be formed in a way where pre-heating of the liquid takes place, and contamination will be found at the surface of the water seal or maybe below the liquid. In that way a pre-treatment is possible.

In a further preferred embodiment for the invention, the system can perform a filtration of the contaminated liquid in at least one filter. Filtration may be necessary in order to remove larger particles from the liquid because these particles later on in the process may cause stop of e.g. magnetic valves. The first filter can be formed as a double filter where one of the filters can be removed and purified while the other filter is still in full operation. In that way it is possible to operate the system more or less independently of the degree of contamination because it is possible to effect purification of the filters in parallel to operating the system.

In a further preferred embodiment for the invention, the system can comprise at least one pump for generating a sub-pressure in the common process enclosure. The sub-pressure generated by the pump only has to be generated once because at the time when the sub-pressure exists in the common process enclosure, it only has to be adjusted when there is a change in the volume of liquid in the common process enclosure. However, as the liquid entering the common process enclosure is more or less

equal to the liquid leaving the common process enclosure, the pump generating the sub-pressure almost has no work to effect. Therefore this system is highly energy-efficient.

5 In a further preferred embodiment for the invention, the heater system can be formed as a heat exchanger, which heat exchanger comprises inlet and outlet for a heating liquid, which heat exchanger further comprises inlet and outlet for contaminated liquid, . Hereby further heating of the contaminated liquid can be achieved, and by using a heat exchanger for the heating process, it is possible to use an existing energy  
10 source, such as cooling process water from technical installations or maybe warm water supplied using solar collectors. If the system is to be used on board a ship, there will probably be sufficient supply of hot cooling water from the diesel engines. Therefore, this heating can also be performed with an environmentally neutral power transmission. Thereby the system as disclosed in this patent application can be operated at  
15 very low power consumption.

In a further preferred embodiment for the invention, the evaporator can be formed by at least a first pump, which pump is pumping heated contaminated liquid through at least one inlet into the common process enclosure whereby flush evaporating is performed in the sub-pressure generated by a second pump. Hereby very rapid steam  
20 generation can be achieved. If the temperature of the contaminated liquid sent to the inlet is higher than the temperature in the common process enclosure in relation to the existing pressure, very rapid evaporation will take place. The non-evaporating droplets or particles of the contaminated liquid will not evaporate and will instead be collected  
25 in a tray placed below the inlet. Here the contaminated liquid can be removed immediately from the common process enclosure. Hereby is achieved that no foam can be formed in the liquid in the common process enclosure. Avoiding the existence of liquid has the positive effect that no foam can be generated. If foam is generated in the common enclosure, foam will rapidly fill the enclosure and in that way contaminate  
30 the purified liquid again. It is therefore very important that no foam is generated during the process. Therefore it is important that the sub-pressure is kept at a relatively constant level.

In a further preferred embodiment for the invention, the common process enclosure can comprise a condenser which condenser comprises an inlet and an outlet for cooling means such as air or water. Thus it is achieved that also the condensation process takes place at the sub-pressure in the common process enclosure.

5

The surface of the condenser needs to have a temperature dependence on pressure and temperature so that condensation takes place. It is possible to affect this condensation process in a heat exchanger where liquid or air is pre-heated by the condensation. Pre-heated liquid can be used for the pre-heating of contaminated liquid in this system.

10

In a further preferred embodiment for the invention as disclosed, a method can be used by which the contaminated liquid can be processed in at least the following number of steps:

15

a. perform a pre-purification of the contaminated liquid by performing a first filtration and a preheating combined with a first water seal for separating the contaminated liquid into a pre-purified and a contaminated liquid portion,

20

b. perform evaporation of the contaminated liquid in the common process enclosure the contaminated liquid is heated in the first heat exchanger, in which common process enclosure evaporation is performed a sub-pressure where the contaminated liquid is by the first pump by increasing pressure and pressed through an inlet, whereby flush evaporation is performed in the sub-pressure,

25

c. let the generated steam pass through a second water seal for stopping particles or droplets in access to the clean distillate,

30

d. perform condensation of the steam in a third heat exchanger placed in the common enclosure,

e. by a third pump increase the pressure of the condensed liquid and press the liquid through a second filter,

f. perform measurement of rest purification,

g. if rest purification is below a defined level, send the liquid to the outlet.

5 h. the non-evaporated droplets or particles from the polluted liquid is removed from the common process enclosure

10 By the disclosed method it is possible to purify a liquid, such as water, so that from relatively highly contaminated water it is possible to obtain drinking water. Hereby it is possible to obtain drinking water from seawater, for example on board ships. Combined with other mechanical processes such as diaphragms, it is possible by this method to effect the rest purification of for example water by the evaporation process. For example contents of oil can be reduced to very low levels. In fact the level of oil after this process can be less than 5 ppm.

15 Use of a system or method as previously disclosed for purifying sludge water or bilge water on board ships can be very effective. Hereby bilge water in ships can be sent through the processes as disclosed, and it is possible to achieve water purification that is so efficient that it is allowed to pump the purified water into the sea. Today, requirements for pumping purified water into sea are that contamination level must be  
20 below 15 ppm, in the future this will be reduced to 5 ppm.

25 Use of a system or method as previously disclosed for purifying sea water and for removing salt can be very effective. By the system and/or method disclosed it is possible to desalinate salt water. This can be performed on board ships but also for example in deserts near the sea where sufficient amounts of salt water exist, but it is very expensive to desalinate the salt water so that it can be used for plants or animals. By the method as disclosed in this patent application, it will be possible to supply the system with energy generated from solar panels. Electrical supply necessary for pumping and also for the control system and valves can be generated by electric solar panels. In  
30 this way a purification system can operate with no external power supply.

Use of a system or method as previously disclosed for purifying domestic waste water can be very effective. In many countries there is limited access to clean drinking water. Therefore it is necessary to effect a nearly perfect purification of waste water. By

the pending patent application this can be achieved. Anywhere where it is possible to have a heating supply giving a temperature of app. 60 degrees Celsius, it is possible to operate a system as disclosed in the pending patent application. Waste energy from power plants for example can supply enormous volumes of heat having the required temperature level. Solar panels can also deliver hot water having the required temperature level. Therefore a system as disclosed can operate in cities where there is limited access to purified water.

For generating drinking water it is possible to combine the disclosed invention with a further process where a combined UV OZON process is able to further sterilise water and remove most of organic molecules existing in the water and hereby remove bad smell or taste that could remain in the water.

### **Description of the Drawing**

Fig. 1 shows a first possible embodiment of the invention.

Fig. 2 shows a detailed embodiment for the invention.

### **Detailed Description of the Invention**

Fig. 1 shows a first possible embodiment of the invention. The system 2 has an inlet for contaminated liquid 4 and an outlet 8 for purified liquid and an output 12 for highly contaminated liquid. Further is indicated a common process enclosure 14 in which common process enclosure 14 there is a sub-pressure 15. Inside this common process enclosure 14 is indicated a heating device in the form of a heat exchanger 26 and evaporation system 18 and a condenser 20.

25

In fig. 1 a pre-purification 22 of the contaminated liquid is further indicated. This process can by a preferred embodiment comprise preheating 56 and a kind of water seal 58, where the liquid is separated by gravity so that one kind of contamination is maybe formed at the surface of the liquid and other kinds of contaminations are formed below the liquid. In that way with different pumping means highly contaminated liquid can be removed from the upper surface or maybe below the liquid, and the main part of the liquid can hereafter be sent through a tubing 28 into a heat exchanger 26 for further heating the contaminated liquid and sending the liquid out of the heat ex-

changer by pumping means 42 towards the evaporator 18 which is formed as an inlet 40. This inlet 40 is operating inside a second water seal 50. This water seal 50 comprises at the lower part an outlet 52 connected to the contamination outlet 12.

5 The common process enclosure 14 has a reduced pressure generated by the first pump 38. The condenser 20 can be formed as a heat exchanger with an inlet 44 and an outlet 46 for a cooling media. On board a ship the cooling media could be sea water. In other situations this condensation heat that will heat the cooling liquid can be used further on in the system, maybe for preheating of the contaminated liquid.

10

In operation will contaminated liquid come into the system by the tubing 4 into the pre-purification 22 which pre-purification comprises a pre-heating device 56 which is operating as a heat exchanger which is placed in a water seal 58. The tubing 28 is connecting the purified liquid into the heat exchanger 26. Here is the contaminated liquid heated by the heating media which is connected to inlet 32 and return in outlet 34 which could be cooling water from a diesel engine of a ship. The contaminated liquid is further through tubing 30 by the second pump 42 sent to the evaporator 18, which comprises at least one inlet 40. This inlet 40 is spraying the contaminated liquid into a water trap 50 but because pressure and temperature is relative high and there exist a sub-pressure in the common process enclosure 14 where evaporation takes place. Therefore, the liquid that is able to evaporate will evaporate immediately but the contamination which is not evaporated will form drop lets which will end down in the water trap 50 from where the not evaporated liquid is removed through the tubing 52 to avoid forming foam. The steam that is formed will instead pass over the edge of the water trap 50 and get in touch with the condenser 20 which is cooled by cooling media through the tube 44 and returned through tube 46. Hereby is performed a condensation of the steam that is generated. The condensate liquid is now mostly purified because it has been through an evaporation process. This purified liquid is by the line 54 sent to the outlet 8.

30

Fig. 2 shows a detailed embodiment for the invention. The first pump 102 for generating sub-pressure in the common process enclosure 101. Further is indicated a heat exchanger 103. This heat exchanger is based inside a water trap 104, which comprises a condensing unit 105. Further a boiling safety 106 is disclosed in order to indicate if

there is foam inside the evaporation volume 148, where a magnetic outlet valve 107 for purified liquid and a pump 108 is pumping liquid through a carbon filter 109. From the carbon filter 109 the purified liquid is now sent through a parts per million measuring device 110 and parallel to that is indicated a regulation valve 111. Further  
5 is indicated a three-direction valve 112 which is connected further to a flow measuring device 113 from where the liquid is indicated to a sea connection. Further is indicated from the valve 112 a one-way valve 145 which has to be used if the liquid still is contaminated to a level above what is allowed. Then this liquid is sent back to the bilge water tank 135. The inside volume of the water trap 104 is by opening 150 open for  
10 flow downwards around the condenser 105 and further through a one-way valve 114 where the flow is generated by a pump 115. This pump 115 is by tubing generating a flow to the sludge tank 136.

The inner volume of the common process enclosure 101 is by tubing connected to a  
15 pressure state 116 and further through a one-way valve 117 to the pump 102. Further is indicated a magnetic valve 118 which is used in the situation where foam is indicated by the detector 106, then this valve 118 is open and atmospheric air is let directly into the enclosure. This will immediately reduce any foam.

20 By the magnetic valve 121 it is possible to add fresh water for cleaning process of the heat exchanger 103. One further magnetic valve 122 can open for a connection for fresh water into the inner of the heat exchanger 103. This heat exchanger 103 is connected through a magnetic valve 143 with cooling water from the engine. An oil indicator 125 and magnetic valves 126 and 127 open for a connection to the waste oil tank  
25 137. Further is indicated a magnetic valve 122 which gives the possibility of adding fresh water to the preheater 123. Contaminated liquid leaving the preheater 123 is sent through a filter 128 by a pump 130. Further is a connection through a valve 131 which shifting valve is connected to the bilge water tank 135 and by tubing towards the heat exchanger 103.

30

The inlet of the preheater 123 is connected through a first filter 133 and further through a magnetic valve 132 and by 133 Further is by 134 indicated a one-way valve. 135 is a bilge water tank where 136 is a sludge tank and 137 is the waste oil tank. All the tanks 136, 136 and 137 are connected to a common supply line from bilge water

sump through a valve 141 and further down in the bilge water tank 135 through a valve 140 and into the sludge tank by a valve 139 and through a valve 138 into the waste oil tank 137.

5 In operation bilge water or other kinds of waste water will be sent through the one-way valve 134, the grow filter 133 and further through the magnetic valve 132 into the preheater 123 comprising the heat exchanger 124. This preheater 123 comprises a water trap 142, the contaminated liquid which is leaving the water trap where probably most of the content of oil is pumped back to the waste oil tank 137 but the contaminated liquid is sent by the pump 130 through the valve 131 up to the heater 103 for  
10 further treatment.

By the pressure generated by the pump 130 the liquid is now sent to the inlet 146. Because the sub-pressure generated by the pump 102 exists in the common process enclosure 101, rapid evaporation takes place. The steam flows towards the condenser  
15 105 passing through the water trap 104.

By condensation is the volume of the steam reduced to the volume of the liquid generating a flow through the water trap towards the condenser 105. The now condensate liquid is now sent by the magnetic valve 107 by pump 108 to a carbon filter 109. From  
20 here the now purified liquid is sent to a measuring device 110 through a valve 112 and probably if the purifying is successfully and the content for example is very low below 15 ppm or maybe in the future 5 ppm, the water can be sent directly out in the sea.

25 In order to achieve the best possible quality of the waste liquid which is sucked with a pump 130 through different valves connecting for example a waste oil tank 137, sludge tank 136 bilge water tank 135 or from somewhere else through a duplex filter 133. This filter is collecting greater particles from the waste liquid. From here the waste liquid is sucked through a combined oil separator and pre-cleaner 123, which is  
30 combined with a heat exchanger 124 and heated by cooling water from the ship engine. A water trap 142 is used to assure that oil is separated and does not enter the process enclosure 101.

The pump 130 is pumping the liquid through a three way valve 131, where it can be chosen if the liquid shall be pumped back to the bilge water tank 135 for later treatment or directly to the pre-heater 103 in the process enclosure 101 which is also heated by cooling water from the ship engine. The pre-heater 103 is placed inside the water trap 104. The liquid is from here sent into the evaporation chamber 148 through an inlet 146. Because sub-pressure generated by the pump 102 exists in the common process enclosure 101 a rapid evaporation takes place. The amount of waste liquid that is sent through the inlet 146 is controlled by a valve not shown on the drawing.

From here the evaporated waste liquid is flowing through the water trap 104. Particles and liquid droplets are stopped in the water trap where they will settle and be sucked out together with not evaporated liquid by a pump 115 and will be let back to the sludge tank 136 for further treatment. The evaporation chamber 148 is at any moment mostly empty from liquid in order to avoid generating foam which can occur in a boiling process by sub-pressure.

The steam that passes the particle and drop trap 104 will stream down to the condenser 105 and be converted to a liquid condensate.

By the pump 108 the condensate liquid is sucked out of the process enclosure 101 and is pumped from there through a PPM (parts per million) measuring equipment 110 and a three way valve 112. The PPM measuring unit controls if the condensate is clean enough to have a degree of pollution less than 15 PPM whereby the liquid can be pumped directly into the sea through the three way valve 112 or if the condensate has to be pumped via the three way valve 112 back to the bilge water tank 135 for further treatment.

The pending application can be used on a ship to clean bilge water but it is also possible by this invention to perform cleaning of sea water. Because this process is highly energy effective it is possible to use this method for all kind of cleaning of waste water.

**Table of figure references**

|    |     |                            |
|----|-----|----------------------------|
|    | 2   | system                     |
|    | 4   | contaminated liquid        |
|    | 8   | outlet                     |
| 5  | 12  | an outlet for waste water  |
|    | 14  | process enclosure          |
|    | 15  | sub-pressure               |
|    | 18  | evaporator                 |
|    | 20  | condenser                  |
| 10 | 22  | pre-purification           |
|    | 24  | filter                     |
|    | 26  | heat exchanger             |
|    | 28  | inlet tubing               |
|    | 30  | outlet                     |
| 15 | 32  | inlet                      |
|    | 34  | outlet                     |
|    | 36  | heating liquid             |
|    | 38  | first pump                 |
|    | 40  | inlet                      |
| 20 | 42  | second pump                |
|    | 44  | inlet                      |
|    | 46  | outlet                     |
|    | 50  | second water seal          |
|    | 52  | outlet tubing              |
| 25 |     |                            |
|    | 56  | pre-heating heat exchanger |
|    | 58  | water seal                 |
|    | 101 | process enclosure          |
| 30 | 102 | first pump                 |
|    | 103 | heat exchanger             |
|    | 104 | second water trap          |
|    | 105 | condenser                  |
|    | 106 | boiling safety             |

|    |     |                                 |
|----|-----|---------------------------------|
|    | 107 | magnetic outlet valve           |
|    | 108 | pump                            |
|    | 109 | carbon filter                   |
|    | 110 | PPM measuring device            |
| 5  | 111 | regulation valve                |
|    | 112 | three-direction valve           |
|    | 113 | flow measuring device           |
|    | 114 | one way valve                   |
|    | 115 | pump                            |
| 10 | 116 | pressure state                  |
|    | 117 | one way valve                   |
|    | 118 | valve                           |
|    | 121 | magnetic valve                  |
|    | 122 | magnetic valve                  |
| 15 | 123 | pre-purification heat exchanger |
|    | 124 | heat exchanger                  |
|    | 125 | Oil indicator                   |
|    | 126 | magnetic valve                  |
|    | 127 | magnetic valve                  |
| 20 | 128 | filter                          |
|    | 130 | second pump                     |
|    | 131 | valve                           |
|    | 132 | magnetic valve                  |
|    | 133 | filter                          |
| 25 | 134 | one-way valve                   |
|    | 135 | bilge water tank                |
|    | 136 | sludge tank                     |
|    | 137 | waste oil tank                  |
|    | 139 | valve                           |
| 30 | 140 | valve                           |
|    | 141 | valve                           |
|    | 142 | first water trap                |
|    | 143 | magnetic valve                  |

- 145 one way valve
- 146 inlet
- 148 evaporation volume
- 150 opening for flow

**CLAIMS**

1. System (2) adapted to purify contaminated liquid (4), primarily water, which system (2) comprises at least an inlet for contaminated liquid (4), which system comprises at least an outlet (8) for purified liquid and at least an outlet for waste water (12),  
5 which system (2) performs at least an evaporation process of the contaminated liquid (4), which evaporation is performed in a sub-pressure (15), **characterized in** that the system (2) comprises at least one common process enclosure (14,101), which process enclosure (14,101) comprises a plurality of technical functions, such as a heater (26), an inlet (40) an evaporator (18) and a condenser (20,105).  
10
2. System according to claim 1, **characterized in** that the system performs a pre-purification (22,123) of the contaminated liquid (4).
3. System according to claim 1 or 2, **characterized in** that the system performs a filtration of the treated liquid (4) in at least one filter (24).  
15
4. System according to one of the claims 1-3, **characterized in** that the system comprises at least one first pump (38102) for generating a sub-pressure in the common process enclosure (14).  
20
5. System according to one of the claims 1-4, **characterized in** that the heater is formed as a heat exchanger (26103), which heat exchanger (26,103) comprises an inlet (28) and an outlet (30) for contaminated liquid (4), which heat exchanger further comprises an inlet (32) and an outlet (34) for a heating liquid .  
25
6. System according to one of the claims 1-5, **characterized in** that the evaporator (18) is formed by at least a second pump (42,130), which pump pumps pre-heated contaminated liquid through at least one inlet (40) into the common process enclosure (14,101) whereby flush evaporating is performed by the sub-pressure (15) generated  
30 by a second pump (42).
7. System according to one of the claims 1-5, **characterized in** that the common process enclosure (14,101) comprises the condenser (20,105) which condenser comprises

an inlet (44) and an outlet (46) for cooling means such as air or water or another cooling media.

8. Method for operating a system as disclosed in one of the claims 1-7, **characterized**  
5 **in** that the contaminated liquid is treated in at least the following processes:

a. perform a pre-treatment (22,123) of the contaminated liquid (4) by performing a  
first filtration (24,133) and a preheating combined with a first water seal (58) for separating the contaminated liquid (4) into a pre-purified and a contaminated water portion,  
10

b. perform evaporation of the contaminated liquid (4) in the common process enclosure (14,101) the contaminated liquid (4) is heated in the first heat exchanger (26103), in which common process enclosure (14,101) evaporation is performed a sub-pressure (15) where the contaminated liquid is by the second pump (42,130) by increasing  
15 pressure and pressed through an inlet (40), whereby flush evaporation is performed in the sub-pressure (15),

c. let the generated steam pass through a second water seal (50,150),  
20

d. perform condensation of the steam in a third heat exchanger (20,105) placed in the common enclosure (14,101),

e. by a third pump (54,108) increase the pressure of the condensed liquid and press  
25 the liquid out of the common enclosure (14,101)

f. measurement of rest contamination,

g. if rest contamination is below a defined level send the purified liquid to the outlet  
30 (8).

9. Use of a system or method as disclosed in the claims 1-8 for purification of flush or bilge water at ships.

10. Use of a system or method as disclosed in the claims 1-8 for purification of sea water and for removing salt.

5 11. Use of a system or method as disclosed in the claims 1-8 for purification of domestic waste water.

12. Use of a system or method as disclosed in the claims 1-8 for purification of waste water from ship yards or from yard industry.

10 13 Use of a system or method as disclosed in the claims 1-8 for purification of waste or salt water in areas where drinking water is difficult to access for human or animal.

15 14 Use of a system or method as disclosed in the claims 1-8 for purification of waste water in domestic areas with a large population, where drinking water can be a shortage.

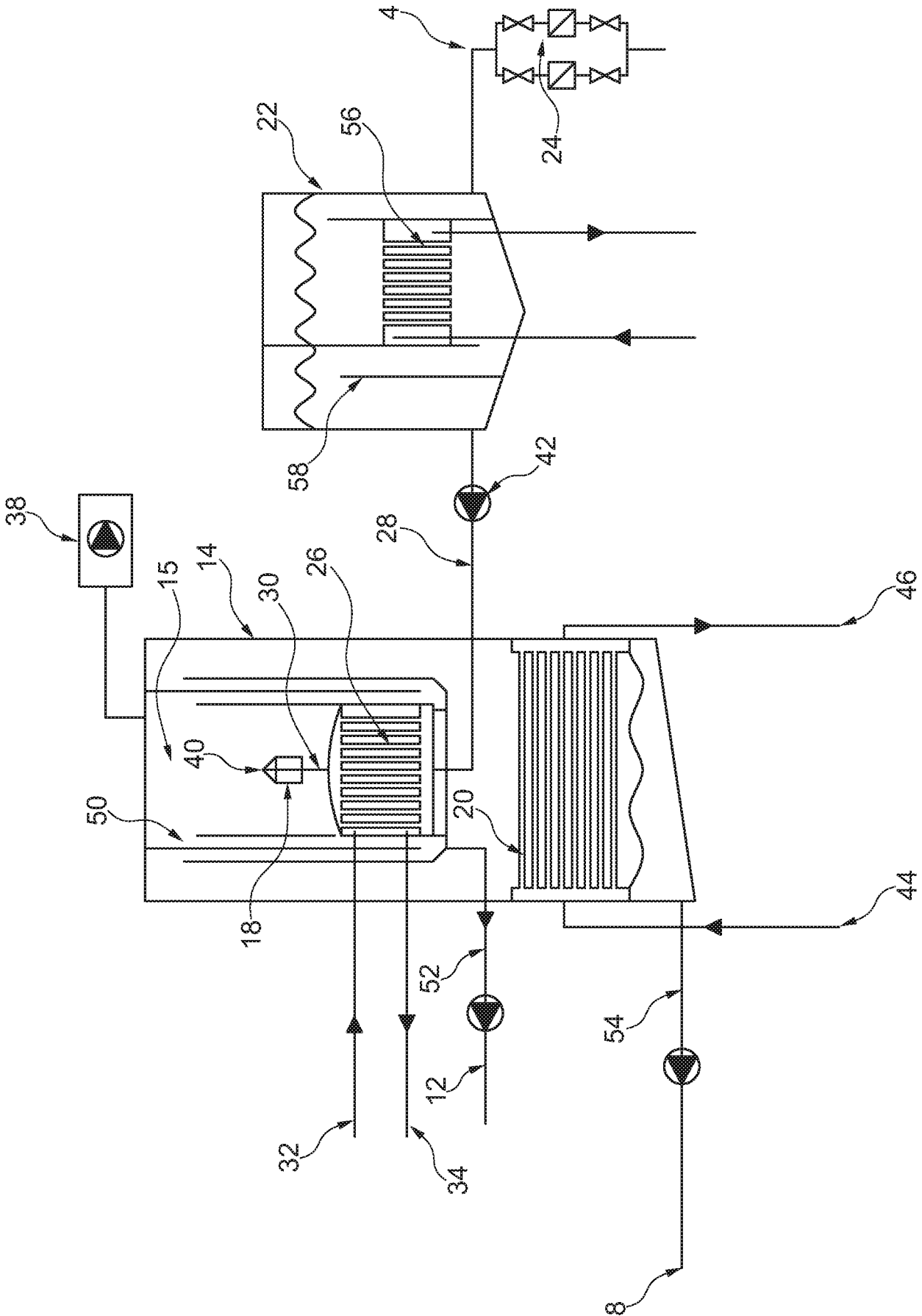


Fig. 1

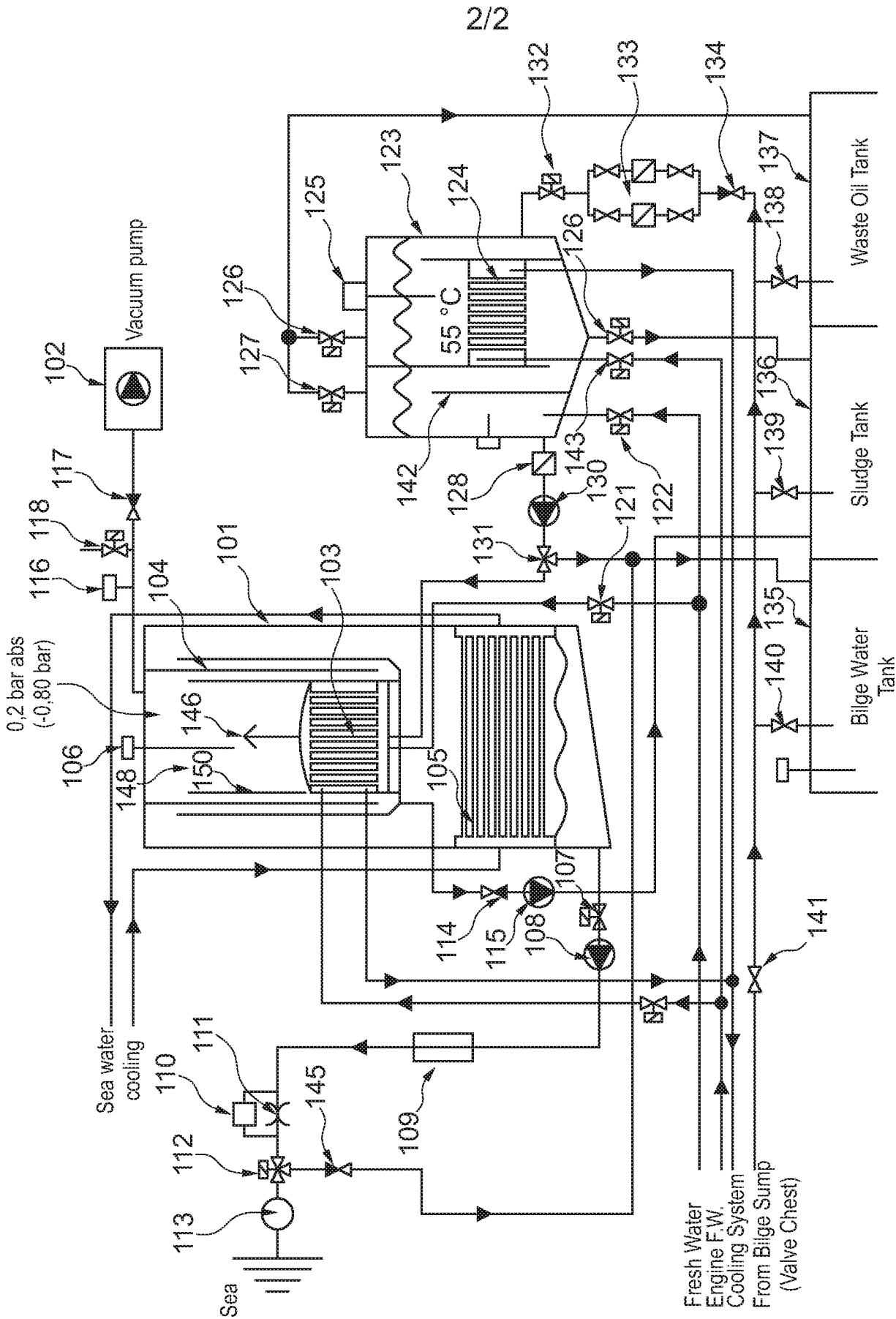


Fig. 2

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2016/050243

## A. CLASSIFICATION OF SUBJECT MATTER

*C02F 1/06* (2006.01)

According to International Patent Classification (IPC)

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C02F, B63J, B01D; CPC: C02F, B63J, B01D; FICLA: C02F, B63J, B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

DK, NO, SE, FI: Classes as above.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                 | Relevant to claim No. |
|-----------|--|-----------------------|
| X         | DE 2943261 A1 (BARTHOLD, H.) 30 April 1981<br>See in particular pages 4-12, claims 1-4, the figure | 1-7, 9, 11, 12        |
| A         | WO 2011/014107 A1 (PPMCLEAN AB) 3 February 2011<br>See whole document (cited by applicant)         | 1-14                  |
| A         | WO 2005/090151 A1 (SIVERTSSON, H.) 29 September 2005<br>See whole document                         | 1-14                  |
| A         | WO 93/02964 A1 (ALFA LAVAL DESALT) 18 February 1993<br>See whole document                          | 1-14                  |
| A         | EP 1443025 A1 (HERNANDEZ HERNANDEZ, F.) 04 August 2004<br>See whole document                       | 1-14                  |

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

04/10/2016

Date of mailing of the international search report

05/10/2016

Name and mailing address of the ISA

Nordic Patent Institute

Helgeshøj Allé 81

DK - 2630 Taastrup, Denmark.

Facsimile No. + 45 43 50 80 08

Authorized officer

Sven Nytoft Rasmussen, M. Sc. Eng., Ph. D.

Telephone No. +45 43 50 84 27

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.

PCT/DK2016/050243

| Patent document cited in search report / Publication date | Patent family member(s) / Publication date   |
|---|--|
| DE 2943261 A1 1981.04.30                                  | WO 8101141 A1 1981.04.30<br>NO 812116 A 1981.06.22<br>DK 276981 A 1981.06.23<br>NL 8020313 A 1981.09.01<br>GB 2077714 A 1981.12.23<br>GB 2077714 B 1983.03.30  |
| WO 2011014107 A1 2011.02.03                               | KR 20120038536 A 2012.04.23<br>KR 101616065B B1 2016.04.27<br>EP 2459440 A1 2012.06.06<br>EP 2459440 B1 2014.10.15<br>CN 102498036 A 2012.06.13<br>CN 102498036B B 2015.12.09<br>US 2012160660 A1 2012.06.28<br>US 8696873 B2 2014.04.15<br>JP 2013500203 A 2013.01.07<br>JP 5559883B B2 2014.07.23<br>DK 2459440T T3 2015.01.26 |
| WO 2005090151 A1 2005.09.29                               | SE 0400755 A 2005.09.23<br>SE 526811 C2 2005.11.08<br>EP 1727730 A1 2006.12.06   |
| WO 9302964 A1 1993.02.18                                  | EP 0600876 A1 1994.06.15<br>JPH 07500526 A 1995.01.19<br>ES 2087819 A1 1996.07.16<br>ES 2087819 B1 1997.02.16<br>PL 169577B B1 1996.08.30<br>KR 0169155B B1 1999.01.15   |
| EP 1443025 A1 2004.08.04                                  | ES 2185514 A1 2003.04.16<br>ES 2185514 B1 2004.01.01<br>WO 03033412 A1 2003.04.24<br>US 2005011743 A1 2005.01.20<br>US 7381310 B2 2008.06.03   |