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(54) **Title:** ENVIRONMENTALLY FRIENDLY WATER INTAKE AND PRETREATMENT METHOD AND SYSTEM

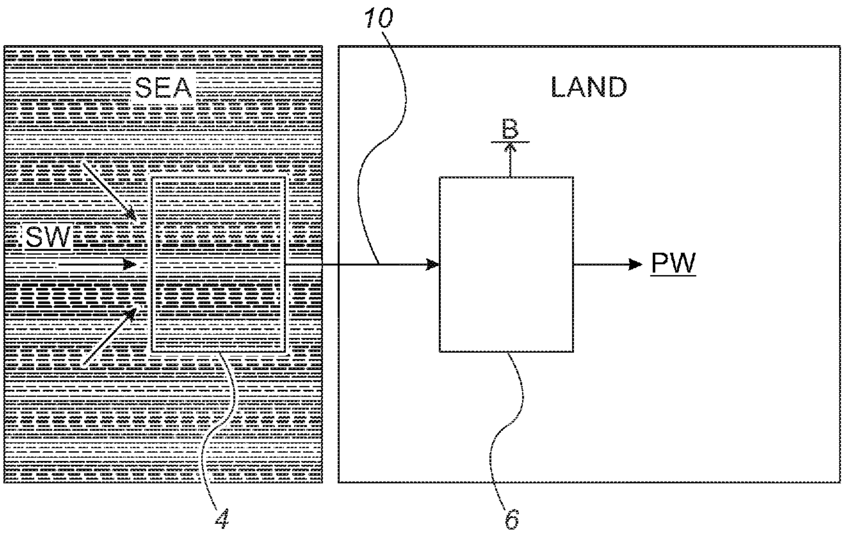

FIG. 2

(57) **Abstract:** A water intake and pretreatment system (4) for a desalination plant comprising at least one intake pipe (10) for delivering filtrated feed water from a water source, such as the sea, to a desalination plant (6) provided on land. A region of the intake pipe includes integrated ultrafiltration or microfiltration membranes to provide pretreatment (4) of the feed water as it enters the intake pipe (10) prior to its delivery to land for desalination of the feed water.

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ENVIRONMENTALLY FRIENDLY WATER INTAKE AND PRETREATMENT METHOD AND SYSTEM

TECHNICAL FIELD

The present invention relates to the field of water treatment, especially to an environmentally friendly seawater intake and pretreatment system and process, particularly but not exclusively for desalination plants.

BACKGROUND

There is an increasing demand to provide clean, drinking water despite 97% of the water on the Earth being located in the seas and oceans in the form of salt or brackish water. Desalination, a technology that converts saline water into clean water, is an important process aiming to address this demand. Generally, thermal or membrane desalination methods are used for this conversion. Thermal desalination methods separate salt from water by a series of evaporation and condensation stages whereas membrane desalination methods depend upon driving forces such as pressure across semi-permeable membranes to effect separation of the salt from the sea water.

Reverse osmosis (RO) desalination is the most commonly used membrane process for converting sea or brackish water into potable water. However, a significant problem encountered with membrane desalination methods is membrane fouling which results from the formation of deposits on the membrane surface. In this respect, the overall performance of such desalination plants depends upon high quality feed water to ensure reliable and stable operation of the desalination system.

This problem has been addressed by the use of different types of pre-treatment of the sea water prior to delivery to the RO membranes to reduce fouling and scaling rates. Mechanical filtration may be used where the sea water is passed through screening, sedimentation or cartridge, sand or membrane filters prior to its passage through the RO desalination membranes. Alternatively or additionally, chemical means may be used to pretreat the water, for example using scale inhibitors, coagulants and disinfectants. However, both types of pretreatment have their downfalls. For example, physical methods often require cleaning and maintenance while the correct dosage of chemicals may be difficult to meet if feed water quality varies rapidly. It is also generally undesirable to introduce chemicals into a water feed.

Ultrafiltration (UF), using membranes having a pore size in the range of 0.01 – 0.1 µm, is one pre-treatment method that has been integrated into a sea water reverse osmosis (SWRO) plant and met with success in that it significantly reduces the rate of membrane fouling and therefore extends the life of the RO membrane. As a result, a number of desalination plants now include a pre-treatment ultrafiltration stage that a large number of UF modules installed on multiple racks on site to filter sea water prior to its passage through the RO membranes modules. Other types of pre-treatment modules are often included, such as screens and other membrane elements, ahead of the UF modules, to prevent damage occurring to the UF membranes. Microfiltration (MF) membranes may also be used, having a pore size in the range 0.1-10 µm.

This type of treatment is desirable but significantly increases the already substantial footprint of a desalination plant. The pre-treatment area of the plant accounts for up to 50% of the footprint. This is clearly problematic, particularly given that desalination plants are often located in regions where dry land above sea level is sparse. Furthermore, this pre-treatment requires all the sea water to be pumped to the inland desalination plant adding to the cost of the overall process. This pumping may also be detrimental to marine life.

It is an object of the present invention to provide an improved water intake and pretreatment method and system that aim to overcome, or at least alleviate, the abovementioned drawbacks.

If a further objection of the present invention to provide an improved pretreatment and desalination method and plant that aims to overcome, or at least alleviate, the abovementioned drawbacks.

BRIEF SUMMARY

One aspect of the present invention provides a water intake and pretreatment system comprising at least one an inlet pipe for locating within a water source, preferably sea water, for delivering feed water from the water source to a membrane desalination plant on land; at least part of said at least one inlet pipe being provided with an integrated plurality of ultrafiltration or microfiltration membranes for filtering the feed water during its entry into the at least one inlet pipe. As a result, the intake pipe delivers only filtrated water to the inland desalination plant.

Another aspect of the present invention provides a water intake and pretreatment method comprising drawing feed water from a water source through at least one inlet pipe located within the water source, preferably sea water, wherein at least part of said inlet pipe is provided with a plurality of ultrafiltration or microfiltration membranes for filtering the feed water during its entry into the inlet pipe.

A further aspect of the present invention provides a pretreatment and desalination plant comprising at least one inlet pipe located within a water source, preferably sea water, for delivering feed water from the water source to a membrane desalination plant, at least part of the said inlet pipe being provided with a plurality of ultrafiltration or microfiltration membranes for filtering the feed water during its entry into the inlet pipe.

Preferably, at least one pump is provided to deliver the ultra- or micro- filtered feed water in the inlet pipe to a membrane desalination plant located on land for carrying out desalination of the ultra- or micro- filtered feed water.

Yet a further aspect of the present invention provides a pretreatment and desalination method comprising drawing feed water from a water source through at least one inlet pipe located within the water source, preferably sea water, wherein at least part of the inlet pipe is provided with a plurality of ultrafiltration or microfiltration membranes for filtering the feed water during its entry into the at least one inlet pipe; pumping the ultra-or micro- filtered water in the inlet pipe from the water source to land to deliver the ultra- or micro- filtered feed water to a membrane desalination plant for carrying out desalination of the filtered feed water.

The inlet pipe or multiple inlet pipes may be provided with a network of integrated ultrafiltration (UF) or microfiltration (MF) membranes, more preferably being ultrafiltration membranes. The inlet pipe has a sealed end and is provided with a network of sealed UF hollow-fiber membrane extending substantially perpendicularly across a proportion of the surface of the inlet pipe through which the feed water must pass to enter the inlet pipe. The ultrafiltration process is outside-in type UF and for the flow of feed water to be outside-in. A vacuum is preferably applied within the inlet pipe to draw the feed water through the fibers. Aeration may also be provided across an outer surface of the fibers to reduce clogging of the UF membranes.

It is preferable to provide a low flux of feed water across the UF or MF membranes, preferably being less than 30 l/m/hr, more preferably less than 20 l/m/hr, ideally less than 10 l/m/hr. It is to be appreciated that the system and method should include backwash means or a backwash mode respectively to allow cleaning of the UF or MF membranes at intervals using either filtrated seawater, brine from the desalination plant or permeate. Backwashing the membranes with changing water salinity is providing the ability to cope with bio-fouling on the membranes.

Preferably, a plurality of inlet pipes are provided with at least part of each inlet pipe being provided with the integrated plurality of ultrafiltration (UF) or microfiltration (MF) membranes, each inlet pipe or a group of inlet pipes being isolatable from the other pipes to allow backwashing of the isolated pipes. Alternatively, or additionally, the at least one inlet pipe may comprise a main inlet pipe that is free from UF or MF membranes, an end of the main inlet pipe being provided with an array of subsidiary pipes in fluid communication therewith, the subsidiary pipes being provided with the ultrafiltration or microfiltration membranes over at least a part of the surface thereof, more preferably wherein each subsidiary pipe or a group of subsidiary pipes is isolatable from the other subsidiary pipes and the main inlet pipe to allow backwashing of the isolated pipes. For example, each inlet or subsidiary pipe may be provided with valves for its isolation and be connectable to a separate water source to allow backwashing.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of embodiments of the invention and to show how the same may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings in which like numerals designate corresponding elements or sections throughout.

In the accompanying drawings:

Figure 1 illustrates a schematic diagram of a seawater pretreatment and desalination system according to the prior art;

Figure 2 illustrates a schematic diagram of a seawater pretreatment and desalination system according to an embodiment of the present invention;

Figure 3 is a perspective view of a section of intake pipe for a seawater pretreatment system according to an embodiment of the present invention;

Figure 4 is an expanded view of area A shown in Figure 3; and

Figure 5 is a schematic diagram of an intake pipe for a seawater pretreatment system according to another embodiment of the present invention.

DETAILED DESCRIPTION

With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is applicable to other embodiments or of being practiced or carried out in various ways and is limited only by the appended claims. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

Figure 1 of the accompanying drawings illustrates a schematic diagram of a conventional pre-treatment system for a desalination plant. Sea water SW is passed through a filter screen 2 to prevent large debris and marine life entering into an intake pipe 10 which pumps sea water to a series of pretreatment modules 4 and then to a reverse osmosis desalination plant 6 provided on dry land. The pre-treatment modules 4 comprises an ultra-filtration system to remove elements such as silt, algae, bacteria and larger molecular weight of organic matters that would foul the RO membranes. Once the sea water has been treated in the ultra-filtration system it enters the reverse osmosis desalination plant 6 to provide product water PW and brine B. This conventional set-up requires a significant footprint on the land because both the ultra-filtration modules and the RO desalination plant require a large area to provide sufficient treatment of the sea water. This also adds to the cost of the plant site.

Figure 2 of the accompanying drawings is a schematic diagram of the basic concept of the present invention. The pre-treatment module 4 comprising an UF system is provided under the sea, being formed integrally with the intake pipe. Once the filtered water is in the intake pipe 10 it is pumped onto land directly to the RO desalination plant 6 to produce product water PW and brine. This significantly reduces the overall total footprint of the pre-treatment and RO desalination plant and prevents any marine life to be pumped from the sea to the RO desalination plant 6.

Figures 3 and 4 of the accompanying drawings illustrate one embodiment of a modified intake pipe 10 to enable pre-treatment of the sea water to take place as it enters the intake pipe off-shore. The intake pipe has a sealed end 44 and is provided with a network of sealed fibers 42 to provide outside-in dead-end ultrafiltration of the sea water as it enters the intake pipe. The sea water is passes through the fibers into the intake pipe under negative pressure. This causes the feed sea water to be drawn from outside the fibers to pass radially inward through the UF membrane forming the walls of the fibers leaving particles above a certain size, such as solids within the sea water and sludge 48, on the outside surface of the fibers with filtered sea water 50 entering the intake pipe as filtrate. A single header 43 may be provided on each group of fibers and an aeration bore 46 is provided centrally of group to virtually eliminate clogging of the fibers. The filtrate is then pumped through the intake pipe to the RO desalination plant 6 that is provided on the land.

It is to be appreciated that while the use of ultrafiltration membranes formed integrally with the inlet pipe are discussed in relation to the accompanying drawings, the semi-permeable membrane may comprise microfiltration membranes. The UF or MF making up the sealed fibers may be made of any appropriate material. Generally, polymeric membranes may be used, such as polyvinylidene fluoride (PVDF), polysulfone, polypropylene, cellulose acetate or polylactic acid but ceramics type membrane may also be used. Additionally, the system is designed to operate under relatively low fluxes (the rate of flow of the liquid through per unit membrane area) of less than 30 l/m/hr, more preferably less than 20 l/m/hr. This provides a number of advantages in that it significantly reduces the amount of membrane fouling, thereby minimizing the frequency of backwash cleaning of the membranes and prevents marine life surrounding the UF or MF from being affected as the marine life cannot pass through the membranes and therefore does not enter the intake pipe. This is another significant benefit of the present invention in that it minimizes the effect of the desalination plant on marine life. Conventionally, marine life such as small fishes and larva may inadvertently be pumped into the desalination plant or may be effected by the rejection of standard pre-treatment backwash effluent.

The operation of the ultra-filtration or microfiltration membranes attached to the intake pipe(s) will result in fouling of the membranes necessitating cleaning of the fibers at defined intervals. A backwash mode should be provided wherein filtrate from within the intake pipe is pressed out from the filtrate side to the seawater side to remove fouling substances from the membrane surface.

Figure 5 of the accompanying drawings illustrates a preferred embodiment for the intake pipe 10 which increases the volume of sea water that may be ultrafiltered (or microfiltered) and allows for backwashing of segments 10a, 10b, 10e of the pipe at different intervals. In this respect, the main intake pipe 10 divides into a plurality of subsidiary pipes 10a, 10b, 10e at the UF operational end of the pipe, each subsidiary pipe having a sealed end 44 and being provided with a network of groups of ultrafiltration membranes 42 extending from at least part of their surface. Each subsidiary pipe, or group of pipes, is provided with appropriate valves to allow isolation of the pipe or group of pipes (illustrated by B in Figure 5) from the UF process and is connected to a separate water source to allow backwashing of that pipe or group of pipes. In this manner, only one or a proportion of the subsidiary pipes may be removed from the UF process to allow backwashing while others remain in operation enabling continuous pre-treatment of the sea water as it enters the main intake pipe 10. Once cleaned, the pipes can be reconnected to enable the normal UF process to resume, with another pipe or group of pipes being taken out of circulation for backwashing as and when required. The separate water source may be provided from source using a dedicated pumping system.

It is clear that the process and system of the present invention significantly reduces the overall footprint of a membrane based desalination plant that includes

UF pre-treatment modules. Furthermore, the detrimental effect of this process on marine life is minimized and should be considered as eco-friendly.

In the above description, an embodiment is an example or implementation of the invention. The various appearances of "one embodiment", "an embodiment" or "some embodiments" do not necessarily all refer to the same embodiments.

Although various features of the invention may be described in the context of a single embodiment, the features may also be provided separately or in any suitable combination. Conversely, although the invention may be described herein in the context of separate embodiments for clarity, the invention may also be implemented in a single embodiment.

Embodiments of the invention may include features from different embodiments disclosed above, and embodiments may incorporate elements from other embodiments disclosed above. The disclosure of elements of the invention in the context of a specific embodiment is not to be taken as limiting their used in the specific embodiment alone.

Furthermore, it is to be understood that the invention can be carried out or practiced in various ways and that the invention can be implemented in embodiments other than the ones outlined in the description above.

The invention is not limited to those diagrams or to the corresponding descriptions. For example, flow need not move through each illustrated box or state, or in exactly the same order as illustrated and described.

Meanings of technical and scientific terms used herein are to be commonly understood as by one of ordinary skill in the art to which the invention belongs, unless otherwise defined.

While the invention has been described with respect to a limited number of embodiments, these should not be construed as limitations on the scope of the invention, but rather as exemplifications of some of the preferred embodiments. Other possible variations, modifications and applications are also within the scope of the invention, as limited by the claims.

CLAIMS

1. A water intake and pretreatment system comprising at least one inlet pipe for locating within a water source for delivering feed water from the water source to a membrane desalination plant on land; at least part of said at least one inlet pipe being provided with an integrated plurality of ultrafiltration (UF) or microfiltration (MF) membranes for filtering the feed water during its entry into the at least one inlet pipe.

2. A water intake and pretreatment system as claimed in claim 1 wherein the inlet pipe has a sealed end and is provided with a network UF or MF membrane fibers extending from the surface of the inlet pipe through which the feed water must pass to enter the inlet pipe.

3. A water intake and pretreatment system as claimed in claim 1 or claim 2 wherein filtration is provided through the inlet pipe, thus the pipe delivers filtrated water only during its operation.

4. A water intake pipe and pretreatment system as claimed in claim 1, 2 or 3 wherein the membranes provide outside-in filtration of the feed water with the flow of feed water being outside-in.

5. A water intake pipe and pretreatment system as claimed in any one of the preceding claims wherein means is provided for the application of negative pressure within the inlet pipe to draw the feed water through the membranes.

6. A water intake pipe and pretreatment system as claimed in any one of the preceding claims wherein means is provided for aeration across an outer surface of the membranes.

7. A water intake pipe and pretreatment system as claimed in any one of the preceding claims wherein a plurality of inlet pipes are provided with at least part of each inlet pipe being provided with the integrated plurality of ultrafiltration (UF) or

microfiltration (MF) membranes, each inlet pipe or a group of inlet pipes being isolatable from the other pipes to allow backwashing of the isolated pipes.

8. A water intake pipe and pretreatment system as claimed in any one of claims 1 to 6 wherein the at least one inlet pipe comprises a main inlet pipe that is free from UF or MF membranes, an end of the main inlet pipe being provided with an array of subsidiary pipes in fluid communication therewith, the subsidiary pipes being provided with the ultrafiltration or microfiltration membranes over at least a part of the surface thereof, each subsidiary pipe or a group of subsidiary pipes, being isolatable from the other subsidiary pipes and the main inlet pipe to allow backwashing of the isolated pipes.

9. A water intake and pretreatment system as claimed in claim 7 or 8 wherein each inlet pipe or subsidiary pipe, or a group of inlet or subsidiary pipes, is provided with isolation valves and is connectable to a separate water source to allow backwashing of their membranes.

10. A water intake pipe and pretreatment system as claimed in any one of the preceding claims wherein means is provided for backwashing wash of the subsidiary pipes using filtrated seawater, brine or permeate water

11. A pretreatment and desalination plant comprising at least one inlet pipe located within a water source for delivering feed water from the source to a membrane desalination plant, at least part of the said inlet pipe being provided with a plurality of ultrafiltration or microfiltration membranes for filtering feed water during its entry into the at least one inlet pipe; optionally including at least one pump to deliver the filtered feed water in the at least one inlet pipe to a membrane desalination plant located on land for carrying out desalination of the filtered feed water.

12. A pretreatment and desalination plant as claimed in claim 11 wherein the desalination plant is a reverse osmosis desalination plant.

13. A water intake and pretreatment system according to any one of claims 1 to 10 or a pretreatment and desalination plant according to claim 11 or 12 wherein the water source is sea water.

14. A water intake and pretreatment method comprising drawing feed water from a water source through at least one inlet pipe located within the water source wherein at least part of said inlet pipe is provided with an integrated plurality of ultrafiltration (UF) or microfiltration (MF) membranes for filtering the feed water during its entry into the at least one inlet pipe.

15. A water intake and pretreatment method according to claim 14 wherein a low flux of feed water is provided across the UF membranes at low flux rates, preferably being less than 30 l/m/hr, more preferably less than 20 l/m/hr.

16. A water intake and pretreatment method according to claim 14 or claim 15 further comprising a backwash mode to allow cleaning of the UF or MF membranes at intervals, preferably using filtrated seawater, brine or permeate water.

17. A pretreatment and desalination method comprising drawing feed water from a water source through at least one inlet pipe located within the water source, preferably sea water, wherein at least part of the at least one inlet pipe is provided with a plurality of ultrafiltration or microfiltration membranes for filtering the feed water during its entry into the at least one inlet pipe; pumping the filtered water in the inlet pipe from the water source to land to deliver the filtered water to a membrane desalination plant for carrying out desalination of the filtered sea water.

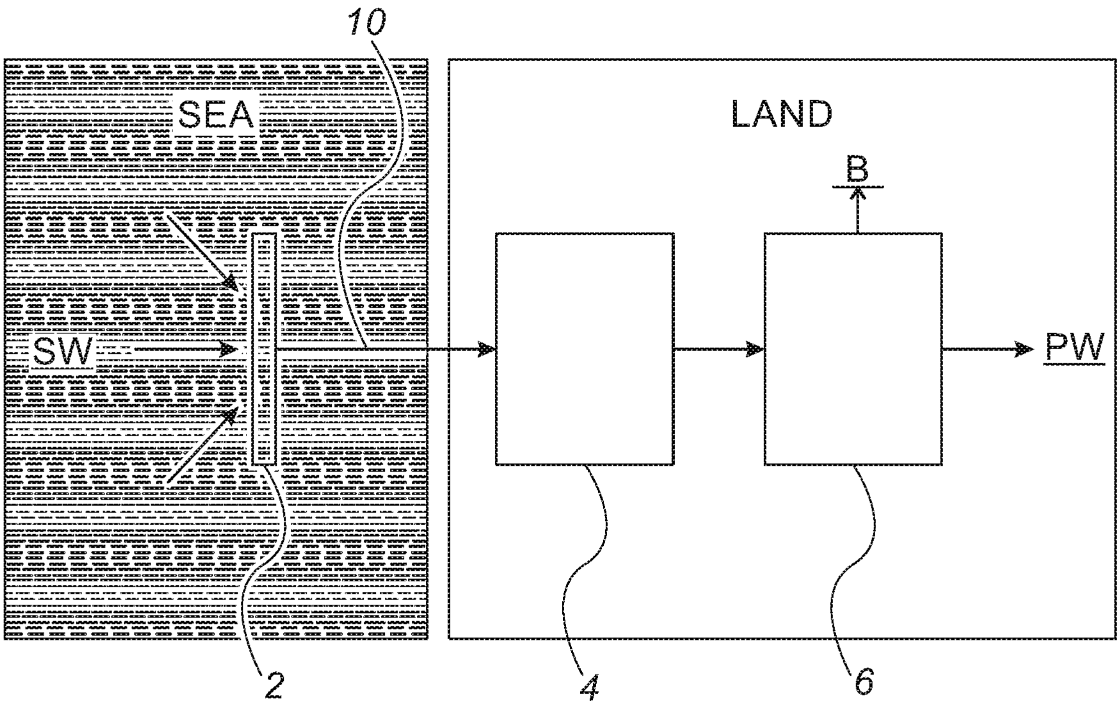

FIG. 1
PRIOR ART

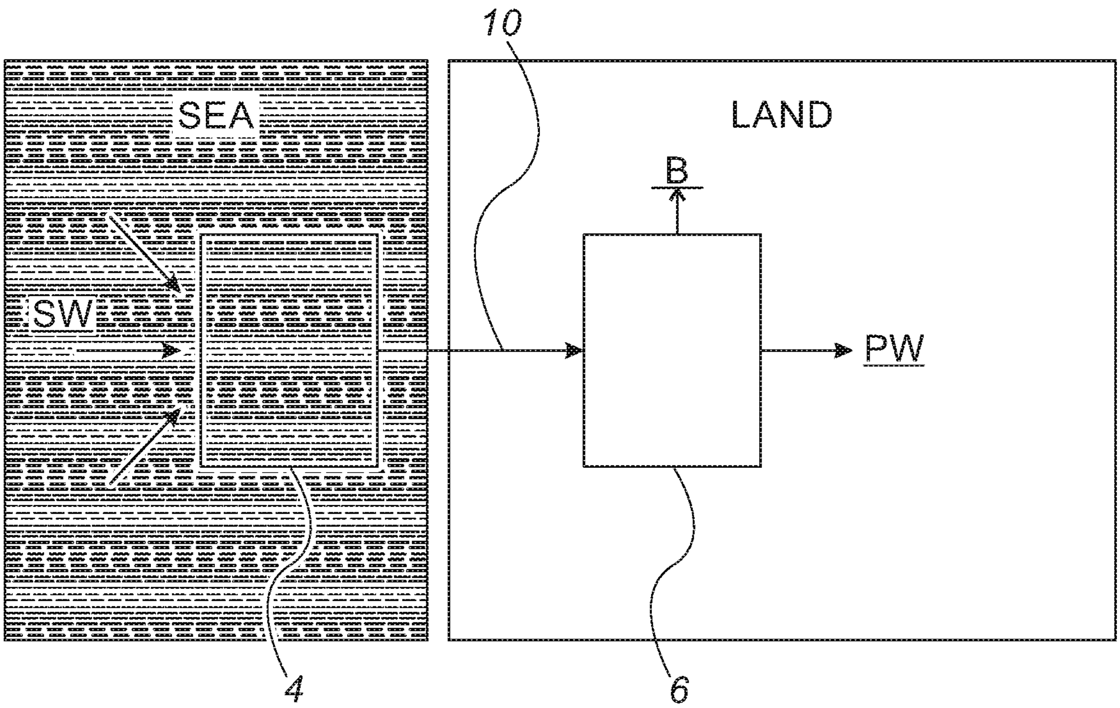

FIG. 2

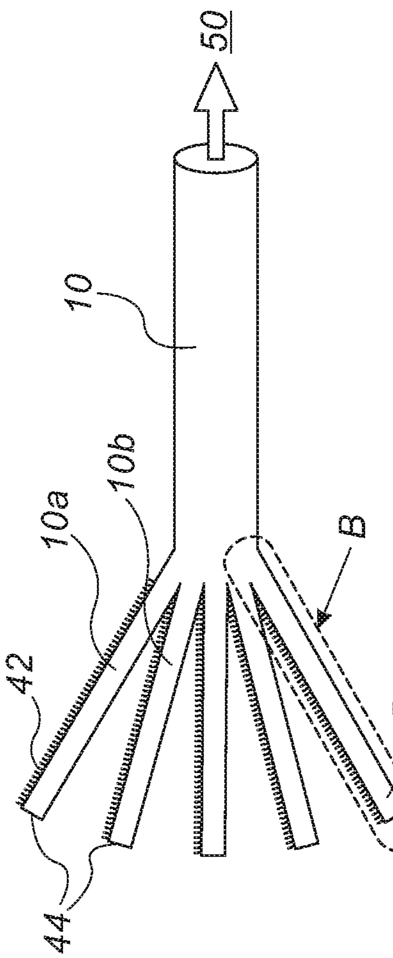

FIG. 5

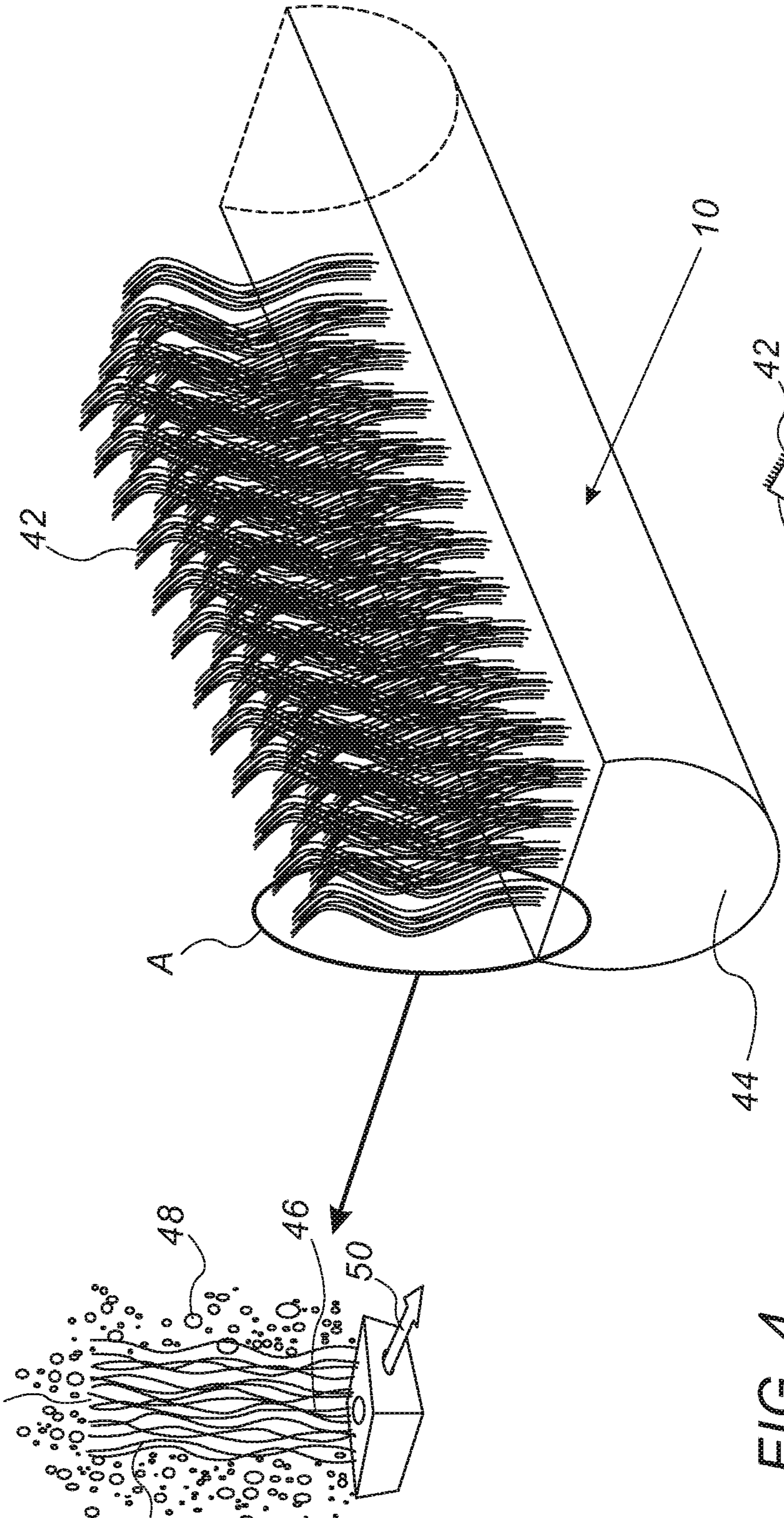

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/059507

A. CLASSIFICATION OF SUBJECT MATTER
INV. C02F1/44
ADD. C02F103/08 B01D63/02 B01D61/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C02F B01D

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/190849 A1 (VUONG DIEM XUAN [US]) 14 August 2008 (2008-08-14) paragraphs [0020] - [0021], [0107], [0146] - [0147], [0172], [0194]; figures 11A/B,12	1-4,6, 11-15
X	US 2011/198237 A1 (POWELL SCOTT W [US]) 18 August 2011 (2011-08-18) paragraphs [0005], [0015], [0041], [0065] - [0070]; figures 1,11,12	1,5,11
X	WO 2013/074228 A1 (GEN ELECTRIC [US]) 23 May 2013 (2013-05-23) paragraphs [0006], [0009], [0012]; figure 1	1,7-17

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
19 February 2019	28/02/2019

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/059507

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/264254 A1 (USHIKOSHI KENICHI [JP] ET AL) 10 October 2013 (2013-10-10) paragraphs [0019], [0042]; figures 1,2	1,11,14, 15,17
A	US 2008/093299 A1 (MAHENDRAN MAILVAGANAM [CA] ET AL) 24 April 2008 (2008-04-24) the whole document	1-17
A	EP 2 996 989 A1 (SANKO TEKSTIL ISLETMELERI SANAYI VE TICARET A S [TR]; ZEREN FEVZI [US]) 23 March 2016 (2016-03-23) the whole document	1-17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2018/059507

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008190849 A1	14-08-2008	AU 2008216299 A1	21-08-2008
		BR PI0807930 A2	01-07-2014
		CA 2676230 A1	21-08-2008
		CN 101626982 A	13-01-2010
		EA 200970717 A1	30-04-2010
		EP 2125630 A1	02-12-2009
		JP 2010517772 A	27-05-2010
		KR 20090117944 A	16-11-2009
		TW 200902452 A	16-01-2009
		US 2008190849 A1	14-08-2008
		US 2010237016 A1	23-09-2010
		WO 2008100957 A1	21-08-2008
US 2011198237 A1	18-08-2011	US 2010140180 A1	10-06-2010
		US 2011198237 A1	18-08-2011
		WO 2010060016 A1	27-05-2010
WO 2013074228 A1	23-05-2013	US 2013118978 A1	16-05-2013
		WO 2013074228 A1	23-05-2013
US 2013264254 A1	10-10-2013	AU 2012305529 A1	11-07-2013
		CA 2823920 A1	14-03-2013
		CN 103298750 A	11-09-2013
		JP 5564021 B2	30-07-2014
		JP 2013052364 A	21-03-2013
		US 2013264254 A1	10-10-2013
		WO 2013035576 A1	14-03-2013
US 2008093299 A1	24-04-2008	US 2004238432 A1	02-12-2004
		US 2008093299 A1	24-04-2008
EP 2996989 A1	23-03-2016	EP 2996989 A1	23-03-2016
		US 2014339169 A1	20-11-2014
		WO 2014185936 A1	20-11-2014