

CLAIMS

1. A subsea desalination system comprising:
a subsea desalination template (1) adapted to be located on a seabed, including at
5 least one subsea desalination module zone (41), at least one module fluid
coupling (46) and template piping (36) in fluid connection with the at least one
module fluid coupling (46);
at least one retrievable subsea desalination module (5) adapted to be placed in
the at least one subsea desalination module zone (41) of the subsea desalination
10 template (1), the at least one retrievable subsea desalination module (5) including
a subsea template fluid coupling (47) adapted to be connected to the at least one
module fluid coupling (46), and at least one reverse osmosis cartridge (23) in fluid
connection with the subsea template fluid coupling (47);
at least one seawater circulation pump assembly (49) in fluid connection with a
15 seawater side of the at least one reverse osmosis cartridge (23);
at least one desalinated water transport pump assembly (48) in fluid connection
with a desalinated water side of the at least one reverse osmosis cartridge (23) in
the retrievable subsea desalination module (5) and at least one desalinated water
pipeline (2);
20 at least one retrievable subsea water pump module (17) including at least one of
the desalinated water transport pump assembly (48), and the at least one
seawater circulation pump assembly (49);
at least one template fluid coupling (47) on the at least one retrievable subsea
water pump module (17), adapted to be connected to at least one module fluid
25 coupling (46) on a template with a pump module zone (42); and
wherein the at least one desalinated water pipeline (2) is adapted to extend to a
location above a sea level.
2. The subsea desalination system of claim 1, further including a permanent
30 seabed foundation (50) secured to seabed anchoring elements (40), and wherein
the subsea desalination template (1) is adapted to be located on top of the
permanent seabed foundation (50).

3. The subsea desalination system of claim 1, wherein the subsea desalination template (1) is adapted to be located on a further base template (55) in fluid connection with the desalinated water pipeline (2) and a concentrated seawater outlet (3).
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4. The subsea desalination system of claim 3, wherein the further subsea base template (55) is adapted to be located on top of a permanent seabed foundation (50).
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5. The subsea desalination system of claim 1, wherein the subsea desalination template (1) further includes seabed anchoring elements (40) secured to the subsea desalination template (1).
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6. The desalination system of any of the preceding claims, wherein the template with a pump module zone (42) is the desalination template (1).
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7. The desalination system of any of the preceding claims, wherein the at least one seawater circulation pump assembly (49) and the at least one desalinated water transport pump assembly (48) are located in a common retrievable subsea water pump module (17).
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8. The desalination system of any of the claims 1-6, wherein the at least one seawater circulation pump assembly (49) is located in a retrievable subsea seawater circulation pump module (17b);
the at least one desalinated water transport pump assembly (48) is located in a retrievable subsea desalinated water transport pump module (17a); and
wherein the retrievable transport pump module (17a) is located in a desalinated water transport pump module zone (42) and the retrievable subsea circulation pump module (17b) is located in a circulation pump module zone (45).
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9. The desalination system of any of the preceding claims, further including at least one retrievable control module (18) located in at least one control module zone (44) on the desalination template (1).

10. The desalination system of any of the preceding claims, wherein the at least one subsea desalination module (5) includes a seawater inlet filter (22) arranged to filter seawater entering the at least one reverse osmosis cartridge (23).

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11. The desalination system of claim 10, wherein the seawater inlet filter (22) is located on top of the at least one subsea desalination module (5).

12. The desalination system of any of the preceding claims, wherein the template with a pump module zone (42) is a separate pumping template (16), and wherein a desalinated water flow path extends between the separate pumping template (16) and the subsea desalination template (1).

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13. The desalination system of claim 8, further including a separate filtering and pumping station (21) wherein a filter (22) and the circulation pump assembly (49) in a circulation pump module (17b) is located on the filtering and pumping station (21) upstream and in fluid connection with the desalination template (1), pumping seawater through the at least one subsea desalination module (5).

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14. The desalination system of any of the preceding claims, wherein at least one separate pumping template (16) with the at least one pumping module (17) is located on a downstream side of the at least one subsea desalination template (1) and includes a desalinated water inlet and a desalinated water outlet, whereby the separate pumping template (16) with the at least one pumping module (17) is adapted to convey the desalinated water from the desalination template (1).

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15. A subsea desalination module (5) for a desalination system of claim 1, comprising a plurality of reverse osmosis cartridges (23) and a subsea template fluid coupling (47) adapted to be connected to at least one module fluid coupling on a desalination template..

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16. A method exchanging a used subsea desalination module (5) installed on a subsea desalination system of claim 1, including the steps of:

- identifying that the used subsea desalination module (5) require service based on regular scheduled intervals or parameters selected from the group of parameters: desalinated water flow rate, water pressure drop over the subsea desalination module (5) and desalinated water salinity;
- 5 providing a vessel (6) above the subsea desalination system;
lowering a subsea desalination module lifting means onto the used subsea desalination module (5);
securing the subsea desalination module lifting means to the used subsea desalination module;
- 10 releasing the used subsea desalination module (5) from a subsea desalination template (1);
lifting the subsea desalination module lifting means and the used subsea desalination module on to the vessel;
lowering the subsea desalination module lifting means and an exchange subsea desalination module onto subsea the desalination template;
- 15 securing the exchange subsea desalination module (5) to the subsea desalination template (1); and
releasing the subsea desalination module lifting means from the exchange subsea desalination module (5).

ABSTRACT

The present invention relates to a modularized subsea desalination system. A subsea desalination template includes subsea desalination module zones 41 and module fluid couplings 46. A desalinated water outlet is in fluid connection with the module fluid coupling 46 in the subsea desalination module zone. Subsea desalination modules 5 with reverse osmosis cartridges 23 are in fluid connection with a subsea template fluid coupling 47, a seawater inlet section and a concentrated seawater outlet section. A transport pump assembly 48 for desalinated water in a pump module 17 is in fluid connection with the subsea desalination template 1 and the desalination modules 5. A seawater circulation pump 49 is in fluid connection with a seawater side of the at least one reverse osmosis cartridge 23. A desalinated water pipeline 2 convey fluid from the desalinated water transport pump assembly 48 to a location above a sea level. Furthermore, the invention relates to a subsea desalination module 5 and a method exchanging a subsea desalination module 5 requiring service.