



- (51) International Patent Classification: *C02F 1/44* (2006.01)
- (21) International Application Number: PCT/US2016/039377
- (22) International Filing Date: 24 June 2016 (24.06.2016)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 62/184,159 24 June 2015 (24.06.2015) US
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- (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,

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(54) Title: METHODS OF DEWATERING OF ALCOHOLIC SOLUTIONS VIA FORWARD OSMOSIS AND RELATED SYSTEMS

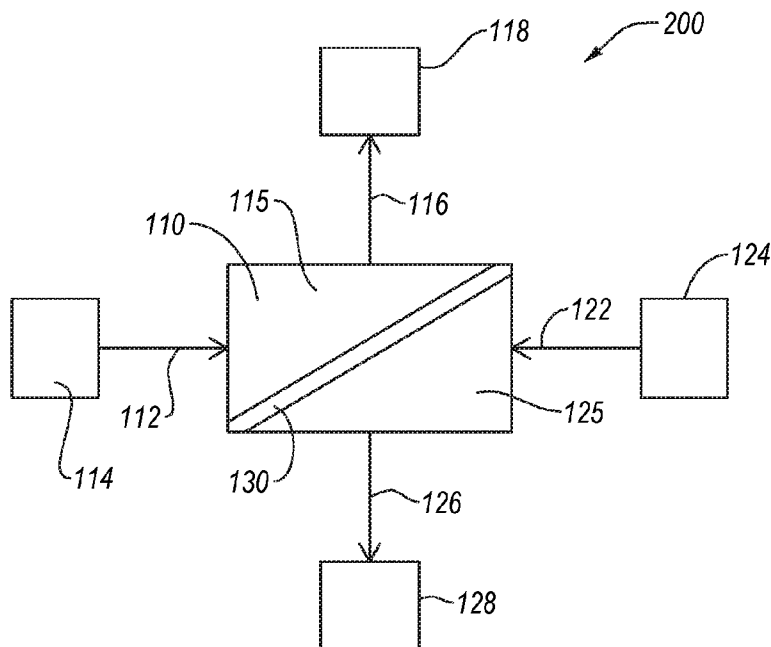


FIG. 2

(57) Abstract: Embodiments described herein relate to methods and systems for dewatering alcoholic solutions via forward osmosis.





SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,  
GW, KM, ML, MR, NE, SN, TD, TG).

— before the expiration of the time limit for amending the  
claims and to be republished in the event of receipt of  
amendments (Rule 48.2(h))

**Published:**

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

**(88) Date of publication of the international search report:**

9 March 2017

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/39377

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(8) - C02F 1/44 (2016.01) CPC - B01D61/005; C02F1/445; B01D2311/25; B01D61/002; C12C11/11 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC(8): C02F 1/44 (2016.01) CPC: B01D61/005; C02F1/445; B01D2311/25; B01D61/002; C12C11/11; B01D2325/00; B01D71/00; B01D2317/00; B01D2321/00 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) Pat Base (AU BE BR CA CH CN DE DK EP ES FI FR GB IN JP KR SE TH TW US WO), Google Patent, Google Scholar; Search terms: forward osmosis concentration water solute draw solution circulate alcohol ethanol beer wine spirit osmotic pressure distillation impermeable glycerol FO desalinate dewater dissolved agent re-circulate recycle regenerate glycerin		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.™
X	WO 2014/144778 A1 (PORIFERA, INC.) 18 September 2014 (18.09.2014) para [014], [016]-[019], [021], [025], [034] [036]; figure 1; table 1	1-3, 5-6, 7a, 7b, 8 and 12
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Y		4, 9-11, 13-23 and 33-43
Y	US 4,792,402 A (FRICKER) 20 December 1988 (20.12.1988) col 1, ln 11-24 and ln 67-68; col 2, ln 1-5; col 4, ln 31-61; example 1	4, 35 and 39
Y	US 2012/0267297 A1 (IYER) 25 October 2012 (25.10.2012) para [0010], [0049], [0053], [0074]	9-11, 33-43
Y	US 2015/0064306 A1 (TATERA) 5 March 2015 (05.03.2015) para [0013], [0017], [0030], [0034]-[0035], [0043]	13-23
Y	US 2013/0220581 A1 (HERRON et al.) 29 August 2013 (29.08.2013) para [0028]-[0030]	11 and 40
Y	US 2014/0319056 A1 (FUCHIGAMI et al.) 30 October 2014 (30.10.2014) para [0052], [0122]	18-19
A	US 2010/0155333 A1 (HUSAIN et al.) 24 June 2010 (24.06.2010); the entire document	1, 13 and 33
		14
		15
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/>		
* 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 "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
11 January 2017		19 JAN 2017
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

## INTERNATIONAL SEARCH REPORT

International application No. --

PCT/US 16/39377

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:  
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-23 and 33-43, directed to a method of dewatering a solution.

Group II: Claims 24-32, directed to a system for dewatering an alcoholic solution.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

**\*\*Please see the continuation at the end of this form\*\***

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-23 and 33-43

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

**\*\*Continuation of Box III (Lack of Unity)\*\*****Special Technical Features:**

Group I does not require a system for dewatering an alcoholic solution; a forward osmosis element including at least one selectively permeable forward osmosis membrane separating a first side of the forward osmosis element from a second side of the forward osmosis element, as required by Group II.

Group II does not require a method of circulating a draw solution in a second side of the forward osmosis system; generating a diluted draw solution in the second side of the forward osmosis system; producing a product stream including a concentrated feed solution from the first side of the forward osmosis system, as required by group I.

**Common Technical Features:**

Group I and II share the technical feature of dewatering an alcoholic solution; forward osmosis; permeable; an alcohol solution/beverage on the first side; and a draw solution in the second side; the draw solution having an alcohol concentration equal to or greater than the alcohol solution. However, these shared technical features do not represent a contribution over prior art, because the shared technical feature is being obvious over WO 2014/144778 A1 to Porifera, Inc. (hereinafter Porifera) in view of US 2010/0155333 A1 to Husain et al. (hereinafter Husain). Porifera teaches dewatering an solute solution (para [017]-[019]; figure 1; Feed stream 102, enters the forward osmosis module 103, where it is dewatered and leaves the system as reject stream 104. Here, the solute would be salt, such as sodium chloride); forward osmosis (para [019]; figure 1; forward osmosis module); permeable (para [014]; use of nanofiltration and forward and reverse osmosis); a solute solution on the first side (para [017]-[019]; figure 1; Feed stream 102, enters the forward osmosis module 103, where it is dewatered and leaves the system as reject stream 104. Here, the solute would be salt, such as sodium chloride. Further, the first side would be the side where feed 102 (solute solution) enters forward osmosis module 103); and a draw solution in the second side (para [017]-[019]; figure 1; draw stream 105 enters the forward osmosis module 103, and this would be the second side); the draw solution having a solute concentration equal to or greater than the solute solution (para [016]-[019]; the draw solution 105 has a concentration higher than feed 100 (solute solution); and the solute can be salt, such as sodium chloride). However, Porifera does not teach that the solute is alcohol (the compound that is concentrated/dewatered is alcohol). Husain, on the other hand, teaches that the solute is alcohol (the compound that is concentrated/dewatered is alcohol) (para [0023]; dewatering of an aqueous alcohol solution). Therefore, it would have been obvious to one ordinary skilled in the art to dewater alcohol, as taught by Husain; with using forward osmosis to dewater a solute, as taught by Porifera; because processes are known for producing high concentration organic solutions such as alcohols [are] useful in the production of alternative fuels (Husain; para [0002]).

As the shared technical features were known in the art at the time of the invention, they cannot be considered common technical features that would otherwise unify the groups. Therefore, Groups I-II lack unity under PCT Rule 13.