



(12) **United States Patent
Lipp**

(10) **Patent No.: US 10,676,377 B2**
(45) **Date of Patent: Jun. 9, 2020**

(54) **SELECTIVE SEPARATION PROCESS**

(58) **Field of Classification Search**
CPC combination set(s) only.
See application file for complete search history.

(71) Applicant: **BATEMAN ADVANCED
TECHNOLOGIES LTD.**, Yokneam
(IL)

(56) **References Cited**

(72) Inventor: **Jonathan Lipp**, Givat Avni (IL)

U.S. PATENT DOCUMENTS

(73) Assignee: **TENOVA ADVANCED
TECHNOLOGIES LTD.**, Yokneam
(IL)

5,587,083 A * 12/1996 Twardowski B01D 61/022
210/651
6,004,464 A * 12/1999 Lien B01J 49/50
210/639

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 44 days.

(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **15/310,773**

WO 96/33005 A1 10/1996
WO 00/03791 A1 1/2000

(22) PCT Filed: **May 18, 2015**

(Continued)

(86) PCT No.: **PCT/IB2015/053642**

Trisep (Infosheet [online], revised 2017 [retrieved on Jun. 28, 2018.
Retrieved from the Internet: <URL: www.trisep.com/s/ACM5.
pdf>). (Year: 2017).*

§ 371 (c)(1),
(2) Date: **Nov. 13, 2016**

(Continued)

(87) PCT Pub. No.: **WO2015/177705**

Primary Examiner — Ryan B Huang
(74) *Attorney, Agent, or Firm* — Marc Van Dyke;
Momentum IP Group

PCT Pub. Date: **Nov. 26, 2015**

(65) **Prior Publication Data**

US 2017/0081217 A1 Mar. 23, 2017

(30) **Foreign Application Priority Data**

May 19, 2014 (GB) 1408885.0

(51) **Int. Cl.**
C02F 1/44 (2006.01)
B01D 61/12 (2006.01)

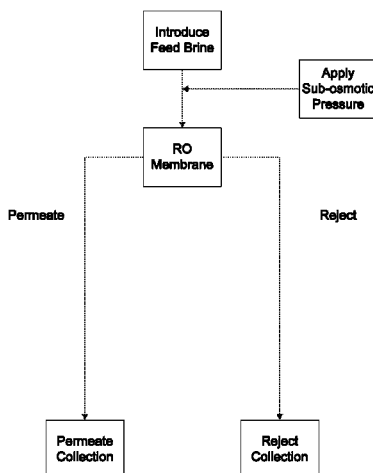
(Continued)

(52) **U.S. Cl.**
CPC **C02F 1/441** (2013.01); **B01D 61/025**
(2013.01); **B01D 61/12** (2013.01);
(Continued)

(57) **ABSTRACT**

A method of selectively separating ions, including: (a) providing a reverse osmosis (RO) separation arrangement having an RO membrane; (b) introducing a feed brine to the RO membrane, the brine containing multivalent cations, alkali cations and halide anions, a total concentration of the alkali cations and halide anions being at least 4%, by weight of the feed brine; (c) applying a sub-osmotic pressure to the feed brine, to drive a first portion of the brine through the RO membrane to produce a permeate solution, a remainder of the feed brine being rejected by the RO membrane and being discharged as a reject solution; the sub-osmotic pressure being applied so as to preferentially distribute the multivalent cations to the reject solution, with respect to the

(Continued)





US010189710B2

(12) **United States Patent**
Lipp

(10) **Patent No.:** **US 10,189,710 B2**
(45) **Date of Patent:** **Jan. 29, 2019**

(54) **METHOD OF PURIFYING PHOSPHORIC ACID**

(71) Applicant: **BATEMAN ADVANCED TECHNOLOGIES LTD.**, Yokneam (IL)

(72) Inventor: **Jonathan Lipp**, Givat Avni (IL)

(73) Assignee: **TENOVA ADVANCED TECHNOLOGIES LTD.**, Hi-Tech Park, Yokneam (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/110,745**

(22) PCT Filed: **Jan. 18, 2015**

(86) PCT No.: **PCT/IB2015/050369**
§ 371 (c)(1),
(2) Date: **Jul. 10, 2016**

(87) PCT Pub. No.: **WO2015/107500**
PCT Pub. Date: **Jul. 23, 2015**

(65) **Prior Publication Data**
US 2016/0332879 A1 Nov. 17, 2016

(30) **Foreign Application Priority Data**
Jan. 20, 2014 (GB) 1400876.7

(51) **Int. Cl.**
C01B 25/237 (2006.01)
C01B 25/234 (2006.01)

(52) **U.S. Cl.**
CPC **C01B 25/2377** (2013.01); **C01B 25/234** (2013.01)

(58) **Field of Classification Search**
CPC . B01D 61/027; C01B 25/234; C01B 25/2208; C01B 25/223; C01B 25/225
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,070,443 A * 1/1978 Kikuchi C01B 25/234 423/321.1
4,857,211 A * 8/1989 Nineuil C01B 25/2208 134/3
5,945,000 A * 8/1999 Skidmore B01D 61/027 210/650

FOREIGN PATENT DOCUMENTS

KR 20060011699 A1 2/2006

OTHER PUBLICATIONS

Gonzalez et al. "Purification of phosphoric acid solutions by reverse osmosis and nanofiltration" Desalination, 147 (2002) 315-320.*
International Search Report for PCT/IB2015/050369, dated Apr. 21, 2015.

Written Opinion for PCT/IB2015/050369, dated Apr. 21, 2015.

(Continued)

Primary Examiner — Amber R Orlando

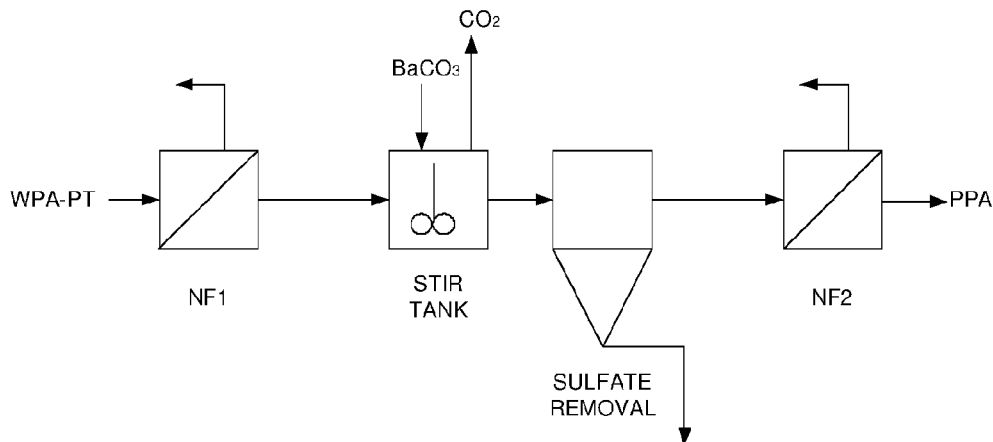
Assistant Examiner — Syed T Iqbal

(74) *Attorney, Agent, or Firm* — Marc Van Dyke

(57) **ABSTRACT**

A method of purifying phosphoric acid solution produced in a wet process using nanofiltration. The claimed method contains the following: (a) providing wet phosphoric feed (b) subjecting the said feed to a first nanofilter (c) produce sulfate solids (d) removing the solids (e) subjecting a second nanofilter.

20 Claims, 2 Drawing Sheets





US010058797B2

(12) **United States Patent**
Firestein et al.

(10) **Patent No.:** **US 10,058,797 B2**
(45) **Date of Patent:** **Aug. 28, 2018**

(54) **CONTACTING ARRANGEMENT**
(71) Applicant: **BATEMAN ADVANCED TECHNOLOGIES LTD.**, Yokneam (IL)
(72) Inventors: **Mark Firestein**, Yokneam Moshava (IL); **Oded Lerner**, Haifa (IL); **Nadav Dobrin**, Kfar Yona (IL)
(73) Assignee: **TENOVA ADVANCED TECHNOLOGIES**, Yokneam (IL)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 188 days.

(58) **Field of Classification Search**
CPC B01D 11/04; B01D 11/043; B01D 11/02; B01D 21/0042; B01D 21/0045; B01D 21/0048; B01D 21/0039; B01D 21/0069; B01F 13/10; B01F 13/0074; B01F 13/0081; B01F 13/0094; B01J 19/32; B01J 2219/32; B01J 2219/322; B01J 2219/32203; B01J 2219/32206; B01J 2219/32282;
(Continued)

(21) Appl. No.: **14/909,518**
(22) PCT Filed: **Aug. 11, 2014**
(86) PCT No.: **PCT/IB2014/063856**
§ 371 (c)(1),
(2) Date: **Feb. 2, 2016**
(87) PCT Pub. No.: **WO2015/022627**
PCT Pub. Date: **Feb. 19, 2015**

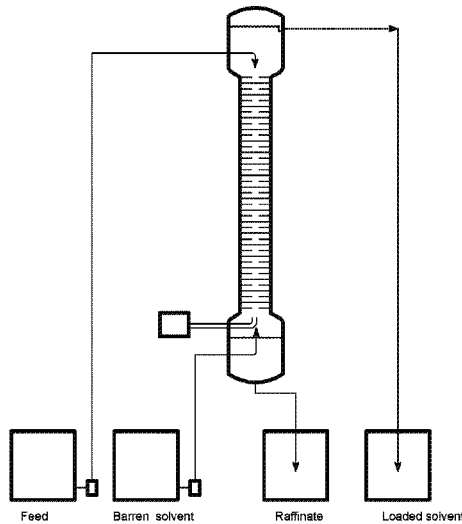
(56) **References Cited**
U.S. PATENT DOCUMENTS
590,535 A 9/1897 Arbuckle
2,400,962 A * 5/1946 Thompson B01D 11/043 422/256
(Continued)

(65) **Prior Publication Data**
US 2016/0166948 A1 Jun. 16, 2016
(30) **Foreign Application Priority Data**
Aug. 12, 2013 (GB) 1314425.8

FOREIGN PATENT DOCUMENTS
EP 0541005 A2 5/1993
EP 635293 A2 1/1995
GB 2144052 A 2/1985
OTHER PUBLICATIONS
International Search Report for PCT/IB2014/063856, search report dated Dec. 16, 2014.
(Continued)

(51) **Int. Cl.**
B01D 11/04 (2006.01)
B01J 19/32 (2006.01)
B01F 13/00 (2006.01)
(52) **U.S. Cl.**
CPC **B01D 11/043** (2013.01); **B01F 13/0074** (2013.01); **B01J 2219/32206** (2013.01)

Primary Examiner — Joseph Drodge
(74) *Attorney, Agent, or Firm* — Marc Van Dyke
(57) **ABSTRACT**
Contacting arrangements adapted to be installed within a liquid-liquid extraction column, and including pairs of disk and doughnut plates.
20 Claims, 10 Drawing Sheets





US010040000B2

(12) **United States Patent**
Lerner et al.

(10) **Patent No.:** **US 10,040,000 B2**
(45) **Date of Patent:** **Aug. 7, 2018**

(54) **REVERSE FLOW SETTLER APPARATUS**
(71) Applicant: **Tenova Advanced Technologies Ltd.,**
Yokneam (IL)
(72) Inventors: **Oded Lerner, Haifa (IL); Keren**
Larmour-Ship, Mitzpe Netofa (IL);
Mark Vancas, San Manuel, AZ (US)
(73) Assignee: **TENOVA ADVANCED**
TECHNOLOGIES LTD., Yokneam
(IL)

(58) **Field of Classification Search**
CPC B01D 17/0208; B01D 17/0211; B01D
17/0214; B01D 21/0042; B01D 21/0087;
B01D 21/2405
USPC 210/519, 521, 532.1, 540, 801
See application file for complete search history.

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 5 days.

(56) **References Cited**
U.S. PATENT DOCUMENTS
1,702,612 A * 2/1929 Morse B01D 17/0208
210/519
2,638,177 A 5/1953 Kalman
2,728,457 A * 12/1955 Clarke B01D 17/0211
210/521
3,419,145 A 12/1968 De Celis
4,396,508 A * 8/1983 Broughton B01D 17/0211
210/522
5,100,545 A * 3/1992 Brooks B03B 5/30
210/532.1

(21) Appl. No.: **15/323,418**
(22) PCT Filed: **Jul. 2, 2015**
(86) PCT No.: **PCT/IB2015/055002**
§ 371 (c)(1),
(2) Date: **Jan. 1, 2017**

(Continued)
FOREIGN PATENT DOCUMENTS
EP 0553599 A1 8/1993
GB 2113564 * 8/1983

(87) PCT Pub. No.: **WO2016/001872**
PCT Pub. Date: **Jan. 7, 2016**

OTHER PUBLICATIONS
International Search Report for PCT/IB2015/055002, search report
dated Oct. 13, 2015.

(65) **Prior Publication Data**
US 2017/0157535 A1 Jun. 8, 2017

(30) **Foreign Application Priority Data**
Jul. 3, 2014 (GB) 1411947.3

(Continued)
Primary Examiner — Christopher Upton
(74) *Attorney, Agent, or Firm* — Marc Van Dyke

(51) **Int. Cl.**
B01D 17/028 (2006.01)
B01D 17/02 (2006.01)
B01D 21/24 (2006.01)
(52) **U.S. Cl.**
CPC **B01D 17/0211** (2013.01); **B01D 17/0214**
(2013.01); **B01D 21/2405** (2013.01)

(57) **ABSTRACT**
A reverse flow settling apparatus.

20 Claims, 10 Drawing Sheets

