

(43) International Publication Date  
31 December 2014 (31.12.2014)

WIPO | PCT

(10) International Publication Number  
**WO 2014/209669 A1**

## (51) International Patent Classification:

**B01D 61/44** (2006.01) **C02F 1/42** (2006.01)  
**B01D 61/46** (2006.01) **C02F 1/46** (2006.01)  
**B01D 61/54** (2006.01) **C02F 1/469** (2006.01)

## (21) International Application Number:

PCT/US2014/042655

## (22) International Filing Date:

17 June 2014 (17.06.2014)

## (25) Filing Language:

English

## (26) Publication Language:

English

## (30) Priority Data:

61/836,756 19 June 2013 (19.06.2013) US

(71) Applicant: **MASSACHUSETTS INSTITUTE OF TECHNOLOGY** [US/US]; 77 Massachusetts Avenue, Cambridge, MA 02139 (US).

(72) Inventors: **KWAK, Rhokyun**; 70 Pacific Street, Apt. 463C, Cambridge, MA 02139 (US). **HAN, Jongyoon**; 5 Appletree Lane, Bedford, MA 01730 (US).

(74) Agent: **ELMORE, Carolyn, S.**; Elmore Patent Law Group, P.C., 484 Groton Road, Westford, MA 01886 (US).

(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, LT, 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, 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: WATER DESALINATION/PURIFICATION AND BIO-AGENT PRECONCENTRATION

(57) Abstract: Between two juxtaposed similar ion exchange membranes (AEMs or CEMs), an ion depletion zone (dde) and ion enrichment zone (den) are generated under an electric field. As cations are selectively transferred through the CEMs, for example, anions are relocated in order to achieve electro-neutrality, resulting in the concentration drop (increase) in ion depletion (enrichment) zone. The concentration drop (i.e. salt removal) is low and spatially gradual at relatively low voltage or current (i.e. Ohmic regime). However, at higher voltage or current (i.e. overlimiting regime), strong electroconvective vortex accelerates cation transport through CEMs, allowing us to "relocate" most salt ions. The flat depletion zone occurs with significantly low ion concentration, and corresponding strong electric field in the zone, and any charged agents cannot penetrate this flat zone. As a result, we can separate and collect the desalted/purified flow from brine flow by bifurcating the channel at the end of the CEMs.



WO 2014/209669 A1