(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
18 September 2025 (18.09.2025)

WIPO | PCT

(10) International Publication Number
WO 2025/193884 A1

(51) International Patent Classification:
B01D 61/58 (2006.01) *B01D 69/02* (2006.01)
B01D 61/02 (2006.01) *C22B 3/22* (2006.01)
B01D 61/42 (2006.01)

(21) International Application Number:
PCT/US2025/019666

(22) International Filing Date:
13 March 2025 (13.03.2025)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/565,224 14 March 2024 (14.03.2024) US
63/565,450 14 March 2024 (14.03.2024) US

(71) Applicant: **GRADIANT CORPORATION** [US/US]; 130 New Boston Street, Suite 200, Woburn, MA 01801 (US).

(72) Inventors: **KOTA, Siva, Kumar**; Villa No 188, Noya, Al Athlah St, Yas Island, Abu Dhabi (AE). **SUNDARAM, Deepak**; 398 Kallang Road, The Riverine By The Park, Unit #18-04, Singapore 339098 (SG). **NATARAJAN, Sankar**; 13-02, 11, Tanjong Rhu Road, Singapore 436896 (SG). **CHONG, Chun, Yew**; 35, Eng Kong Crescent, 03-02 Eng Kong Green, Singapore 599427 (SG).

(74) Agent: **ALAM, Saad** et al.; Wolf, Greenfield & Sacks, P.C., 600 Atlantic Avenue, Boston, MA 02210-2206 (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, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, 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, ST, SV, SY, TH,

(54) **Title:** REMOVAL OF HYDROFLUORIC ACID FROM LIQUID STREAMS, INCLUDING FLUORIDE SALT PRECIPITATION

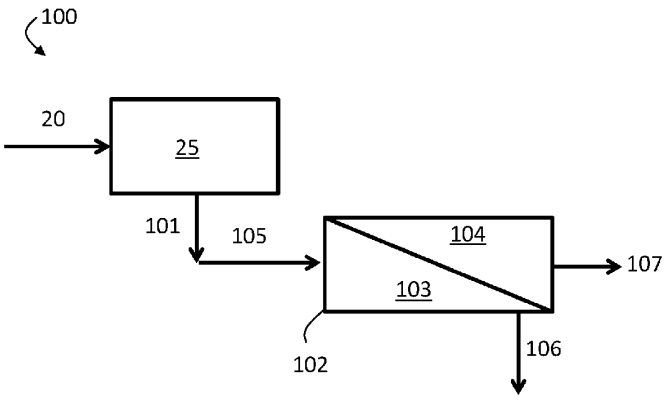


FIG. 1

(57) **Abstract:** Methods and related systems for treating hydrofluoric acid-containing streams are provided. The hydrofluoric acid-containing stream may be, for example, an aqueous wastewater stream from an industrial process such as a semiconductor manufacturing process. The pH of the stream may be adjusted such that a relatively high percentage of the hydrofluoric acid (HF) molecules in the stream are deprotonated to form fluoride ions. In some instances, at least a portion the pH-adjusted stream forms part of (or all of) an inlet stream that is transported to a membrane separator. The membrane separator may produce a retentate outlet stream with a higher concentration of fluoride ions than the inlet stream and a permeate outlet stream containing a portion of liquid from the inlet stream. The methods may include additional treatments, such as removing other species present in the hydrofluoric acid-containing stream, such as silica. Some fluoride may be precipitated as a salt.

WO 2025/193884 A1

[Continued on next page]

TJ, TM, TN, TR, TT, TZ, UA, UG, US, UY, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, 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, ME, 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))*