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# 축전식 흐름전극 기반의 **전기화학적 수처리 기술(FCDI)**

3차원 격자구조 형태의 미세유로 집전체를 통한 축전식 흐름전극 기반의 저비용 수처리 탈염 기술.

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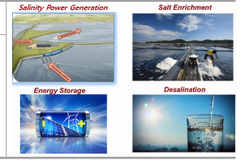
## 기술의 구성도/개념도


FCDI 기술개념도 | 흐름전극 | 3D 흐름전극 구조체

## 기술의 주요 내용 및 특징

- 기존 CDI용 고정전극 대신 슬러리형태의 축전식 흐름전극을 통한 단위셀당 무한 이온흡착 용량을 구현함으로써 저비용의 스케일업이 용이한 새로운 전기화학적 탈염 수처리 기술
- 이온교환 및 집전기술을 통합한 3D 전극구조체 기술
  - 전통적인 2차원 적층구조를 탈피한 저비용의 컴팩트한 새로운 전극화학 셀구조
    - 적층구조 대비 100배 이상의 체적당 접촉면적 구현
    - 적층구조 전기화학셀 가격대비 1/10 예상

## 기술의 적용처

| 응용분야 | 적용제품 | |
|---|---|---|
| 수처리, 에너지변환, 에너지저장, 자원회수 등 | 축전식 탈이온, 염수발전, 해수담수화, 정수, 초순수, 산업폐수 처리, ESS, 결정화 농축 등 |  |

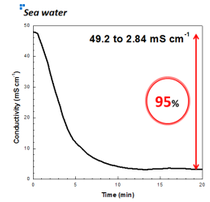


## 기술의 비교우위성/기존 기술 대비 차별성

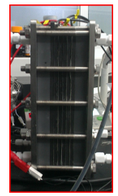
| 기존 기술 | 본 기술 |
|---|---|
| 현존 증발 및 RO기술을 대체할 차세대 수처리 기술로서 전기화학 막분리 기반의 기존 CDI기술의 현안 문제점<br>◦ 제한된 이온흡착용량<br>◦ 반복적인 이온흡·탈착의 불연속성<br>◦ 2차원적 적층의 고비용 스케일업 | 고정상 전극과 달리 전극 활물질의 박막코팅 불필요. 유동상 흐름전극을 이용하여 대용량 탈염과 에너지 저장, 생산기술로 활용 가능.<br>◦ 단위셀에서 무한 흡착용량 구현<br>◦ 대용량 흐름전극기반의 연속공정<br>◦ 3D 구조체 기반의 저비용 스케일업 기술 |

## 실험 및 실증 데이터


세계최초 명함크기 FCDI 단위셀 (N1)




해수영역 95% 탈염성능 (N1셀)



2D Stacking Scale-up

세계최초 3D Scale-up

## 기술의 성숙도

1 기초연구 | 2 | 3 | **4 실험** | 5 | 6 시작품 | 7 | 8 실용화 | 9 사업화

[TRL 4: 실험실 규모의 소재/부품/시스템 핵심성능 평가]

고성능 3D 구조체 기반의 축전식 흐름전극을 이용한 탈염 공정기술
Lab scale 시작품 개발 단계

- 마이크로채널 구조의 축전식 흐름전극 기술 확보
- 3D 전극구조체 기반의 탈염장치 시작품 개발

## 지식재산권 현황

| 순번 | 발명의 명칭 | 출원번호 | 출원일자 | 등록번호 | 등록일자 |
|---|---|---|---|---|---|
| 1 | 유동상 전극시스템 | KR2011-006010 | 2011.08.16 | US9,963,363 B2 | 2018.05.08 |
| 2 | 격자형 흐름전극 구조체 | KR2015-0030566 | 2015.03.04 | KR10-1750417 | 2017.06.19 |

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# Electrochemical water treatment technology via capacitive flow electrodes

## (Flow-electrode Capacitive Deionization, FCDI)


**Principal researcher**

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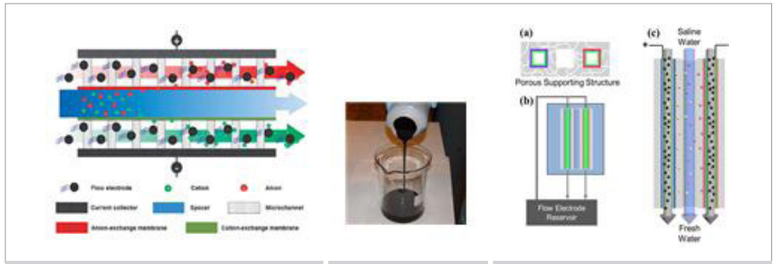
**Kim Dong-Kook**


The present technology is a low-cost water treatment desalination technology based on capacitive flow electrode through a microchannel current collector in a 3D lattice structure.

### Structural Diagram/Conceptual Diagram

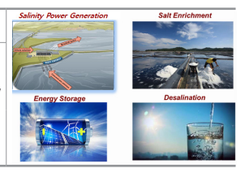



Schematic diagram of FCDI cell | Flow-electrode | 3D flow cell structure

### Description and Characteristics of Technology

- The present technology is a novel electrochemical desalination water treatment technology that may be easily scaled up at a low cost, because an unlimited ion adsorption capacity per unit cell has been realized by employing a slurry type capacitive flow electrode instead of the conventional fixed electrode for CDI.
- 3D electrode structure technology integrating ion exchange and current collector technologies
  - Novel low-cost and compact electrochemical cell structure replacing conventional 2D layered structure
    - The contact area per unit volume is 100 times larger than that of the layered structure.
    - The price is about 1/10 of that of the electrochemical cells having a layered structure.

### Scope of Application

| Application Fields | Products | |
|---|---|---|
| Water treatment, energy conversion, energy storage, resources recycling, etc. | Capacitive deionization, seawater power generation, sweater desalination, water filtration, deionized water, industrial wastewater treatment, ESS, crystallization concentration, etc. |  |

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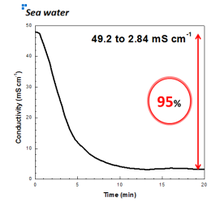
### Comparative advantages over existing technologies

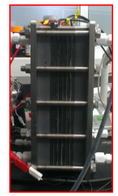
| Conventional Technology | Present Technology |
|---|---|
| The conventional CDI technology based on electrochemical membrane separation has issues that may prevent it becoming a next-generation water treatment technology that will replace the current evaporation and RO technologies.<br>◦ Limited ion adsorption capacity<br>◦ Discontinuity of repeated ion adsorption and desorption<br>◦ High-cost scale-up by 2D lamination | The present technology does not require film coating of an electrode active material in contrast to a fixed electrode. The flow electrode may be applied to large-capacity desalination and energy storage and as a production technology.<br>◦ Unlimited adsorption capacity realized in a unit cell<br>◦ Continuous process based on large-capacity flow electrode<br>◦ Low-cost scale-up technology based on 3D structure |

### Experimental data


World's first credit card-sized FCDI unit cell (N1)




Sea water desalination performance in N1 cell



Conventional 2D Stacking Scale-up

World's first 3D scale-up

### Maturity level of technology

1 2 3 **4** 5 6 7 8 9

Basic Research | Experiment | Prototype | Turning into practice | Commercialization

**[TRL 4: Lab-scale core performance evaluation of materials, parts, and system]**

**High-performance 3D structure-based desalination process technology using capacitive flow electrode**

**Lab scale prototype development level**

- The capacitive flow electrode technology based on a microchannel structure has been secured.
- A 3D electrode structure-based desalination apparatus prototype has been developed.

### Current status of intellectual property rights

| No. | Title of Invention | Application Number | Application Date | Registration Number | Registration Date |
|---|---|---|---|---|---|
| 1 | Flow electrode system | KR2011-006010 | 2011.08.16 | US9,963,363 B2 | 2018.05.08 |
| 2 | Lattice type flow cell structure | US15/694,159 | 2017.09.01 | KR10-1750417 | 2017.06.19 |