FLIP-FLOP SERPENTINE FLOW FIELD FOR ELECTROLYTE DISTRIBUTION IN ELECTROCHEMICAL CELLS

IITM Technology Available for Licensing

Problem Statement

Electrochemical devices depend on heterogeneous electrochemical reactions carried out on planar surfaces over which the electrolyte is circulated and **uniform distribution** of the electro-active species through the reaction zone improves the **discharge energy efficiency** of these electrochemical devices. The major **limitations** of these electrochemical devises include:

- Maldistribution**/uneven distribution** of reactant fluids,
- heavy **pressure drop** leading to **heavy energy loss**,
- **poor velocity**, unwanted **bypassing** & channel blockage
- regions of **low through flow** at the electrode.

Hence there is a need to develop an improved method to overcome above-mentioned issues.

Technology Category/ Market

Chemical Engineering: Energy/Infrastructure & Environmental Engg

Industry: Electrochemical, Clean Energy

Applications: improve electrolyte circulation in electrochemical cells such as redox flow batteries, fuel cells and electrolyzers.

Market: Expanding at a **CAGR of 4%,** the global electrochemical instruments market projects increase **US$ 2.56 billion** in 2022 to **US$ 3 billion** by the end of **2026**.

Technology

An electrochemical cell with **serpentine flow field**, wherein the entire flow field is divided into multiple independent segments with the individual entry/exit streams extending between a **common inlet manifold** and a **common outlet manifold**, characterized in:

- **The serpentine flow field is a flip-flop serpentine flow field;**
- **The direction of the electrolyte flow in the porous electrode associated with adjacent segments of said flow field is opposite, & the direction of the electrolyte flow in the porous electrode associated with alternate segments of said flow field is the same; Creating a flip flop characteristic between each segment of said flow field;**
- **Said segments comprising of ribs of varying widths at various points of the said flow**
- **Each segment having same serpentine path length within the flow field so as to maintain uniform flow split among the segments.**
- The flow field comprises **parallel serpentine channels** of equal length except at locations where wider ribs are provided.
- The ribs of **varying widths** are provided at locations **near the entry and exit** of each serpentine flow field segment.
- The ribs located at the entry and the exit of the serpentine flow field segments are **wider** than the ribs located at other **points of the serpentine flow field segments**.

FIG 1 illustrates a schematic arrangement of flow path in the flip-flop serpentine flow field.

FIG 2 illustrates bar graphs showing relative performance for an operating current density of 90 mA/cm² and flow rate of 0.62 ml/min/cm² of four serpentine flow fields.

Key Features / Value Proposition

❖ ***Technical Perspective***

- Improved **electrolyte circulation** in electrochemical cells such as redox flow batteries, fuel cells and electrolyzers by **preventing unwanted early bypassing** of electrolyte through the flow channels and electrode region.
- Reduced **flow maldistribution** over the electrode region and reduced **residence time** of electrolyte in the electrode region for **quick evacuation** of the used electrolyte.

❖ ***User Perspective***

Improved overall performance of the electrochemical cell.

❖ ***Industrial Perspective***

- The said invention overcomes the problem of high pressure drop in **single serpentine flow field**, by proposing a new **flow field design** with a pattern called as Flip-Flop pattern.
- The said flow field pattern is designed in such a manner that the **uniformity of cross-flow** in the electrode region is preserved while ensuring a **short flow path over the cell area**.

Intellectual Property

IDF Ref: 1982
IN Patent No. 409784 **(Granted)**
PCT Application No. PCT/IN2021/050122

TRL (Technology Readiness Level)

TRL- **4** Proof of concept ready Stage

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Images

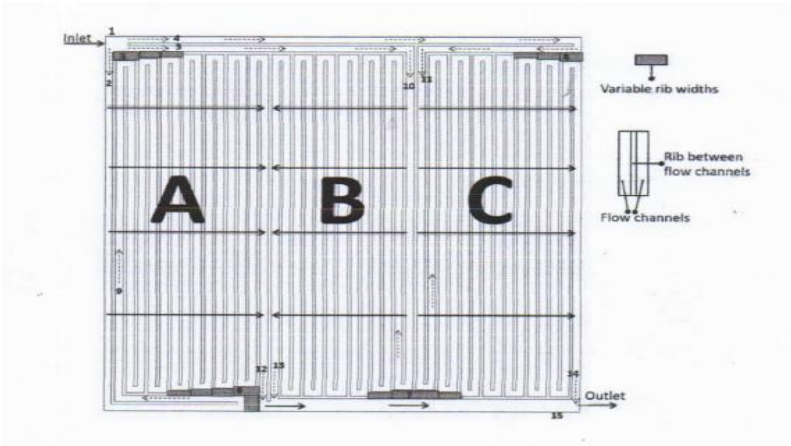

FIG 1

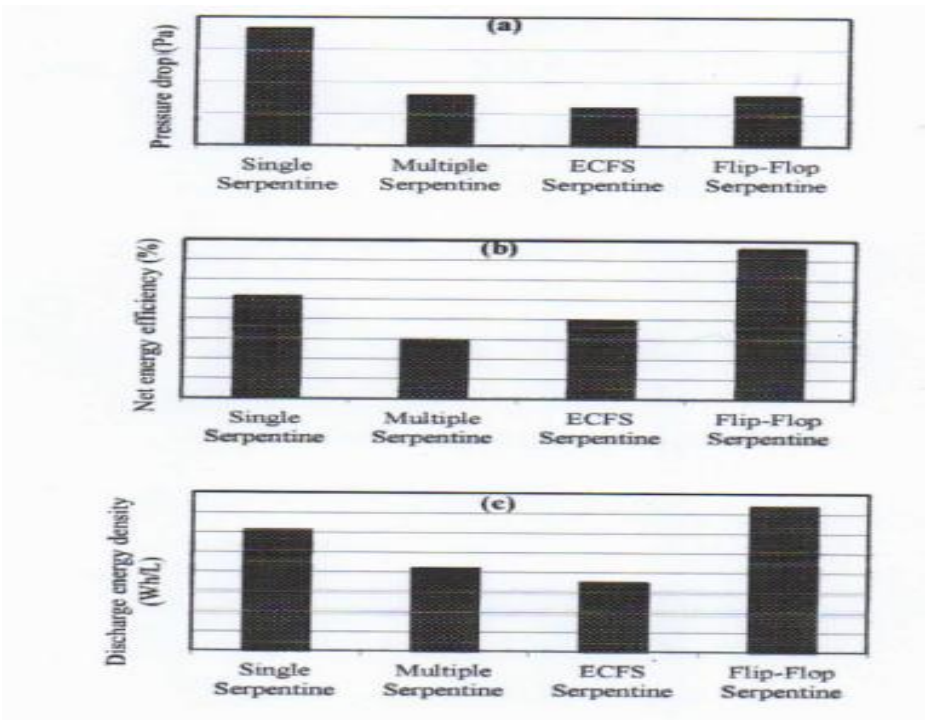

FIG 2

FIG 2: illustrating bar graphs showing relative performance for an operating current density of 90 mA/cm² and flow rate of 0.62 ml/min/cm² of four serpentine flow fields, namely, the single serpentine, the multiple serpentine, ECFS, and the Flip-Flop serpentine flow field based on measured polarization data of:
(a) pressure drop,
(b) net energy efficiency (including pump parasitic losses), and
(c) discharge energy density.

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