Category: **Chemical and Material Sciences**

**Contaminant (Ammonia) Removal from a Solution (Wastewater) Using Flowing Electrode Capacitive Deionization**

**Problem Statement**

Transition metal carbide nanomaterials known as MXenes have the potential to improve the FE-CDI process for energy-efficient removal and recovery of ammonia and other contaminants. In its annual 2019 report, the International Energy Agency (IEA) predicts an 85% increase in energy related water usage in the upcoming years. Considering this, it is imperative that versatile, cost-effective, and energy efficient water technologies are developed. Wastewater reclamation is one step in a multi-stage solution to solve the looming freshwater availability crisis. Wastewater reclamation is environmentally and fiscally relevant because it can yield purified effluent and recover valuable products.

Proven water remediation technologies such as reverse osmosis, multiple effect distillation and multistage flash distillation can require significant direct energy input. Capacitive deionization (CDI) is an emerging technology that has shown promise.

**Technology Overview**

CDI is an electrochemical technology used to absorb ions using electric potential applied between two electrodes. Conventional CDI employs fixed electrodes which upon full saturation must be discharged into a strip solution. Thus, a cell must go through absorption/strip cycles and also likely a rinse step after stripping to remove residues. Flow Electrode capacitive deionization (FE-CDI) employs microscopic particles (both anode and cathode) which are flowed through the cell. A separate strip cell can simultaneously discharge the ions to a concentrate stream for recovery. The advance described here involves dramatically increased absorption capacity of the particles to enhance performance over existing FE-CDI systems.

In an FE-CDI system, an ammonia (ammonium ion is prevalent at neutral pH) stream flows into the top cell and ions report to anode and cathode flowing electrodes. After absorbing ions, the slurry flows to the strip cell operated at the opposite polarity and ions are released into solution. Key components to the cells are a pair of ion-specific membranes (anion and cation specific) which effectively keep the solutions from mixing with the electrode slurry yet allows ions to pass.

**Applications:**

* Municipal waste water treatment – reducing ammonia discharge
* Water treatment for various industrial contaminates prior to discharge
* Treatment of legacy wastewater
* Cleanup of mining effluents
* Recovery of diluted value chemicals

**Benefits:**

* Increased system capacity using novel solid absorption particle
* Larger capacity reduces footprint/increases throughput
* Continuous operation avoids strips cycles
* Reduced cross-contamination and rinsing operations
* Opportunities for new electrode designs and configurations



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Working Prototype

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