NWRI SCSC Fellowship Progress Report April 2015

Project Title: Harvesting energy from desalination concentrate via Electric double-layer capacitor

Tushar Jain - 4/30/2015

This report describes the approach towards the synthesis of electrode and the construction of the flow cell for the process. Carbon electrodes shall be used as the anode and cathode for the adsorption. The construction of flow cell is in progress.

The electric double layer (EDL) capacitor constitutes of carbon electrodes immersed in electrolytic solution. The ions are distributed in the EDL on the electrode surface. Thus, properties of electrode surface plays a crucial role in the adsorption of ions (Jimenez et al., 2013). Thus it is important to synthesize a material that has high surface area. It was decided that a porous carbon electrode should be used for the process. The idea is to deposit a layer of activated carbon (AC) on a support material such as a metal plate or graphite (Ji-Young Choi, 2010). Selection of conducting material depends on various factors such as inertness during the process, its adherence to the AC and conductivity. We are yet to finalize the conducting material. The AC material is glued to the surface by using Polyvinylidene fluoride (PVDF) as the binder. N-Methyl-2-pyrrolidone (NMP) is used as a solvent. The short term goal is to find the ideal ratio of the aforementioned materials to achieve a stable electrode surface that can be bound to the surface. The electrode must also sustain the shear due to influent stream. We are working on the synthesis of carbon electrode by changing the composition of the active material and the amount of binder required.

We are also simultaneously working on the construction of a flow cell for achieving the flow system. The idea is to achieve the flow of aqueous solutions through a passage created between the electrode surfaces. Transparent polycarbonate is decided as the material of construction for the flow cell. The cell is designed such that an alternate flow of saline and fresh water can be achieved.

Future tasks:

Task 1:

Test the performance of carbon electrode with different compositions of AC, solvent and binder. Study the effect of porosity of the electrode. Effect of each component will be studied by varying composition of one parameter at a time.

Task 2:

Study the role of base (conducting) plate for the electrode in the process. This will mainly depend on the bond between the active material and the plate. Materials like Cu plate, Aluminum foil and graphite are shortlisted for the tests.

Task 3:

Come up with a relation between salt concentrations and energy produced. Once the assembly is ready and the electrode and electrochemical parameters are optimized, experiments will be performed with varying salt concentrations.

Reference:

- Jimenez M., Fernandez M., Ahualli S., Iglesias G., Delgado A., Predictions of the maximum energy extracted from salinity exchange inside porous electrodes, Journal of Colloid and Interface Science, 2013., 402, 340-349.
- Ji-Young Choi, Jae-Hwan Choi, A carbon electrode fabricated using a poly(vinylidene fluoride) binder controlled the Faradaic reaction of carbon powder, Journal of Industrial and Engineering Chemistry, 2010, 401-405.