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Continuous Electrode-Ionisation Unit for Production of 50LPH Ultra Pure Water.

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ABSTRACT

The Continuous electrode-ionization (CEDI) unit is design for production of 50 LPH ultra pure water (UPW). The CEDI unit consist of ion exchange membrane, mixed bed resin (MB-12) and positive and negative electrode to remove impurities from RO water. The objective of this paper, is to increase the capacity of CEDI unit up to 50LPH by increasing the electrode area 240*100 mm^2.The CEDI unit consist of 9 compartments in which 5 is of treated & 4 is of reject compartments. The performance of ions exchange membrane is investigated for removal of numbers of ions in each compartments. Higher quality of ultra-pure water is obtained when the maximum number of ions is transferred through the membranes. To take number of experiments by varying the different parameters like applied voltage, current, flow rate etc.The result shows that increase applied voltage, the resistivity of water is increases at constant flow rate. i.e. number of ions transportation from treated compartment to reject compartment

Keywords- **Ultra pure water, Ion exchange resin, Ion exchange membrane, Continuous Electrode-ionisation etc.**

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I. INTRODUCTION

Generally, there are three processes for the production of ultra pure water i.e. Deionization mixed bed resin column, Electro-dialysis, and Continuous Electro-deionization. In this paper, Continuous Electro-deionization (CEDI) process is used for the production of ultra pure water. The CEDI is the process of removing ionized or ionisable particles from water using electrically active media and an electrical potential activation ion transport. The CEDI is the process that consist of alternate arrangement of anion and cation permeable ion exchange membranes and ion exchange resin packed between them. In the CEDI system, the ion exchange resin bed plays a major role in the reduction of the high electrical resistance in the dilute compartment, while the ion exchange membranes leads to depletion and concentration of the solution in the treated and reject compartments respectively.

The working principle of CEDI unit is as shown in Fig.1. Applying a direct current (DC) electric potential causes ions to move from treated compartment to reject compartment through ion exchange membrane. So the concentration of ions is reduced in treated compartment and increased in the reject compartment.

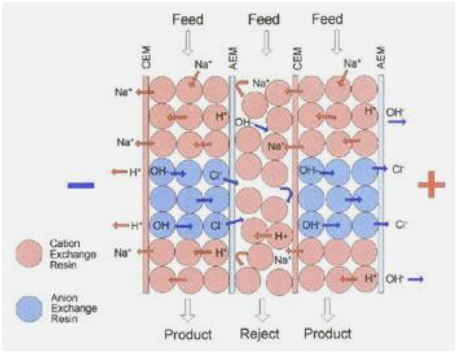

Fig.1Working of CEDI unit

The CEDI process synthesizes two water treatment technologies–deionization and electro-dialysis. In CEDI unit the mechanism of ion transfer takes place in two stages first, the ions are transported into the beads of resin by diffusion and then through the resin towards the membranes by continuous current. The main function of mixed bed resin

(MB-12) is to split up the water molecule in to H+ and OH- ions. These H+ and OH- ions electrochemically convert there in to the hydrogen and hydroxide forms, known as electro-regeneration. This accounts the ability of CEDI system to provide high quality ultrapure water continuously. A transverse DC electrical field is applied by an external power source using electrodes at the bounds of the membranes and compartments. When the electric field is applied, ions in the liquid are attracted to their respective counter-electrodes. This result in depletion of ions in the diluting compartments and this increases the concentration of ions in the adjacent compartment.

CEDI has an advantage of a continuous process and no separate regeneration of the ion exchange resin is required. Compared to ED, the CEDI has the advantage that the conductivity in the resin filled in dilute cell is increased by more than two orders of magnitude.

I. EXPERIMENTAL SET UP

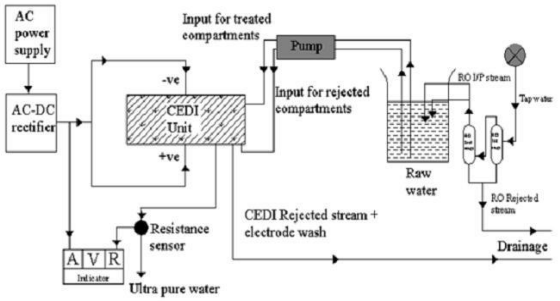

Fig..2 Schematic diagram of CEDI unit for Production of Ultrapure Water

Fig.3 Experimental Set up

A Schematic Layout of the system of the production of Ultrapure Water is shown in the Fig.2. It consists of two processes, Reverse Osmosis and Continuous Electro-deionization. Tap water is allowed to pass through the Reverse Osmosis which produces the water of 14 to 25 ppm from the 50 ppm. The tap water was pretreated using micro-filters and then passed through RO unit. Water from the RO unit is passed to the CEDI unit through the Peristaltic spring operated pump. There are two inlets for the CEDI Unit. One is for Treated and other is for Reject, both these inlets are given to the stack. DC rectifier is used to supply applied voltage to CEDI unit.

The CEDI unit consist of two electrodes housing one for anode and other for cathode & 9 compartments. At each compartment is provided with a small outlet for measuring the quality of water. The rigid PVC plate of 4.5 mm thickness and two Electrodes housing of 16mm thickness are used for construction of CEDI unit as shown in Fig.4. The holes arrangement was made in such way that one stream will supply water to treated compartment and other will supply to the rejected compartments (electrode housing). Similar holes arrangements are provided on the membranes (anion and cation) and silicon gaskets (thickness 0.5 mm) for uninterrupted water flow in the entire unit. The silicon gaskets are provided on the both sides of the rigid PVC plate to make the unit leak proof. The treated compartment is prepared by placing the membranes on both sides of rigid PVC plate and the gap between two membranes was filled with MB-12 resin. The effective area of each membrane in the CEDI unit is 24000 mm2. The SS nuts and bolts are used to tight the entire unit to make it leak proof. The details of the experimental setup are given in the *Table.1*.The rigid PVC gasket with ion exchange bipolar membranes is used to form one compartment. The Gaskets are made in such a way that treated inlet water can pass only in the alternated compartment of treated and reject.

Fig. 4: CEDI Unit

TABLE I
DETAILS OF EXPERIMENTAL SETUP

Parameters	Characteristic
Type of membranes	Ion Exchange Membrane (IONSPTM)
Total area of each Membrane	47520mm2
Effective area of each membrane	24000mm2
Cell Thickness	4.5mm
Gaskets	Built in flow arrangement and spacers from rigid PVC
Electrodes	Cathode:-SS Metal
	Anode:-Titanium with Platinized coated
Electrode Housings	Rigid PVC with built inlet and outlet flow distributions
Pressing Assembly	Threaded rods with nuts for making Stack leak proof
Flow Arrangement	Series
Resin Type	Mixed Bed resin MB 12
Rectifier	APLAB Rectifier
Pump	Peristaltic Pump (Electro lab)

II.RESULT

- To plot graph Resistivity Vs.Voltage at constant flow rate

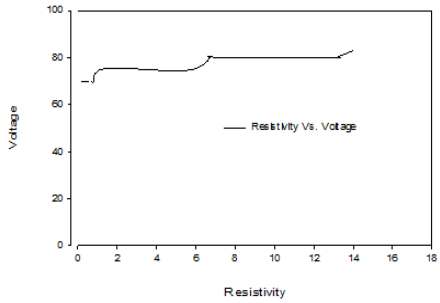

Fig.5.Resistivity Vs. Voltage

CONCLUSIONS

The experimental results shows that with increase applied voltage, the resistivity of water is increases at constant flow rate. i.e. number of ions transportation from treated compartment to reject compartment.

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