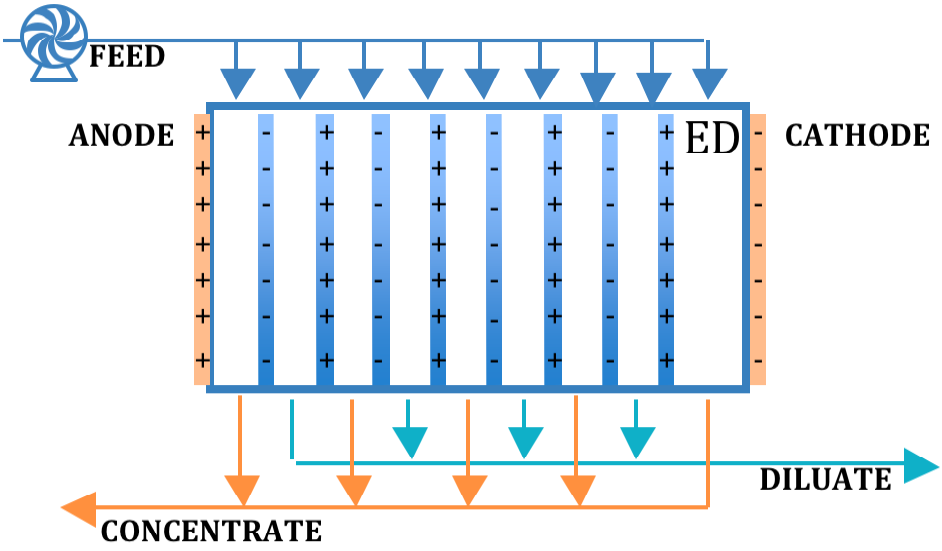
Electrodialysis and Electrodialysis Reversal

Electrodialysis (ED) or electrodialysis reversal (EDR) is an electrochemical charge-driven separation process where dissolved ions are separated through ion permeable membranes under the influence of an electrical potential gradient. Ion exchange membranes, fabricated from ion exchange polymers, have the ability to selectively transport ions with a positive or negative charge and reject ions of the opposite charge. An ED stack consists of a series of anion exchange membranes (AEM) and cation-exchange membranes (CEM) arranged in an alternating mode between an anode and a cathode. The positively charged cations migrate toward the cathode, pass through the cation-exchange membrane and are rejected by the anion-exchange membrane, and vice versa for negatively charged anions that migrate to the anode. This result in an alternating enriched ion concentration in one compartment (concentrate) and depleted concentration in the other (diluate). EDR is similar to ED, except that it also uses periodic reversal of polarity to effectively reduce membrane scaling and fouling, thus allowing the system to operate at relatively higher water recoveries. ED can achieve only low removal of neutrally charged species (e.g., many organic compounds, boron, silica). ED and EDR have been utilized for municipal water and wastewater treatment plants and for desalination of brackish water and reclaimed water.



Summary of technical assessment of ED and EDR

Criteria	Description/Rationale
Status of technology	Mature and robust technology for seawater and brackish water desalination and wastewater reclamation. Have been tested for produced water treatment at laboratory-scale.
Feed water quality bins	Cost effective to total dissolved solids of less than 8,000 mg/L, and treat all types of water chemistry makeup.
Product water quality	Product water quality depends on the number of ED stages. Can achieve more than 90% rejection. Poor removal of non-charged compounds such as organic compounds, silica, boron, and microorganisms.
Recovery	Typical product water recovery is 80% and can exceed 90%
Energy use	Energy consumption is in the range of 0.14–0.20 kWh/lb NaCl equivalent removed.

Summary of technical assessment of ED and EDR

Criteria	Description/Rationale
Chemical use	Scale inhibitor and acid may be required for process control to prevent scaling. Periodic chemical cleaning is typically conducted using acid, caustic, EDTA, disinfectant, or other anti-scaling chemicals.
Expected lifetime of critical components	ED membrane lifetime is estimated to be 4-5 years.
Infrastructure considerations	No special infrastructure requirement, need housing or shed.
O&M considerations	Levels of monitoring and control: current, voltage, total dissolved solids, pH, flow rates, membrane integrity. Highly skilled operators required; the operation of ED and EDR is more complicated than RO membranes Level of flexibility: fairly flexible to varying water quality. Level of robustness: modest to withstand harsh conditions. Level of reliability: requires periodic chemical cleaning and maintenance Types of energy required: electricity.
Capital and O&M costs	Total costs are site specific and depend on feed water total dissolved solids. For treatment of CBM produced water (total dissolved solids of 1000-2000 mg/L), costs are estimated to be under 0.63 cents/kgal (15 cents per barrel) for a 0.34 MGD (8,000 bbl/day) treatment train.
Pretreatment of feed water	Pretreatment requires removal of particles and other scaling and fouling substances through filtration, pH adjustment, and addition of antiscalant.
Post-treatment of product water	Product water needs remineralization for sodium adsorption ratio (SAR) adjustment, and disinfection.
Concentrate management or waste disposal	Concentrate needs disposal.
Applicability for produced water treatment	Excellent for the produced water application.
Note: 1 barrel = 42 US gallon	