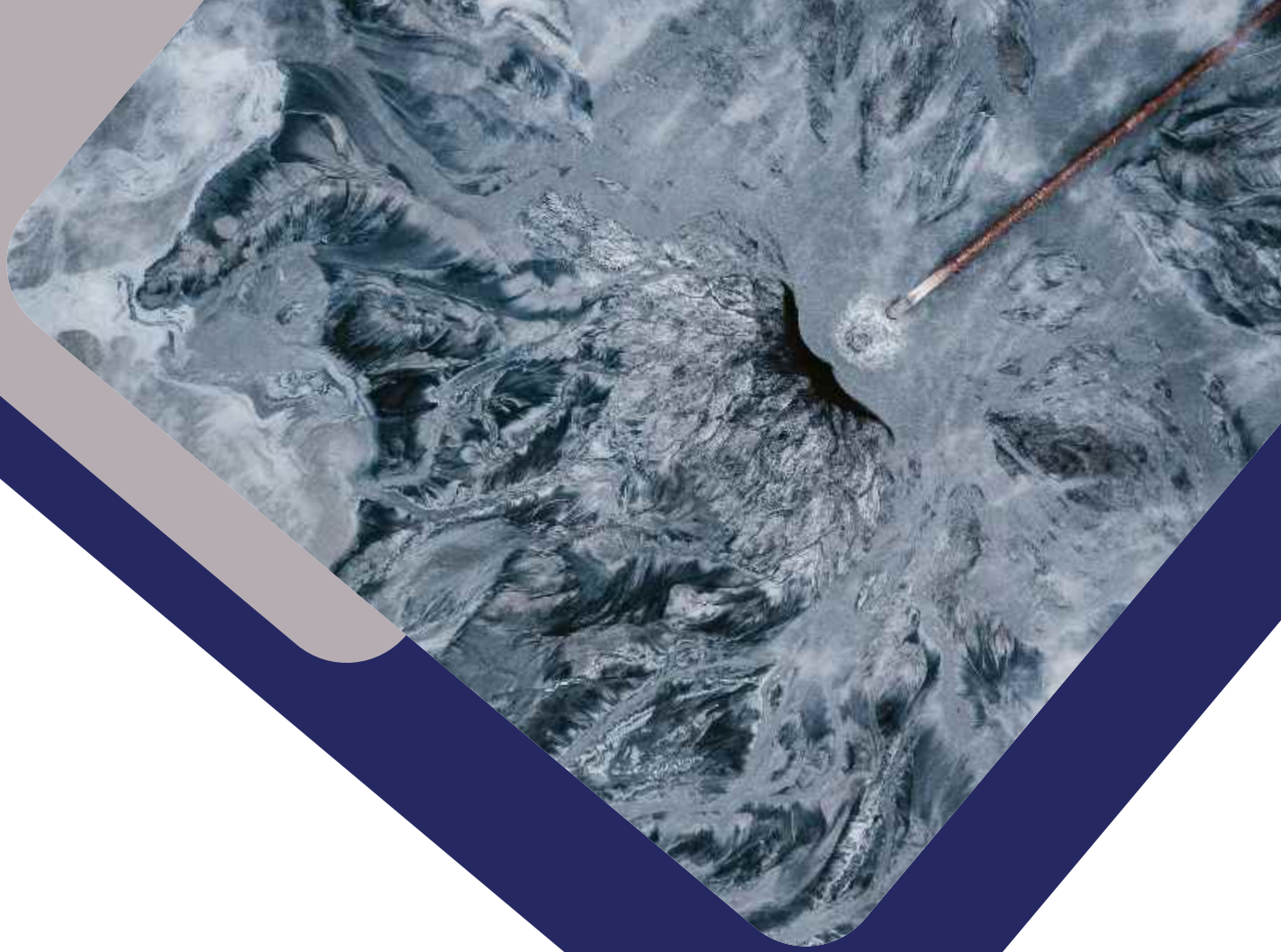

DESALT

EDBM PILOT PLANT
USER GUIDE

info@yasa.ltd
www.yasa.ltd

YASA ET

Content

1. Introduction

This manual contains important information, such as an introduction to the principle of bipolar membrane electrodialysis, experimental bipolar membrane electrodialyzer, and bipolar membrane electrodialysis test equipment.

2. Bipolar Membrane Principle

Bipolar membrane electrodialysis uses an electric field as the driving force and utilizes the characteristics of the bipolar membrane to dissociate water into H+ and OH-. It combines the bipolar membrane with anion and cation exchange membranes.

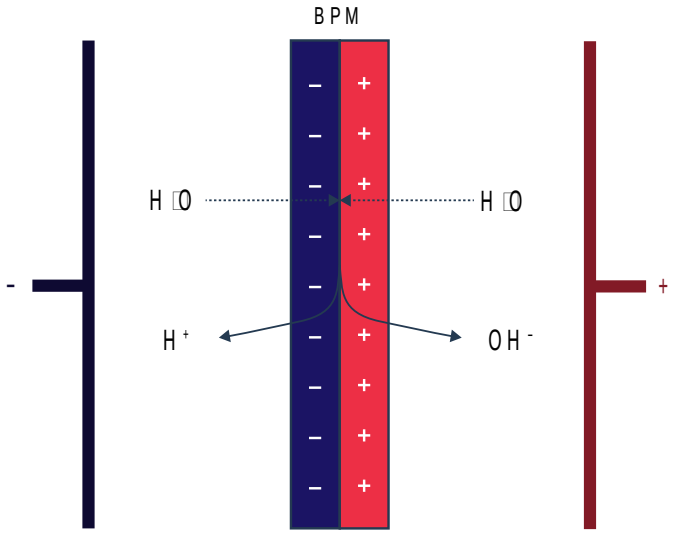

Fig.1 BPED Water Dissociation

The bipolar membrane electrodialysis system is used to convert the salt solution into the corresponding acid and alkali. The use of bipolar membranes in electrodialysis allows for the simultaneous removal of both anions and cations from a solution.

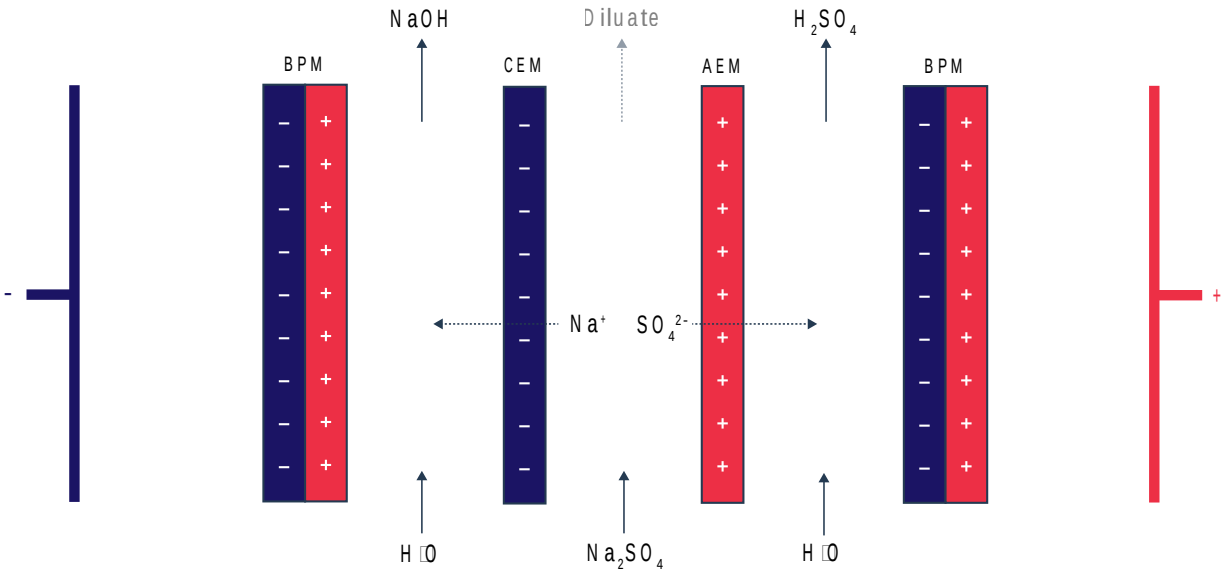

Fig.2 Schematic of Electrodialysis Bipolar Application

The electrodialysis bipolar membrane works by applying a direct current to a solution containing dissolved ionic compounds. The anions and cations are attracted to the anode and cathode, respectively, and are removed from the solution through the use of bipolar membranes and ion exchange membranes.

3. EDBM Pilot Plant

The equipment allows for extensive testing and can be used to assess the effect of Bipolar Electrodialysis on any kind of feed inlet.

The pilot plant is made by the components shown in the pictures below:

*Images for reference only

3.1 EXPERIMENTAL BIPOLAR MEMBRANE ELECTRODIALYZER

The internal structure of the electrodialyzer as shown in the figure below: 1 AEM membrane, 1 CEM membrane, electrodes feed liquid compartment.

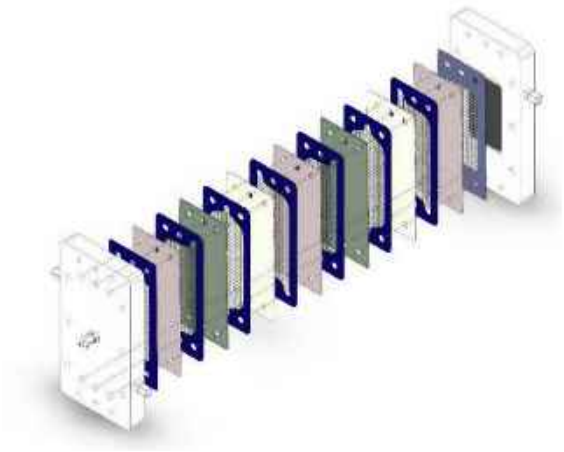

Fig.3 EDBM Electrodialyzer

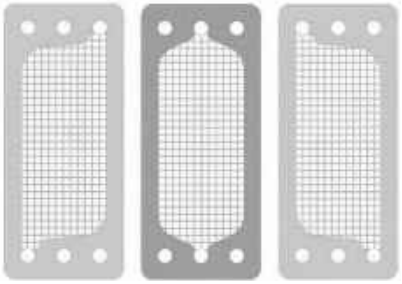

Fig.4 EDBM Electrodialyzers Spacers

The alternate stacking of plates, an anion exchange membrane and an acid chamber partition forms a membrane pair; several membrane pairs are stacked together, with polar membranes and electrodes chambers on both sides.

3.1.1 ELECTRODE COMPARTMENT

On both sides of the membrane stack are two electrode plates, specifically the anode plate and the cathode plate, and the corresponding compartments are the anode chamber and the cathode chamber.

In the occurrence of electrification, an oxidation reaction occurs on the surface of the anode plate, and a reduction reaction occurs on the surface of the cathode plate. The specific electrode reaction varies with the electrode solution. Commonly used electrode solutions are sodium chloride solution and sodium sulphate solutions. Based on the experiment/testing scope, either NaCl or NaSO4 solutions should be used.

The electrode plate is generally a titanium plate with a ruthenium-iridium oxide catalytic coating, which can be adjusted to a titanium plate with an oxide catalytic coating as required.

*Images for reference only

4. Preparation and Use Guidelines

4.1 GENERAL SETUP

Before testing, please make sure:

1. The pressure gauges are correctly installed to measure the pressure;
2. The pumps and flowmeters are working correctly;
3. There is no leakage of the electrodialysis device;
4. The electrodes of the electrodialysis membrane stack are well connected;
5. All the tubes are connected correctly;
6. The electrodialyzer has been removed from the protective fluid and rinsed with deionized water;

4.1.1 MEMBRANE STACK RINSING

Before starting the electrodialysis experiment, the protective solution of the electrodialyzer should be completely removed. Typical protective solutions are sodium chloride solution or sodium sulphate solution.

Use deionized water to clean the electrodialysis equipment under low pressure. The cleaning takes 0.5-2 hours, depending on the electrolyser dimensions. The cleaning result can be verified by the conductivity of the outlet.

Cleaning conditions guidelines:

- Temperature 25-30°C;
- Pressure less than 2.0 bar.

4.1.2 EQUIPMENT LEAKAGE TEST

Turn on the circulating water pumps, fill the electrodialysis membrane stack compartments and run the water in a cycle, adjust the pump flow button to ensure the inlet pressure is controlled.

The pressure generated by the water flow does not exceed 2.0 bar. The pressure should be maintained constant at 0.4 bar, and after 10 minutes, the device should be observed, and there should be no obvious droplet extravasation.

The maximum leakage shouldn't exceed 1 ml/min per membrane pair. If the leakage exceeds the maximum value, each fastening bolt should be loosened, tightened slowly and evenly, and then re-tested.

If the internal leakage test still does not meet the standard, it is necessary to check whether the membrane is damaged or there is an error in the assembly process.

4.2 OPERATION AND USE

4.2.1 PREPARATION BEFORE EXPERIMENT

Make sure that the piping and tubing are installed correctly to the equipment pumps, flow meters, solution tanks, to ensure that the feed, alkali, acid, and electrode solutions are not leaking.

The feed ports are at the bottom side of the electrodialyzer, the outlet ports are on the top side.

A certain amount of corresponding solution (depending on experiment requirements) is added to the feed tank, alkali tank, acid tank and electrodes tank and the solution volume should ensure sufficient circulation.

Before the experiment, it is necessary to assess whether the feed liquid needs to be pre-treated according to the feed parameters.

The feed solution concentrations are based on the experiment requirements and scope.

4.2.2 POWER-ON OPERATION

Start the electrodes solution pump first, then start the feed liquid pump, acid liquid pump and alkali liquid pump. The flow rate of the polar chamber is generally controlled to 4~6 cm/sec, and the flow rate of the alkali chamber, acid chamber and feed liquid chamber is controlled.

Adjust the flow rate to keep the inlet flow and pressure of each feed solution basically the same. Each solution was circulated for 3-5 minutes to ensure that each compartment was filled with liquid, and the air bubbles in the compartment are exhausted.

Then connect the positive pole (red terminal) and negative pole (black terminal) of the DC power supply to the anode lead and cathode lead of the electrodialyzer respectively, and power the electrodialyzer through the DC power supply.

The DC power supply can work in steady current mode or in voltage stabilization mode.

Important: If the wire connection is wrong, the bipolar membrane in the electrodialysis equipment will be damaged after power is turned on, and the damage cannot be repaired.

Important: the applied current should not exceed 4.2 A (current density 500 A/m2), and the suggested applied voltage is controlled to 1.2V per repeating unit.

4.2.3 POWER-OFF OPERATION

When the treatment reaches the expected results, first gradually reduce the voltage and current of the DC power supply to 0, then turn off the feed pumps, and then replace the feed solutions with deionized water to rinse the membrane stack and equipment components.

4.3 GENERAL MAINTENANCE

If the unit leaks internally or externally, tighten the unit further; if the condition does not improve, the membrane or diaphragm may need to be replaced.

After the experiment, please rinse the feed liquid or electrode liquid in the electrodialyzer, solution tank and water pump. If the equipment is not used for a long time, please inject 5% NaCl solution to preserve the electrodialyzer.

4.4 CLEANING PROCEDURES

If there is a partial blockage in the electrodialyzer, manifested by a pressure rise or flow drop, the equipment needs to be cleaned. Cleaning includes backwashing and chemical cleaning. During the cleaning procedures, the DC power must be powered off.

Reverse flushing is to exchange the inlet water pipes and outlet water pipes of the desalination chamber and the concentration chamber of the electrodialyzer respectively, so that the direction of water flow in the electrodialyzer is opposite to the original configuration. When the electrodialyzer is partially blocked, it can be backwashed with deionized water for more than 30 minutes.

If the electrodialyzer is still partially clogged after backwashing, chemical cleaning is required:

1. If the blockage is caused by the precipitation of inorganic salts, first rinse the electrodialyzer with deionized water, then inject 1% hydrochloric acid and let it stand for more than 30 minutes, and then rinse with clean water; depending on the degree of pollution, it may be necessary to repeat several times

2. If the fouling is caused by organic pollutants, first rinse the electrodialyzer with deionized water, then inject 1% sodium hydroxide and let it stand for more than 10 minutes, and then rinse with clean water; depending on the degree of contamination, it may be necessary to repeat several times.

3. If it is caused by bacterial growth, first flush the electrodialyzer with deionized water, then inject clean water containing 20 ppm free chlorine and let it stand for more than 10 minutes, then rinse with clean water; depending on the degree of contamination, it may be necessary to repeat the procedure several times.

5. Quick Set Up Guide

QUICK SETUP GUIDELINES

1	Connection	Connect the inlet and outlet tubes to the equipment skid and membrane stack.
2	Rinsing the membrane	Recirculate distillate water in the membrane stack for at least 1 hour. Recirculate at 40 l/h the feed channels solutions, at 20 l/h for the electrode channel solution
3	Feed solutions	Prepare the feed solutions and connect them to the membrane stack and skid. Recirculate at 40 l/h
4	Electrode feed solutions	Prepare a solution of NaOH/NaCl/Na2SO4/... as electrode feed. Recirculate at 20 l/h
5	Power supply	Connect the anode and cathode to the power supply through the provided cables
6	Starting the test	Start the power supply and set V, A according to the test parameters
7	Monitoring	Monitor TDS/pH/Temp/Flowrate
8	Turning off the equipment	Gradually reduce the power supply output till it reaches 0V, 0A then reduce the flowrate of each pump to 0 l/h
9	Cleaning the membrane	Recirculate distillate water in the membrane stack for at least 1 hour. 40 l/h flowrate for the feed channels, 20 l/h for the electrode channel
10	Storage	Inject 5% NaCl solution to preserve the electrodialyzer

TROUBLESHOOTING

In case of pressure increase or flow drop during testing, please consider the following causes and implement the recommended solutions:

1	Inorganic salts - fouling, blockage	Rinse the electrodialyzer with deionized water, then inject a 1% Hydrochloric Acid (HCl) solution and let it rest in the stack for more than 30 minutes. Then rinse with deionized water for 30 minutes
2	Organic pollutants - fouling, blockage	Rinse the electrodialyzer with deionized water, then inject a 1% Sodium Hydroxide (NaOH) solutions and let it rest in the stack for more than 10 minutes. Then rinse with deionized water for 30 minutes
3	Bacterial growth	Rinse the electrodialyzer with deionized water, then inject 20 ppm free chlorine and let it rest in the stack for more than 10 minutes. Then rinse with deionized water for 30 minutes

6. Contact Us

For more information about our technology and services, kindly get in touch with our team:

info@yasa.ltd

www.yasa.ltd

www.desalt-iex.com

www.yashahuanjing.cn

Online Store

+86 136 3643 1077

THANK YOU FOR THE BUSINESS WITH US.

YASA ET (Shanghai) Co., Ltd.
2388, Xiupu Road, Pudong New Area,
Shanghai, China
Phone: +86 136 3643 1077
E-mail: info@yasa.ltd
Web: www.yasa.ltd