Supporting Information

Novel pendant benzene di-sulfonic acid blended SPPO membranes for alkali recovery: Fabrication and Properties

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Membrane Characterizations

S1. NMR, FTIR spectra, thermal stability, mechanical properties

NMR spectra of all prepared materials was recorded with an AV III 400 NMR spectrometer (400 MHz, Bruker) using DMSO-d_6 and D_2O (with tetramethylsilane as an internal reference) as solvent. FTIR spectra of the synthesized BAPBDS, DSBPB and dried membranes were recorded by using the technique KBr & attenuated total reflectance (ATR) with FTIR spectrometer (Vector 22, Bruker) having resolution of 2 cm^{-1} and a total spectral range of 4000–400 cm^{-1}. TGA for the prepared membranes were carried out using a Shimadzu TGA-50H analyzer within the temperature range 25°C to 800°C under nitrogen flow, with a heating rate of 10 ^{o}C/min. Tensile strength (TS) and Elongation at break (E_b) measurements of the dry membranes were conducted using a Q800 dynamic mechanical analyzer (DMA, TA Instruments, USA) at a stretch rate of 0.5 N min^{-1} at 25 ^{o}C.

S2. Microscopic Characterizations for CEMs

Membrane morphological characterization was successfully done through a field emission scanning electron microscope (FE-SEM, Sirion200, FEI Company, USA). Surface and cross-sectional views of membranes were taken from dry membranes. The SEM images of membranes SPPO, DSBPB-20 and DSBPB-60 were selected as representative cases.

S3. Ion exchange capacity (IEC)

In theory IEC represents the number of exchangeable ionic groups (equivalents) present per dry membrane weight. IEC for the prepared membranes were measured by the classical titration method by the following way: firstly, the membrane samples were equilibrated in 1.0 (M) HCl solution for 24 hours such that all charge sites were converted into the H^+ form. Then, the membranes were washed very carefully with deionized water in order to remove

excess amount of HCl. The washed membranes were then equilibrated with 50 mL of 2 (M) NaCl solutions for 48 hours. The amount of H^+ ions liberated was estimated by acid–base titration with 0.01 (M) NaOH solution using phenolphthalein as an indicator. The ion-exchange capacity (*IEC*; mmol/g) of the membrane was calculated by the equation *IEC*= *ab/w* where *w, a and b* represents the dry weight of the membrane, titre value during titration and the concentration of NaOH solution respectively.

S4. Water Uptake

Membrane hydrophilic nature was investigated by water uptake (WR) measurement. Membrane samples were oven dried and accurately weighed to confirm their dry weight. Then membranes were immersed in water for 72 hours at 25 ^{o}C and wet weight of those membranes were recorded after removal of surface water with tissue paper. From the difference in mass before and after the complete drying of the membranes, WR values were calculated as the relative weight gain per gram of the dry sample using following equation (1).

$$W_R = \frac{(w_{wet} - w_{dry})}{w_{dry}} \times 100 \qquad (1)$$

The volume fraction of water in the membrane matrix (φ_w) can be determined by the following equation (2).

$$\varphi_w = \frac{\Delta W / d_w}{\frac{\Delta W}{d_w} + \frac{W_d}{d_p}} \qquad (2)$$

Where, ΔW= Difference of weight in dry and wet state,

d_p= Density of dry membrane.

W_d= Weight of dry membrane.

d_W= Density of water.

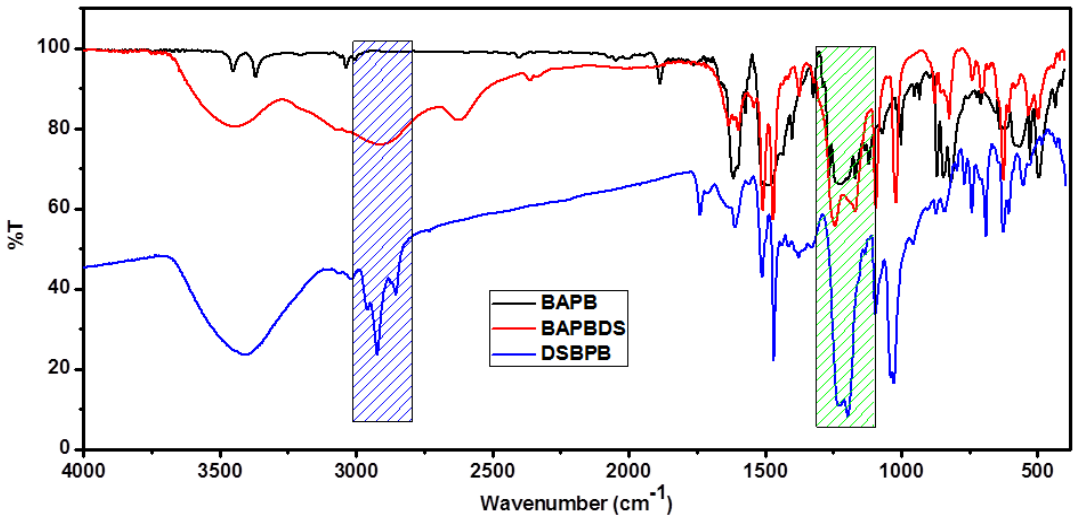

Figure S1. Comparison of IR spectrum of BAPB, BAPBDS and DSBPB.