1. FT-IR

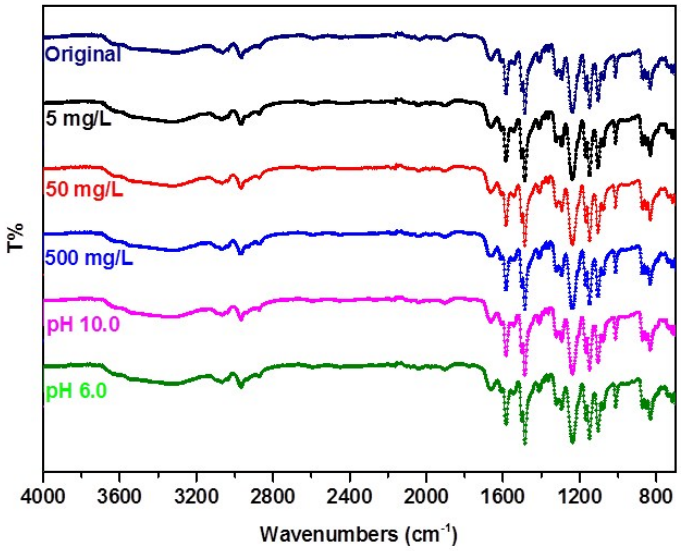

Figure 1. FT-IR of membranes prepared at different conditions

As shown in figure 1 above, the chemical structure of the membrane surface were characterized by FT-IR for membranes prepared at different conditions. From the figure, there was no significant different in the location and the number of the absorption peaks for the blank and prepared membranes. As a result, the FT-IR result couldn't prove the functional groups on the surface of membranes.

2. Swelling degree (SD) of membranes

In order to determine the swelling degree of membranes, the water adsorption of membranes prepared from different conditions was measured. In brief, the membranes were cut into strips of 2 cm × 2 cm. The strips were dried at 25 ℃ overnight and the weight of dried membranes was measured. Then the dried strips were immersed in water for 24 h and the wet membrane was weighed. The water swelling degree (SD) of membrane was calculated according to the followed equation:

$$SD(\%) = \frac{W_s - W_d}{W_d} \times 100$$

Where, W_s is the mass of the swollen membranes and W_d is the mass of the dry membranes.

The corresponding experimental data was as follows in the table:

Membranes	W_d(g)	$W_s(g)$	SD (%)
Original	0.0397	0.0456	0.149
5 mg/L (pH 8.0)	0.0404	0.0441	0.092
50 mg/L (pH 8.0)	0.0395	0.0442	0.119
500 mg/L (pH 8.0)	0.0380	0.0429	0.129
pH 6.0 (50mg/L)	0.0403	0.0445	0.104
pH 8.0 (50mg/L)	0.0395	0.0442	0.119
pH 10.0 (50mg/L)	0.0401	0.0450	0.122

The substrate membranes used in our experiments were commercial polyamide reverse osmosis

composite membranes. They had three layers, including nonwoven fabric, microporous support and ultrathin barrier layer and only the swelling of the ultrathin barrier layer played a dominate role on CO_2 separation. As PEI concentration and pH increased, the swelling degree of membranes increased. When SD was relatively low, facilitated transport of CO_2 by PEI and H_2O was enhanced as the PEI concentration or pH level was increased. While SD was increased, the free volume between PEI polymer chains increased which decreased the number of water molecules between polymer chains and was unfavorable to facilitated transport of CO_2. This is consistent with the change of membrane performance with PEI concentration and pH level increasing.