

**Pilot-scale evaluation of the sustainability of membrane desalination systems for  
concentrate volume minimization of coal chemical wastewater**

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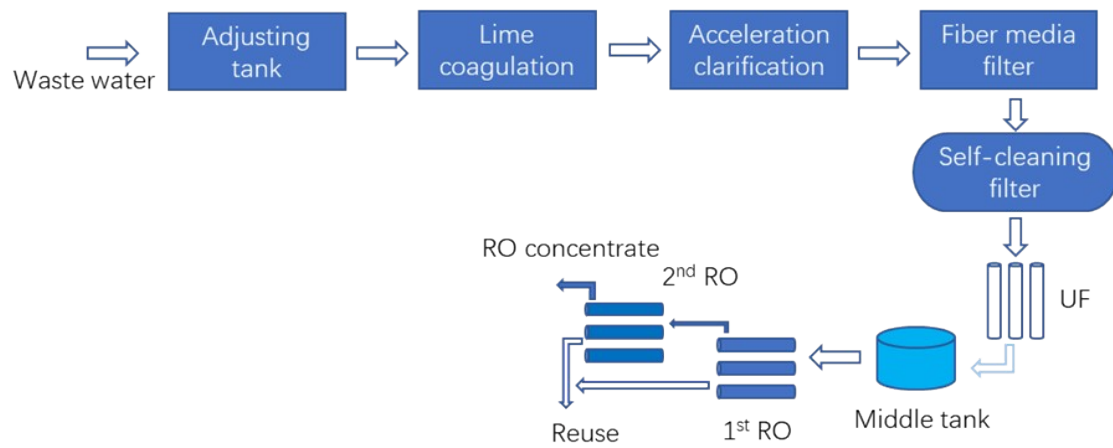
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**Fig. S1.** The schematic diagram of wastewater reclamation plant for a coal chemistry industry.

**Table S1. Membrane parameters in VSEP scenario**

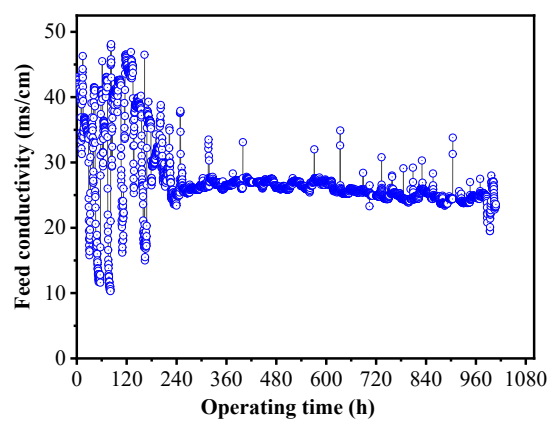
<b>Item</b>	<b>VESP</b>
<b>Manufacturer</b>	DOW
<b>Membrane Model</b>	RO-11
<b>Membrane material</b>	Composite Polyamide
<b>Water permeability (LMH)</b>	40
<b>Membrane effective area (m<sup>2</sup>)</b>	120
<b>Operating temperature (°C)</b>	60
<b>Range of feed pH</b>	2-10
<b>Operational pressure (bar)</b>	70
<b>Rejection (%)</b>	99.7%

**Table S2. Membrane parameters in DTRO scenario**

<b>Item</b>	<b>DTRO</b>
<b>Manufacturer</b>	Unisol Membrane Technology GmbH
<b>Model Number</b>	MP-DT-RO3
<b>Membrane material</b>	Composite Polyamide
<b>Water permeability</b>	29
<b>Membrane effective area (m<sup>2</sup>)</b>	9.405
<b>Operating temperature (°C)</b>	≤ 45
<b>Range of feed pH</b>	2–12
<b>Operational pressure (bar)</b>	≤ 90
<b>Rejection (%)</b>	≥97.5%

**Table S3. Membrane parameters in FO-RO scenario**

<b>Item</b>	<b>FO</b>	<b>RO-1</b>	<b>RO-2</b>	<b>RO-3</b>
<b>Manufacturer</b>	FTS	FTS	Dow	Dow
<b>Model Number</b>	FO-CTA- 8040-45- VDS	HBCR-TFC- 4040	SW30- 8040	BW30- 8040
<b>Membrane material</b>	CTA	Composite Polyamide	Composite Polyamide	Composite Polyamide
<b>Water permeability</b>		150 LMH	32	45
<b>Membrane effective area (m<sup>2</sup>)</b>	9.9	37	37	37
<b>Operating temperature (°C)</b>	≤ 40	30	45	45
<b>Range of feed pH</b>	4-7.5	3-10	2-11	2-11
<b>Operational pressure (bar)</b>	< 10	< 80	83	41
<b>Rejection</b>	99.9%	60%	99.6	99.5



**Fig. S2. Feed conductivity of the FO system**

**Table S4. Details of chemical cost in the VSEP scenario**

<b>Item</b>	<b>Consumption per ton of feed water (kg/m<sup>3</sup>)</b>	<b>Price USD (\$)</b>	<b>Operating cost per ton of feed water</b>	<b>Note</b>
Hydrochloric acid (30%)	1.0	0.046	0.046	Adjusting pH to 6.5
Antiscalant	0.009	3.51	0.0032	5 ppm
Acid cleaning-Citric acid	0.0035	2.46	0.0172	Cleaning frequency: Once a week,1%
Alkaline cleaning -Sodium hydroxide	0.034	0.62	0.0042	Once a week,0.1%
Alkaline cleaning -metal chelating agent (EDTA)	0.0035	4.31	0.0030	Once a week,1%

Since the statistical data came from the year of 2021, the CNY was converted into USD by the annual average exchange rate (1 USD = 6.5 CNY) in 2021 ([National Bureau of Statistics of China \(NBSC\), 2021](#)).

**Table S5. Details of chemical cost in the DTRO scenario**

<b>Item</b>	<b>Consumption per ton of water (kg/m<sup>3</sup>)</b>	<b>USD (\$)</b>	<b>Operating cost per ton of water</b>	<b>Note</b>
Hydrochloric acid (30%)	1.0	0.046	0.046	Adjusting pH of feed water to 6.5
Antiscalant	0.009	3.51	0.0032	5 ppm
Acid cleaning-Citric acid	0.0035	2.46	0.0172	Once a week,1%
Alkaline cleaning -Sodium hydroxide	0.034	0.62	0.0042	Once a week,0.1%
Alkaline cleaning -metal chelating agent (EDTA)	0.0035	4.31	0.0030	Once a week,1%



**Table S6. Details of chemical cost in the FO-RO scenario**

<b>Item</b>	<b>Consumption per ton of water (kg/m<sup>3</sup>)</b>	<b>USD (\$/kg)</b>	<b>Operating cost per ton of water</b>	<b>Note</b>
Hydrochloric acid (30%)	1.0	0.046	0.046	Adjusting pH
Sodium chloride	0.777	0.238	0.185	Supplemental draw solution concentration