Fast decolorization of anionic dyes wastewater by polyethyleneimine(PEI)-coated microporous composite membranes

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Introduction

Herein, microporous composite membranes with superior capability of anionic dyes removal via gravity filtration were prepared by a surface-crosslinking process. Polyethyleneimine (PEI) thin layer was coated onto hydrophilic PVDF microporous membrane by the amidation reaction between PEI and trimesoyl chloride (TMC). The PEI loading amount, membrane surface physiochemical properties, and pore structure were tuned by controlling PEI concentration and solvent type.

Methods

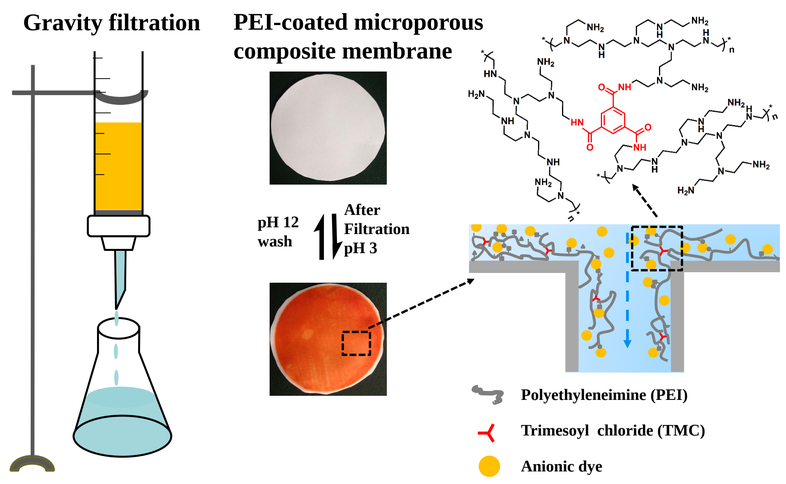

Figure 1. Scheme of the dye solution decolorization by PEI-coated membranes under gravity filtration

Results and Discussions

1. Physicochemical properties of the PEI-coated PVDF membranes

Table 1 Weight gain and flux of membranes*

PEI/TMC ratio	Solvent type	Weight gain (mg dm^{-2})	Pure water flux (L m^{-2} h^{-1})
	b1	--	--
a1	b2	55±10.1	78±15
	b3	--	--
	b1	44±2.6	5±2
a2	b2	**135.9±15.8**	83±19
	b3	71.3±10.1	85±34
	b1	25±6.1	9±2
a3	b2	100.3±19.8	34±14
	b3	77.9±11.4	0

*Tested under 10cm water column at 25℃

Table 2 Pore size and porosity of membranes*

Membrane type	Average pore diameter (nm)	Porosity(%)
Nascent PVDF	997	78.5
PVDF/PEI-a1-b2	594	75.56
PVDF/PEI-a2-b2	583	69.87
PVDF/PEI-a3-b2	607	75.5

* PVDF/PEI represents PEI-coated membrane; PVDF/PEI-x-y represents preparation conditions: PEI/TMC ratio-solvent type

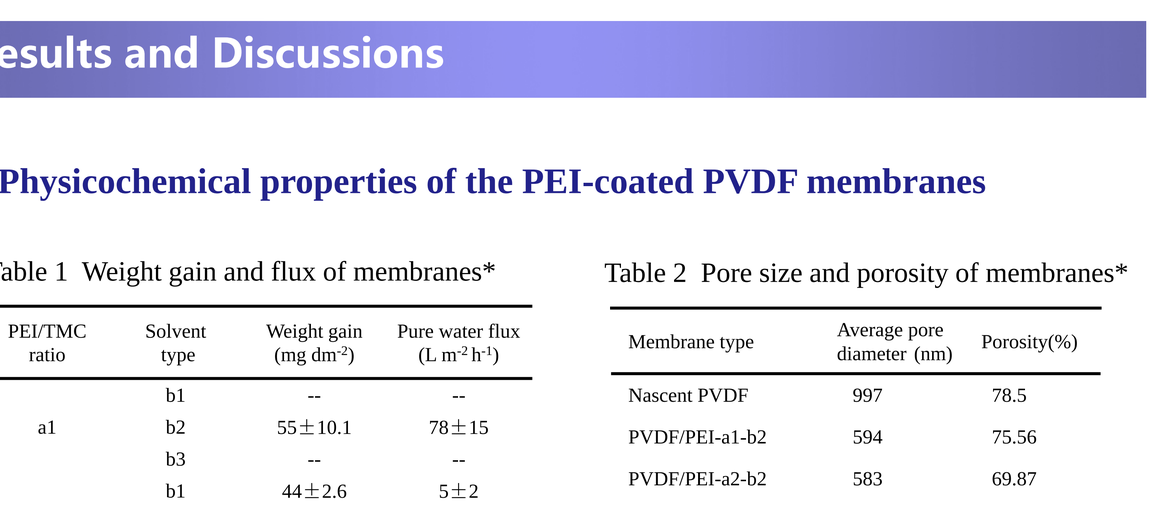

Figure 2. SEM images of PVDF nascent membrane (A), PVDF/PEI-a1-b2 membrane (B), PVDF/PEI-a2-b2 membrane (C), PVDF/PEI-a3-b2 membrane (D)

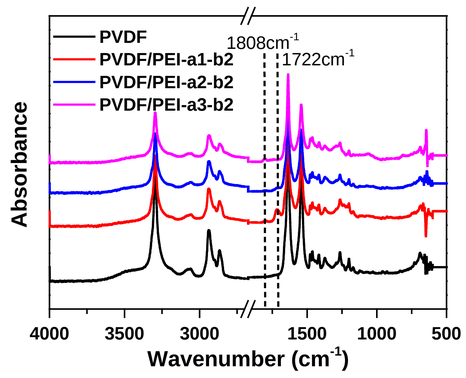

Figure 3. FTIR-ATR of PEI-coated membranes

Table 3 XPS of PEI-coated membranes

Element	PVDF	PVDF/PEI-a2-b2
N1s	11.92	11.45
C1s	77.29	74.7
O1s	10.79	13.64
F1s	--	--
Cl2p	--	0.21

2. Decolorization of anionic dye water by PEI-coated PVDF membranes

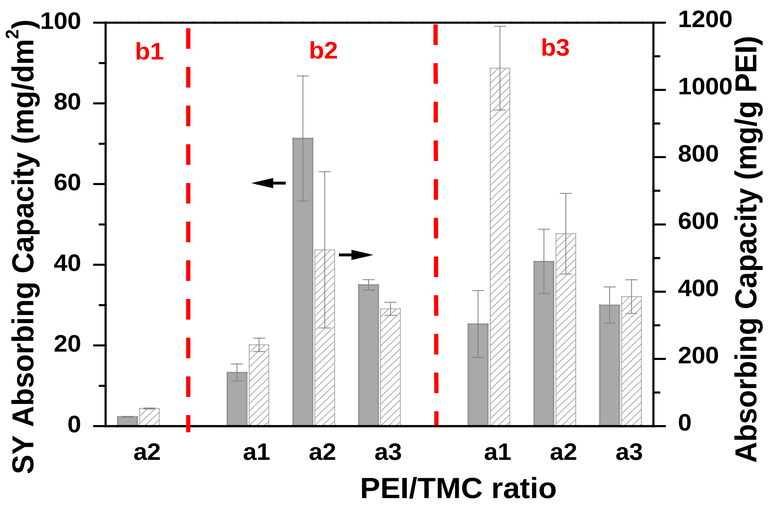

Figure 4. Sunset Yellow (SY) absorbing capacity of PEI-coated membranes

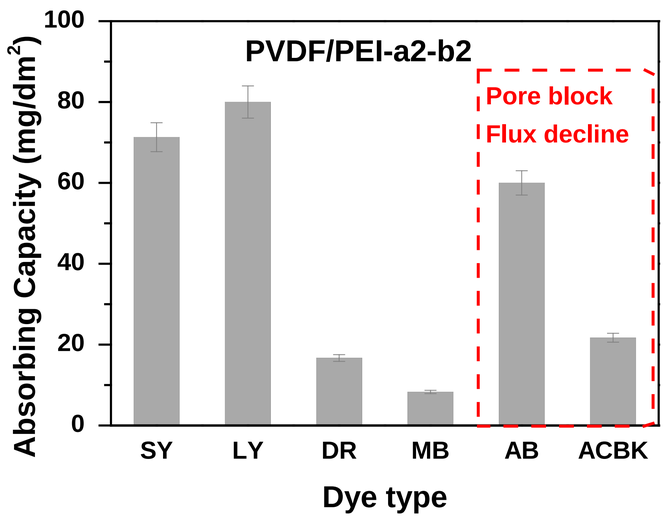

Figure 5. Membrane absorbing capacity of a series of anion dyes: Sunset Yellow (SY), Lemon Yellow (LY), Direct Red (DR), Methyl Blue (MB), Amino Black (AB), Acid Chrome Blue K (ACBK) by gravity filtration of PVDF/PEI-a2-b2

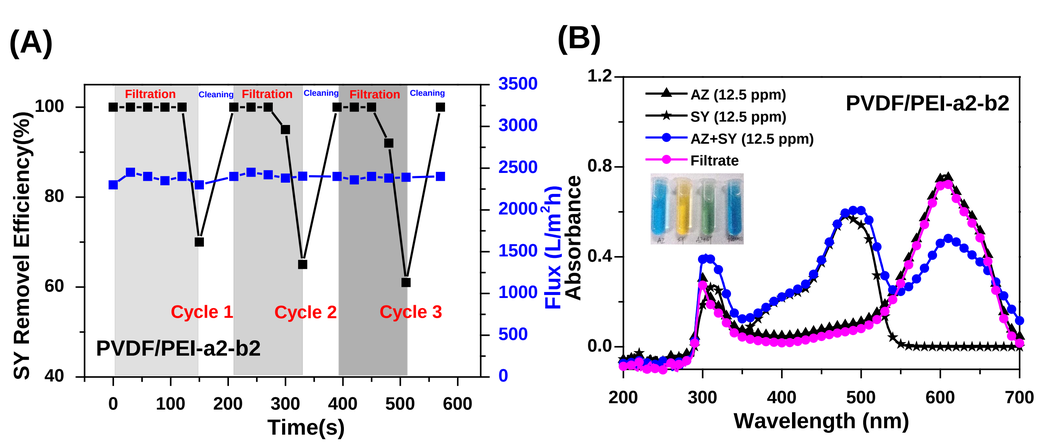

Figure 6. Treatment of SY solution over three cycles of operation under suction filtration (0.1MPa) (A) and separation of SY and Azure (AZ) by PVDF/PEI-a2-b2 membrane (B)

Conclusion

1. High efficient coating of PEI layer via surface-crosslinking
2. High treating capacity of anionic dyes in acidic solution during gravity filtration
3. Good reusability of composite membranes after desorption in basic solution