

Supporting Information

Fluoroalkyl-grafted methacrylate-PDMS membrane using fluoromonomer as diluent for enhancing biobutanol pervaporation

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Table S1 Solvents and preparation time used in the preparation of PDMS pervaporation membranes.

Membrane material	Solvent	Solvent content (wt%)	Preparation time (h)	Separation system	Ref.
PDMS	<i>n</i> -Heptane	90.05	24	Ethanol-water	1
PDMS	<i>n</i> -Heptane	90.87	36	Ethanol-water	2
PDMS	<i>n</i> -Hexane	45	24	Butanol-water	3
PDMS	<i>n</i> -Heptane	89	31	Ethanol-water	4
PDMS	<i>n</i> -Hexane	45	24	Butanol-water	5
PDMS	<i>n</i> -Hexane	89.26	5	Ethanol-water	6
PDMS	<i>n</i> -Hexane	90.00	24	Butanol-water	7
PDMS	<i>n</i> -Heptane	33.3	24	Desulfurization	8
PDMS	<i>n</i> -Heptane	20	3	Butanol-water	9
PDMS	<i>n</i> -Hexane	90.00	24	Ethanol-water	10
PDMS	<i>iso</i> -Octane	88.24	46	Butanol-water	11

Preparation of ABE fermentation broth

Butanol fermentation broth can be obtained based on the method in our previous study.^{12,13}

Clostridium acetobutylicum ABE 1201 was adopted. The culture medium contained 60 g L⁻¹ glucose, 1 g L⁻¹ KH₂PO₄/K₂HPO₄, 1 mg L⁻¹ *p*-aminobenzoic acid, 0.01 mg L⁻¹ biotin as vitamins, and 2.2 g L⁻¹ ammonium acetate, 0.2 g L⁻¹ MgSO₄·7H₂O, 10 mg L⁻¹ MnSO₄·H₂O, and 10 mg L⁻¹ FeSO₄·7H₂O. Anaerobic environment for fermentation was achieved by bubbling the nitrogen from the bottom of flask for 15 min. Before inoculation, the medium was sterilized by autoclaving at 116 °C for 25 min. 10 % of inoculation size was adopted. Batch fermentation was carried out at 37 °C without stirring for 96 h. The fermentation broth was used as the feed for pervaporation without cells separation. Because of the co-generation of organic acids as by-product, pH of the broth to be pervaporative separation was decreased to ~4.3 from 7 in the initial medium.

Table S2 Current advances of pervaporation performances of various polymeric membranes in literatures for butanol separation.

Membrane	Feed temp. (°C)	Feed conc. (wt%)	Separation factor	Total flux (g m ⁻² h ⁻¹)	Permeation conc. (wt%)	<i>PSI</i>	Ref.
PDMS	40	1	26	457	20.8	11425	14
PDMS	60	3	13.4	1065	29.3	13206	15
PDMS	60	1	~43	680	30.1	28560	16
PDMS	40	1	26.1	457	20.6	11400	17
PDMS	40	1	42	770	29.8	31570	18
PDMS	37	1	27.6	810	21.8	21546	19
PDMS	80	1.5	18.7	435.4	22.1	7707	20
PDMS	30	1	42	53	29.8	2173	21
PDMS	37	1.5	8	38.8	10.9	272	22
PDMS	37	1.26	16.2	951	17.4	14455	1
SBR ^a	30	1	9	40	8.3	320	23
EPDM ^b	30	1	6	24	5.7	120	23
PEBA ^c	23	1	12	32	10.8	352	24
PUR ^d	50	1	10	88	9.2	792	25
PTFE ^e	50	1	10	805	9.2	7245	26
PTFE ^e	38	1.3	8.5	170	9.9	1275	26
PERVAP-1060 ^f	40	1	27	300	21.4	7800	27
PDMS	30	1	43.1	159.6	30	6719	28
PDMS	37	1.5	14.6	1306.9	18.2	17774	29
PDMS	40	1	38.6	282	28.0	10603	30
PDMS	37	1	23.5	890	19.2	20025	19
PDMS	60	1	32	1375	24.4	42625	31
PDMS	37	1	34	95	25.6	3135	32
MA-PDMS	60	1	38	594	28.7	22141	This study

MA-PDMS- F1	60	1	41	862	30.5	34452	This study
MA-PDMS- F2	60	1	39	1066	28.6	40868	This study
MA-PDMS- F3	60	1	34	1216	25.5	40062	This study

^aStyrene butadiene rubber (SBR).

^bPropylene diene rubber (EPDM).

^cPoly(ether block amide) (PEBA).

^dPolyurethane (PUR).

^ePolytetrafluoroethylene (PTFE).

^fGFT PDMS membrane (PERVAP-1060).

Table S3 Comparison of pervaporation performance of PDMS based membranes for separating ABE fermentation broth.

Membrane	Feed concentration (g L ⁻¹)			Flux (g m ⁻² h ⁻¹)	Separation factor			Ref.
	Butanol	Ethanol	Acetone		Butanol	Ethanol	Acetone	
PDMS	15	2.5	7.5	120.2	13.7	4.8	23.2	33
PDMS	-	-	-	621	19.8	10.1	33.4	34
PDMS	7.58	0.53	3.77	783.91	10.28	2.92	-	35
PDMS	11	2	6	670	15.1	6.7	20.6	1
PDMS	11.5	2.3	5.6	816	18.2	4.1	17.5	36
PPhS ^a /PDMS	-	-	-	284.94	34.03	14.05	5.03	28
PDMS	11.3	1.5	3.2	840	13.99	7.22	18.11	37
PDMS	2.7	0.8	0.6	349	14.3	8.7	36.6	38
MA-PDMS-F1	1.25 ^b	0.3 ^b	0.6 ^b	803	32.0	7.8	25.1	This work
MA-PDMS-F2	12.1 ^b	0.3 ^b	0.6 ^b	997	29.6	7.2	22.6	This work

^aPolyphenylsiloxane (PPhS).

^bUnit with wt%

Supplementary references

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