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APPENDICES

Appendix A The Relationship between Gas Permeance and Gas Permeability

The thickness of the tested membranes in UOP lab was in the range of 2.6-3.4 mil depending on the inorganic filler loading.

$$\text{Permeance (GPU)} = \frac{\text{Permeability (Barrer)}}{\text{Thickness (cm)}}$$

$$\text{Permeance (GPU)} = \frac{1 \times 10^{-6}.\text{cm}^3.\text{(STP)}}{\text{cm}^2.\text{s. cmHg}}$$

$$\text{Permeability (Barrer)} = \frac{1 \times 10^{-10}.\text{cm}^3.\text{(STP)}.\text{cm}}{\text{cm}^2.\text{s. cmHg}}$$

Appendix B The Experimental Gas Performance of Methane (CH_4), Carbon Dioxide (CO_2), and Hydrogen (H_2) of Matrimid Membrane and Mixed Matrix Membranes at 50 °C and 100 psig

Table B1 Pure Matrimid membrane and activated carbon-Matrimid MMMs

Membrane	Gas Permeance (GPU)			Gas Selectivity	
	CH_4	CO_2	H_2	CO_2/CH_4	H_2/CH_4
Matrimid	0.0049	0.1078	0.3353	22.0	68.6
15 wt.% AC/ Matrimid	0.0072	0.1798	0.5244	25.0	72.8
25 wt.% AC/ Matrimid	0.0167	0.2861	0.7957	17.2	47.7

Table B2 Pure Matrimid membrane and γ-Al_2O_3-Matrimid MMMs

Membrane	Gas Permeance (GPU)			Gas Selectivity	
	CH_4	CO_2	H_2	CO_2/CH_4	H_2/CH_4
Matrimid	0.0049	0.1078	0.3353	22.0	68.6
15 wt.% γ-Al_2O_3/ Matrimid	0.0099	0.1783	0.5338	18.0	53.9
25 wt.% γ-Al_2O_3/ Matrimid	0.0193	0.2941	0.9368	15.2	48.4

Table B3 Pure Matrimid membrane and 4A zeolite-Matrimid MMMs

Membrane	Gas Permeance (GPU)			Gas Selectivity	
	CH_4	CO_2	H_2	CO_2/CH_4	H_2/CH_4
Matrimid	0.0049	0.1078	0.3353	22.0	68.6
15 wt.% 4A/ Matrimid	0.0106	0.1847	0.6044	17.5	57.2
25 wt.% 4A/ Matrimid	0.0359	0.1868	0.6159	5.2	17.1

Appendix C The Experimental Flow Rate of Methane (CH_4), Carbon Dioxide (CO_2) and Nitrogen (N_2) of Matrimid Membrane and Mixed Matrix Membranes in Performance at Room Temperature and 100 psi

Table C1 Pure Matrimid membrane

Gas	Pressure (psi)	Flow Rate (cm^3/s)	Permeance (GPU)	Average of Permeance (GPU)	STDEV of Permeance
N_2	100	7.19E-05	0.0039	0.0039	4.54E-06
		7.19E-05	0.0039		
		7.20E-05	0.0040		
CH_4	100	6.41E-05	0.0035	0.0035	1.71E-05
		6.45E-05	0.0035		
		6.47E-05	0.0036		
N_2	100	7.19E-05	0.0039	0.0039	4.54E-06
		7.19E-05	0.0039		
		7.20E-05	0.0040		
CO_2	100	1.43E-03	0.0784	0.0787	2.60E-04
		1.44E-03	0.0788		
		1.44E-03	0.0788		

Table C2 15 wt.% γ-Al_2O_3-Matrimid

Gas	Pressure (psi)	Flow Rate (cm^3/s)	Permeance (GPU)	Average of Permeance (GPU)	STDEV of Permeance
N_2	100	1.23E-04	0.0067	0.0068	5.76E-05
		1.24E-04	0.0068		
		1.25E-04	0.0069		
CH_4	100	1.13E-04	0.0062	0.0062	4.16E-05
		1.13E-04	0.0062		
		1.14E-04	0.0063		
N_2	100	1.23E-04	0.0067	0.0068	5.76E-05
		1.24E-04	0.0068		
		1.25E-04	0.0069		
CO_2	100	2.10E-03	0.1153	0.1159	5.64E-04
		2.12E-03	0.1162		
		2.12E-03	0.1162		

Table C3 25 wt.% γ-Al_2O_3-Matrimid

Gas	Pressure (psi)	Flow Rate (cm^3/s)	Permeance (GPU)	Average of Permeance (GPU)	STDEV of Permeance
N_2	100	1.27E-04	0.0070	0.0070	1.54E-04
		1.27E-04	0.0070		
		1.32E-04	0.0072		
CH_4	100	1.18E-04	0.0064	0.0065	9.93E-05
		1.18E-04	0.0065		
		1.21E-04	0.0066		
N_2	100	1.27E-04	0.0070	0.0070	1.54E-04
		1.27E-04	0.0070		
		1.32E-04	0.0072		
CO_2	100	2.84E-03	0.1559	0.1570	1.03E-03
		2.87E-03	0.1576		
		2.87E-03	0.1576		

Appendix D The Experimental Gas Selectivity of Matrimid Membrane and Mixed Matrix Membranes in Performance at Room Temperature and 100 psi

Table D1 Gas selectivity determined from gas permeance of Matrimid membrane and γ-Al_2O_3-Matrimid MMMs at room temperature and 100 psi

Membrane	CO_2/CH_4 Selectivity	CO_2/N_2 Selectivity
Pure Matrimid (0 wt.%)	22.2	19.9
15 wt.% γ-Al_2O_3-Matrimid	18.6	17.0
25 wt.% γ-Al_2O_3-Matrimid	24.1	22.3

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