Data Set

The Utilization of Micro-Mesoporous Carbon-Based Filler in the P84 Hollow Fiber Membrane for Gas Separation

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Table S1 Mixed gas performance of the MMMs. Number in parentheses corresponds to the performance increase (+) or decrease (-) in percent

|  |  |  |
| --- | --- | --- |
| **Membrane** | **Binary Gas (Barrer)** | **Selectivity** |
| CO2/CH4 | H2/CH4 | CO2/CH4 | H2/CH4 |
| CO2 | CH4 | H2 | CH4 |
| Neat | 9.09±0.01(-32.09) | 1.15±0.01(-25.92) | 19.92±0.31(-12.31) | 1.43±0.07(-7.89) | 7.90 ± 0.53(-8.60) | 13.93 ± 0.18(-4.97) |
| P84/ZTC 0.5 | 11.42±0.11(-23.80) | 1.51±0.00(-22.27) | 28.96±0.21(-18.30) | 1.68±0.01(-13.51) | 7.56 ± 0.16(-2.02) | 17.24 ± 0.50(-5.58) |
| P84/ZTC 1 | 18.67±0.20(-23.89) | 1.77±0.03(-21.59) | 36.61±0.01(-22.83) | 1.85±0.02(-18.04) | 10.55 ± 0.49(-2.94) | 19.79 ± 0.74(-5.84) |
| P84/ZTC 1.5 | 13.92±0.06(-20.68) | 1.91±0.01(-16.80) | 21.28±0.04(-39.06) | 1.83±0.08(-20.29) | 7.29 ± 0.12(-4.76) | 11.63 ± 0.37(-23.54) |

The Data for Robeson Upper Bound 1991 and 2008 was available elsewhere [1,2].

Table S2 CO2/N2 Reference

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Membrane** | **Filler Loading** | ***P*CO2 (Barrer)** | **αCO2/N2** | **Ref** |
| PES | 0 | 0.12 | 22.5 | [3] |
| PES/MWCNTs | 5 wt% | 0.2 | 22.5 |
| PES/CNT | 5 wt% | 0.2 | 22.1 | [4] |
| PES/CNT-Ru Metal | 5 wt% | 0.13 | 26.5 |
| P84 | 0 | 0.89 | 20.23 | [5] |
| P84/SiO2 | 4 wt% | 0.92 | 19.57 |
| BPPO | 0 | 2.6 | 30 | [6] |
| BPPO/MWCNTs | 5 wt% | 4.7 | 31 |
| BPPO/SWCNTs | 5 wt% | 2.6 | 30 |
| SEBS/ZIF-8 (S) |  | 14.71 | 10.6 | [7] |
| SEBS/ZIF-8 (M) |  | 15.23 | 12 |
| Matrimid/CSM-18.4 |  | 1.32 | 38.1 | [8] |
| Matrimid | 0 | 9.6 | 30 | [9] |
| Matrimid/PIM-1 Blend | 10 wt% PIM-1 | 17 | 30 |
| P84 | 0 | 3.05 | 13.6 | [10] |
| P84 anne 180°C |  | 1.09 | 9.5 |
| P84 anne 200°C |  | 0.97 | 7.7 |
| CA |  | 13.8 | 39.5 | [11] |
| P[CA](Tf2N) |  | 8.9 | 26.8 |
| P[DADMA](Tf2N) |  | 6.8 | 18.4 |
| PI/AAMSN | 3 wt% | 54 | 28.1 | [12] |
| PI | 0 | 66.7 | 27.8 |
| PEBAX/ZIF-8 | 3 wt% | 150 | 41.9 | [13] |
| P84 | 0 | 3.55 | 0.87 | [14] |

Table S3 CO2/CH4 Reference

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Membrane** | **Filler loading** | ***P*CO2 (Barrer)** | **αCO2/CH4** | **Ref** |
| P84 | 0 | 3.55 | 0.76 | [14] |
| PI/TiO2 | 5 wt% | 1.97 | 28.14 | [15] |
| PI | 0 | 2.35 | 19.58 |
| PI/TiO2 | 10 | 2.14 | 16.46 |
| PES | 0 | 25.7 | 3.57 | [16] |
| PES/CMS | 15 wt% | 68 | 11.15 |
| PES/Zeolite 4A |  | 6.7 | 28.7 | [17] |
| PC/Zeolite 4A |  | 4.6 | 51.8 | [18] |
| SEBS/ZIF-8 (S) |  | 14.71 | 5.2 | [7] |
| SEBS/ZIF-8 (M) |  | 15.23 | 5.4 |
| SEBS/ZIF-8 (L) |  | 15.59 | 5.2 |
| PSF/SWNT | 10 wt% | 5.19 | 18.53 | [19] |
| PBNPI/MWCNTs | 15 | 6 | 3.37 | [20] |
| PC-PEG/MWCNTs | 10 | 20.32 | 35.64 | [21] |
| Polyimide/MWCNTs | 1 | 37.37 | 16.5 | [22] |
| PSF/NH2-MIL-101 | 25 | 8.5 | 29 | [23] |
| Matrimid/N2-MIL-101 | 15 | 9.5 | 36 |

Table S4 H2/N2 References

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Membrane** | **Filler loading** | ***PH*2 (Barrer)** | **αH2/N2** | **Ref** |
| P84 | 0 | 25.3 | 4.1 | [14] |
| IL-Pebax/ZIF-8 | 8 wt% | 26 | 7.22 | [24] |
| Pebax/ZIF-8 | 8 wt% | 41 | 5.86 |
| PEI/SOD | 10 wt% | 1280 | 3 | [25] |
| MPU4 |  | 1.29 | 15 | [26] |
| PES | 0 | 6.5 | 46.43 | [27] |
| PES/Zeolite 13X | 50 wt% | 8.5 | 70.8 |
| PES/Zeolite 4A | 50 wt% | 14.1 | 56.4 |
| Pebax | 0 | 12.4 | 5.56 | [28] |
| Pebax/ZIF-67 | 2.5 | 9.91 | 4.86 |
| Pebax/ZIF-67 | 10 | 8.20 | 3.71 |
| Matrimid | 0 | 11.7 | 83.57 | [29] |
| P84 | 0 | 33.2 | 6.24 | [30] |

Table S5 H2/CH4 References

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Membrane** | **Filler loading** | ***PH*2 (Barrer)** | **αH2/CH4** | **Ref** |
| P84 | 0 | 25.3 | 3.56 | [14] |
| P84 | 0 | 33.2 | 4.96 | [30] |
| 6FDA-DAM | 0 | 21.4 | 33.96 | [31] |
| 6FDA-DAM/ZIF-11 | 10 wt% | 106.7 | 30.48 |
| 6FDA-DAM/ZIF-11 | 30 wt% | 76.76 | 31.98 |
| Matrimid/GO | 2 wt% | 30 | 130 | [32] |
| PSF/GO | 2 wt% | 12 | 55 |
| PI/MWCNT@GONRs | 2 wt% | 42.5 | 18.5 | [33] |
| P84/ND | 1 wt% | 6.7 | 310 | [34] |
| PI | 0 | 9 | 41 | [35] |
| PI/MOF5 | 5 wt% | 11 | 40 |
| Pebax/ZIF-8 | 8 wt% | 41 | 3 | [24] |
| IPebax/ZIF-8 | 8 wt% | 26 | 3.59 |
| P84 | 0 | 4.44 | 74 | [36] |
| PBNPI/MWCNT | 15 | 14.31 | 8.04 | [20] |
| PES/SAPO-34 |  | 0.206 | 61 | [37] |
| PC/Zeolite 4A |  | 13.4 | 54.4 | [18] |

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