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Review

# Recent progress of fillers in mixed matrix membranes for $CO_2$ separation: A review

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ABSTRACT

Among various $CO_2$-mitigation technologies, membrane-based technology has offered a more energy efficient and eco-friendly process for $CO_2$ separation from large emission sources, in order to reduce $CO_2$ emission level into atmosphere. In general, polymeric and inorganic membranes have been used in gas separation processes, but each has its own pros and cons. Currently, membrane research has addressed the trade-off limitations of membranes in different ways through fabrication of new type of mixed matrix membranes (MMMs) by incorporation of inorganic particles as fillers into polymer matrices. The performance of MMMs depends on textural properties of fillers, molecular sieving effect and membrane–penetrant interactions. The main challenges in the fabrication of MMMs is selection of fillers, which controls the gas separation characteristics of membranes. In this review, the influences of fillers like zeolite, carbon, and metal organic framework in MMMs fabrication and their $CO_2$ permeability and $CO_2/CH_4$ and $CO_2/N_2$ selectivity were compiled from recent reports. Further, a new protocol is introduced for screening of fillers, which will helps to development of new fillers as well as for fabrication of new MMMs with high $CO_2$ separation capacity.



**Contents**



*Abbreviations:* CA, cellulose acetate; β-CD, beta-cyclodextrins; CCS, carbon capture and sequestration; COK, Centrum voor Oppervlaktechemie en Katalyse; CMS, carbon molecular sieves; CNFs, carbon nanofibers; CNTs, carbon nanotubes; ETS, engelhardt titanosilicate; 6FDA-DAM, 2,2-bis(3,4-carboxyphenyl) hexafluoropropane dianhydride-diaminomesitylene; GO, graphene oxide; GPU, gas permeation unit; GTA, glycerol triacetate; IL, ionic liquids; IPCC, Intergovernmental Panel on Climate Change; MCM, mobil composition of matter; MFI, mordenite framework inverted; MWCNTs, multi-walled carbon nanotubes; MIL, materials institute lavoisier; MMMs, mixed matrix membranes; MOFs, metal organic frameworks; PDMS, polydimethylsiloxane; PEBA or PEBAX, poly(ether-block-amide); PEI, polyethylenimine; PEG, poly(ethylene glycol); PEO, poly ethylene oxide; PES, polyethersulfone; PF, permeability factor; PI, polyimide; PIM, polymers of intrinsic microporosity; PMP, poly(4-methyl-1-pentyne); PMPS, polymethylphenylsiloxane; POZ, poly(2-ethyl-2-oxazoline); PSf, polysulfone; PVC-g-POEM, poly(vinyl chloride)-g-poly(oxyethylene methacrylate); PVDF, poly(vinylidene fluoride); PU, polyurethane; SAPO, sodium-alumino-phosphate; SF, separation factor; SBA, santa barbara amorphous; SWCNTs, single walled carbon nanotubes; SEBS, polystyrene-block-poly(ethylene-ran-butylene)-block-polystyrene; SPEEK, sulfonated poly(ether ether ketone); TS, titanium silicalite; UiO, University of Oslo; UNFCCC, United Nations Framework Convention on Climate Change; ZIF, zeolitic imidazolate framework; ZSM, zeolite socony mobil.

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