



A New Generation of "Molecular Basket" Sorbents (MBS) for Separation of CO₂ and H₂S from Various Gas Streams

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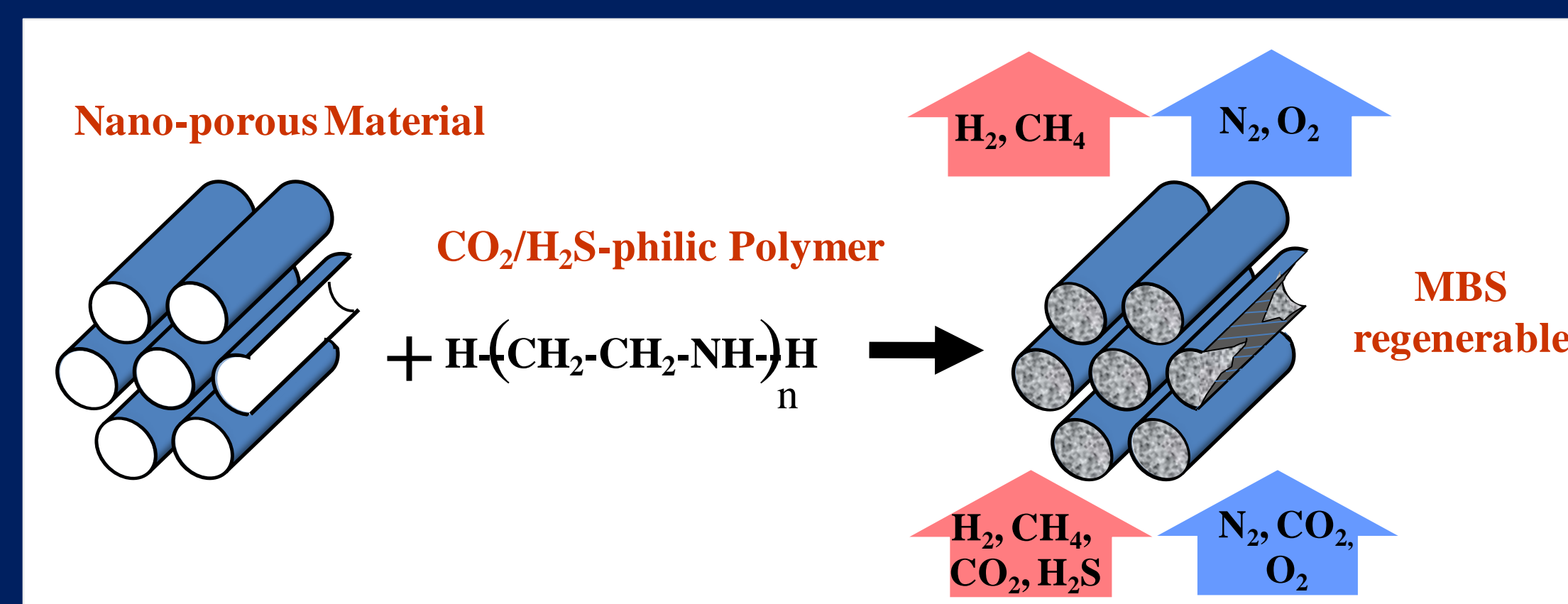
Background

- The presence of CO₂ in the hydrogen, syngas and fuel gas reduces the energy content and lows the efficiency in the transportation, storage and application.
- H₂S and other sulfur contaminants corrode the equipment, and poison catalysts in fuel processing and SOFC and PEMFC.
- Carbon Capture and Sequestration (CCS) is considered as one of the key options for mitigating the emission.
- Novel technologies for removing CO₂, H₂S and other sulfur contaminants are crucial for the hydrogen production and fuel cell application.

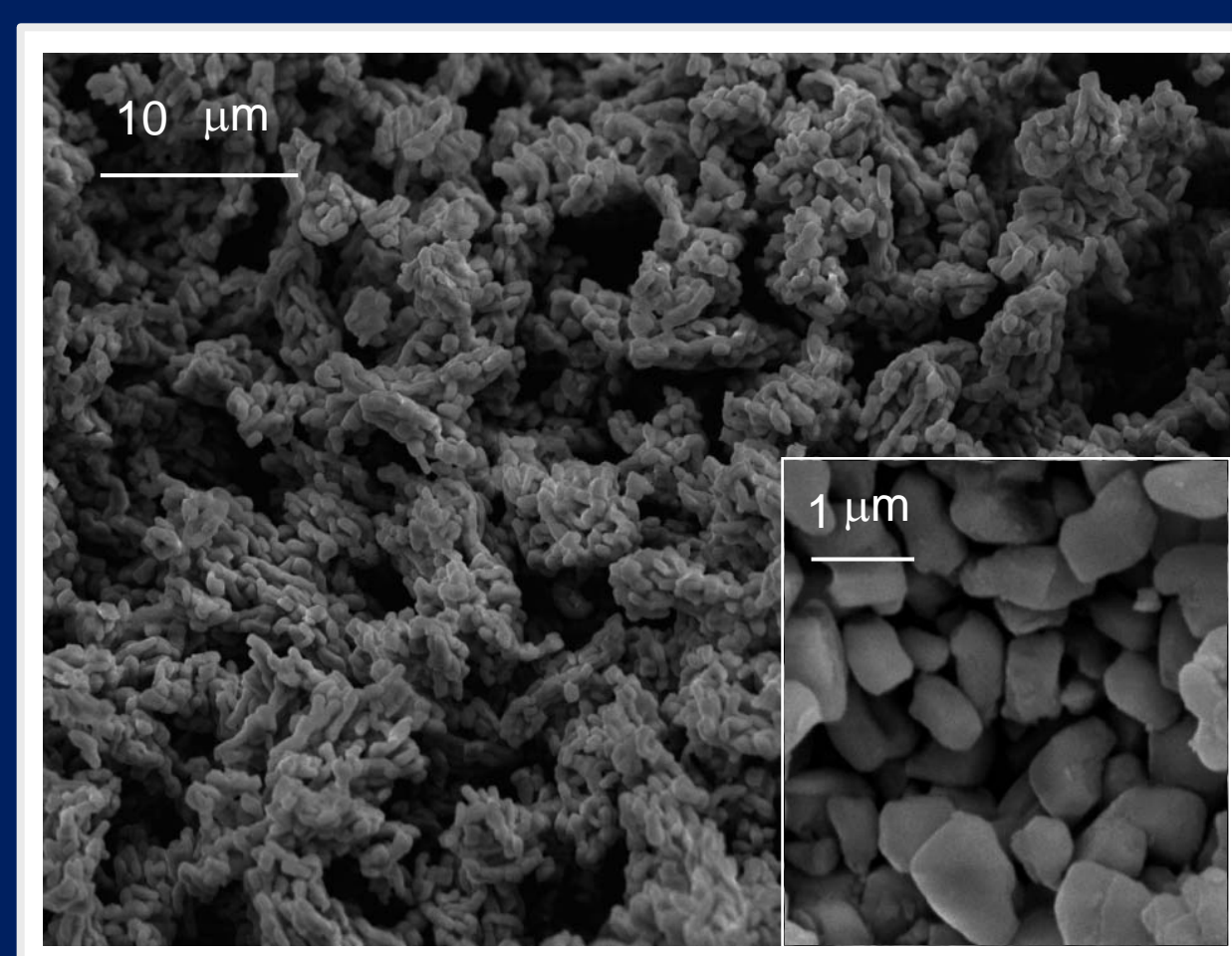
Objective

To remove CO₂ and H₂S for fuel processor development for the solid oxide fuel cell.

Concept of MBS



SEM Images of MBS-2

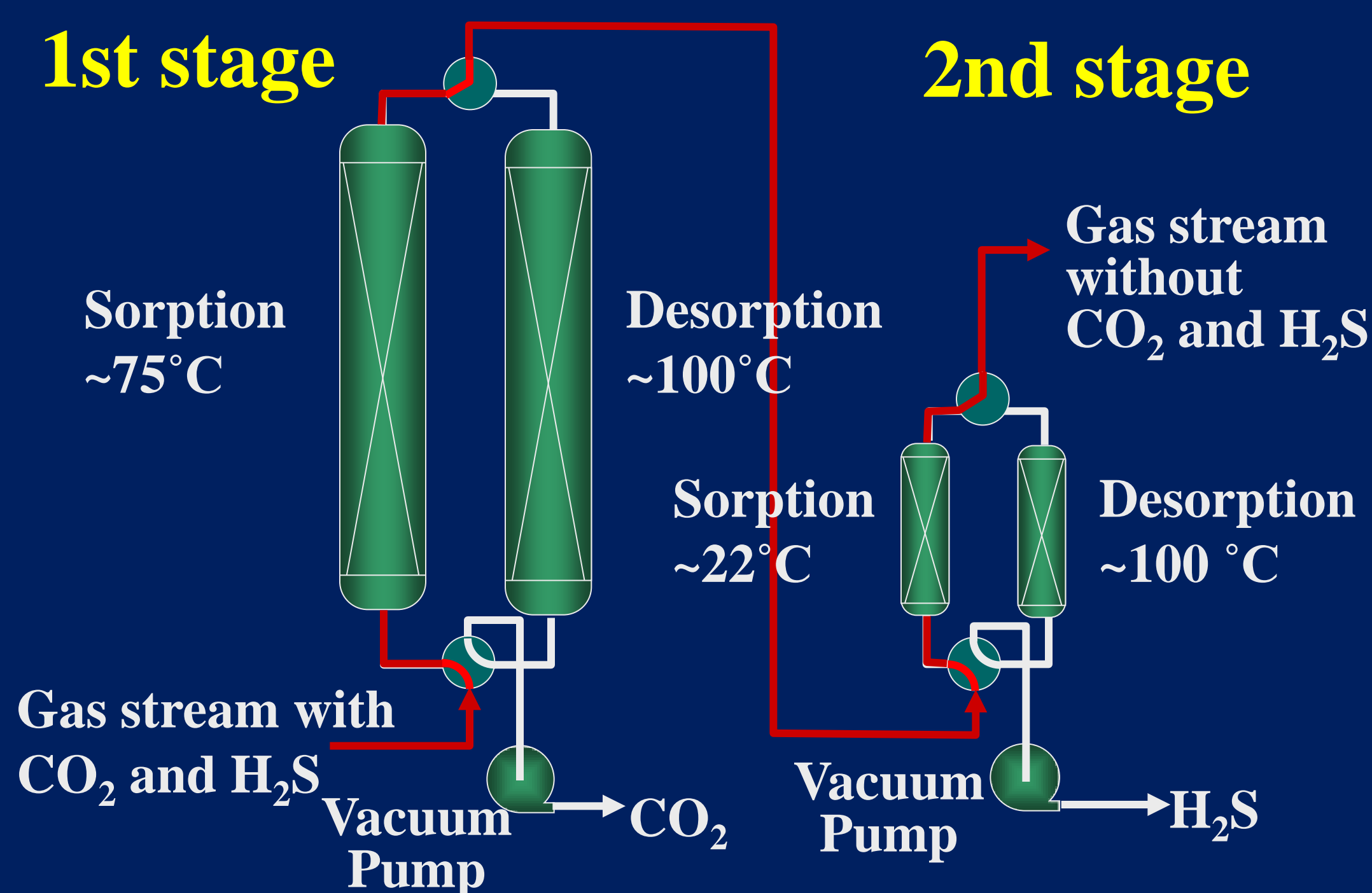


Properties of MBS-2

- Polymer loading: 40-70 wt %
- Particle size: 0.5-2.0 μm
- Surface area: 1-4 x10⁷ m²/m³
- Packing density: 0.4-0.5 g/ml

- Xu et al. *Energy Fuels* 2002, 16, 1463; *Microporous Mesoporous Mater.* 2003, 62, 29; *Int. J. Environ. Technol. Manage.* 2004, 4 (1-2), 32; *Ind. Eng. Chem. Res.* 2005, 44, 8113-8119.
- Ma et al. *J. Am. Chem. Soc.* 2009, 131, 5777-5783.

Two-stage Process for Removing CO₂/H₂S*



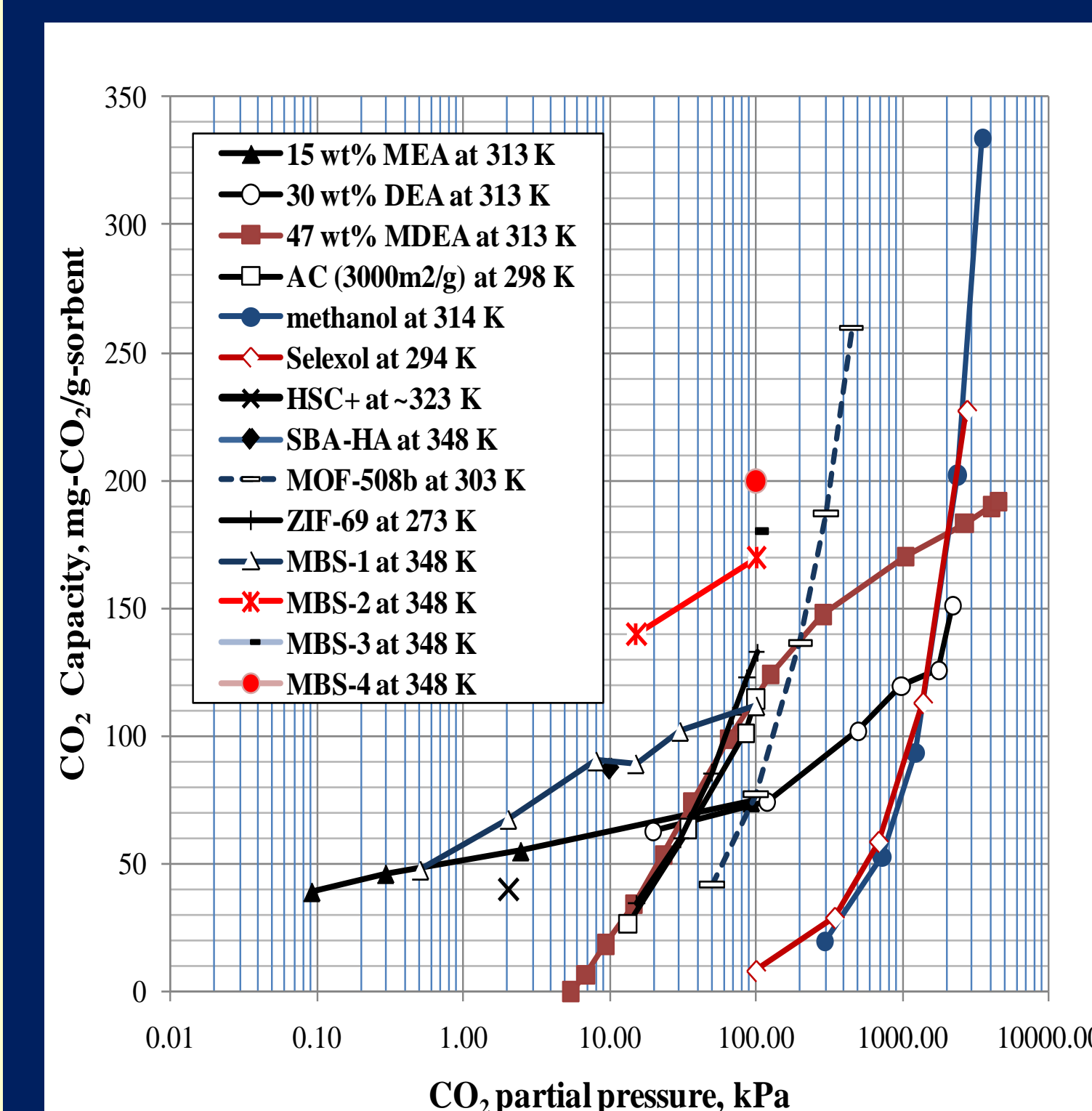
* Song, C.S.; Ma, X.L.; Wang, X.X. WO 2008127602 (A3), PCT Int. Appl. Jan 08, 2009, 82 pp.
Song, C.S.; Ma, X.L.; Wang, X.X. US Patent Application, US 20080264254 (A1) 20081030, filed, Apr 9, 2008, Application No: 12/081,036.
Song, C.S.; Ma, X.L.; Wang, X.X. WO 2008127602 (A2), CAN 149-474053 AN 2008:1282328, PCT Int. Appl. Oct 23, 2008, 82 pp.
Song, C.S.; Ma, X.L.; Wang, X.X. US Provisional Patent Application filed, Apr 11, 2007, Legal Reference Number: PSU-024.
Song, C.S.; Ma, X.L.; Wang, X.X., Pennsylvania State University, PSU Invention Disclosure No. 2006-3226, Aug 1, 2006.

Acknowledgment

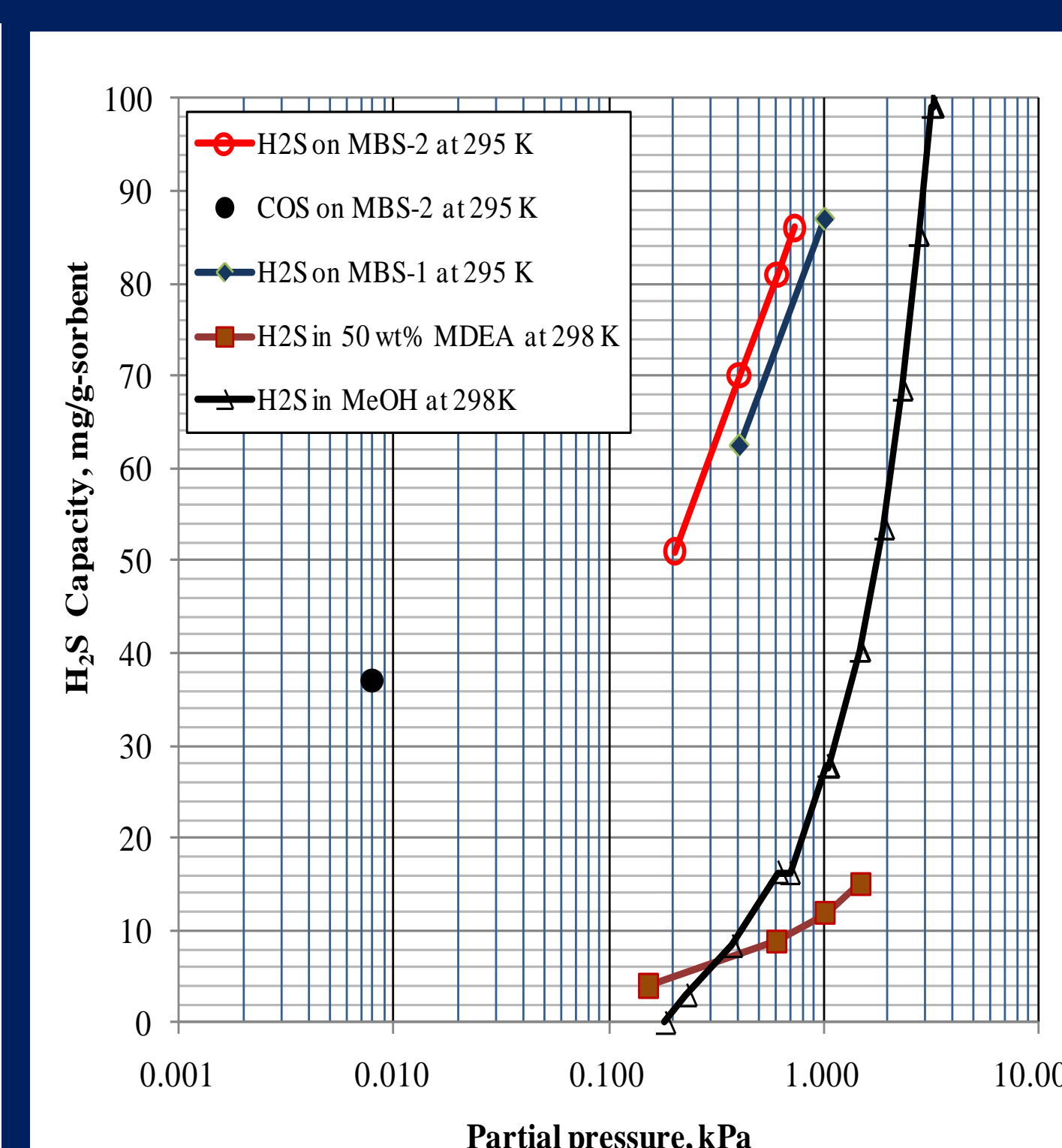
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- Pennsylvania Energy Development Authority (PEDA) under Grant PG050021.
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Sorption Capacity of MBS

For CO₂

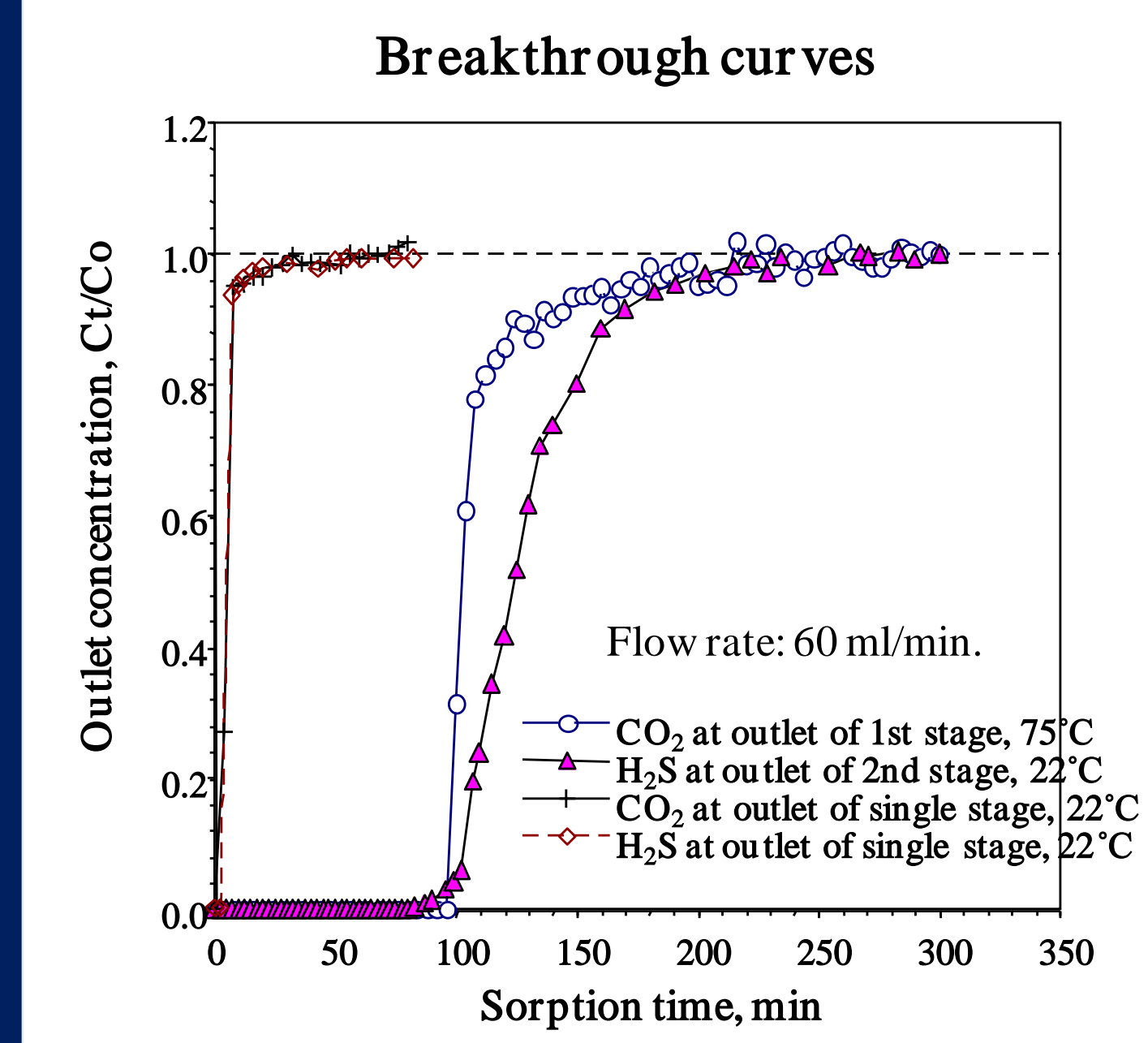
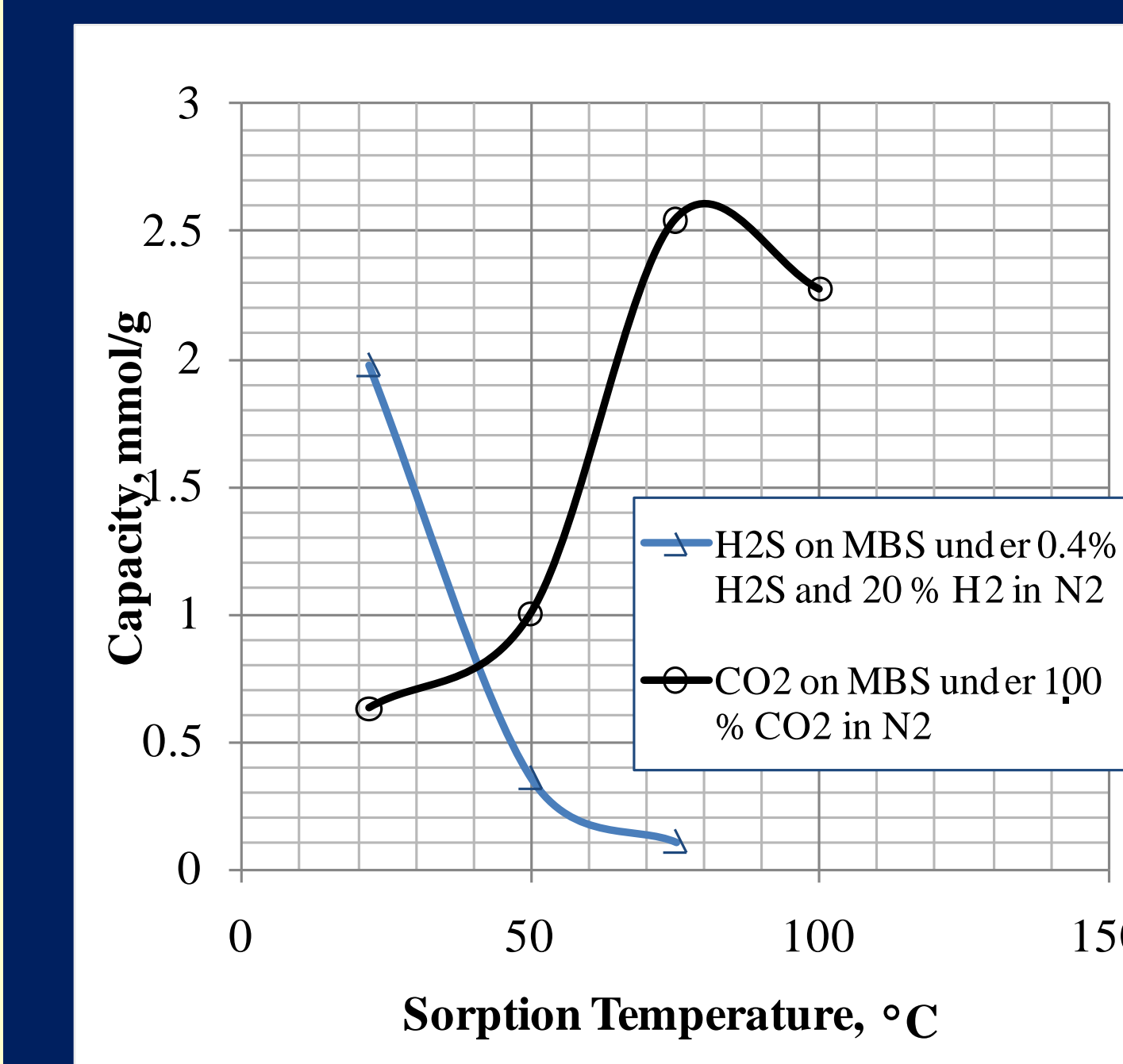


For H₂S and COS



*In comparison with industrial absorbents and state-of-the-art adsorbents

Exceptional Dependence of MBS on Temp



Sorption and Separation Mechanism on MBS

Potential Energy Surface

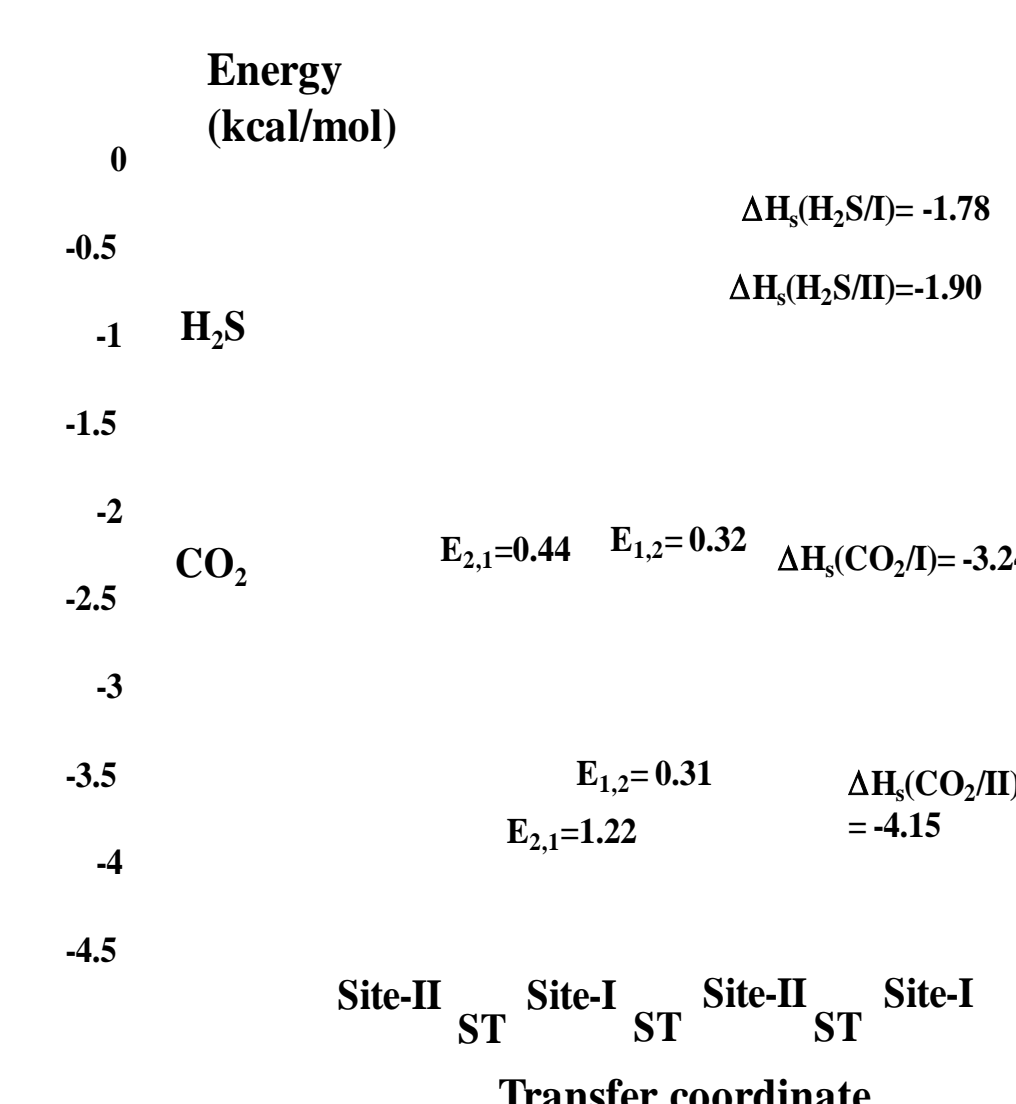
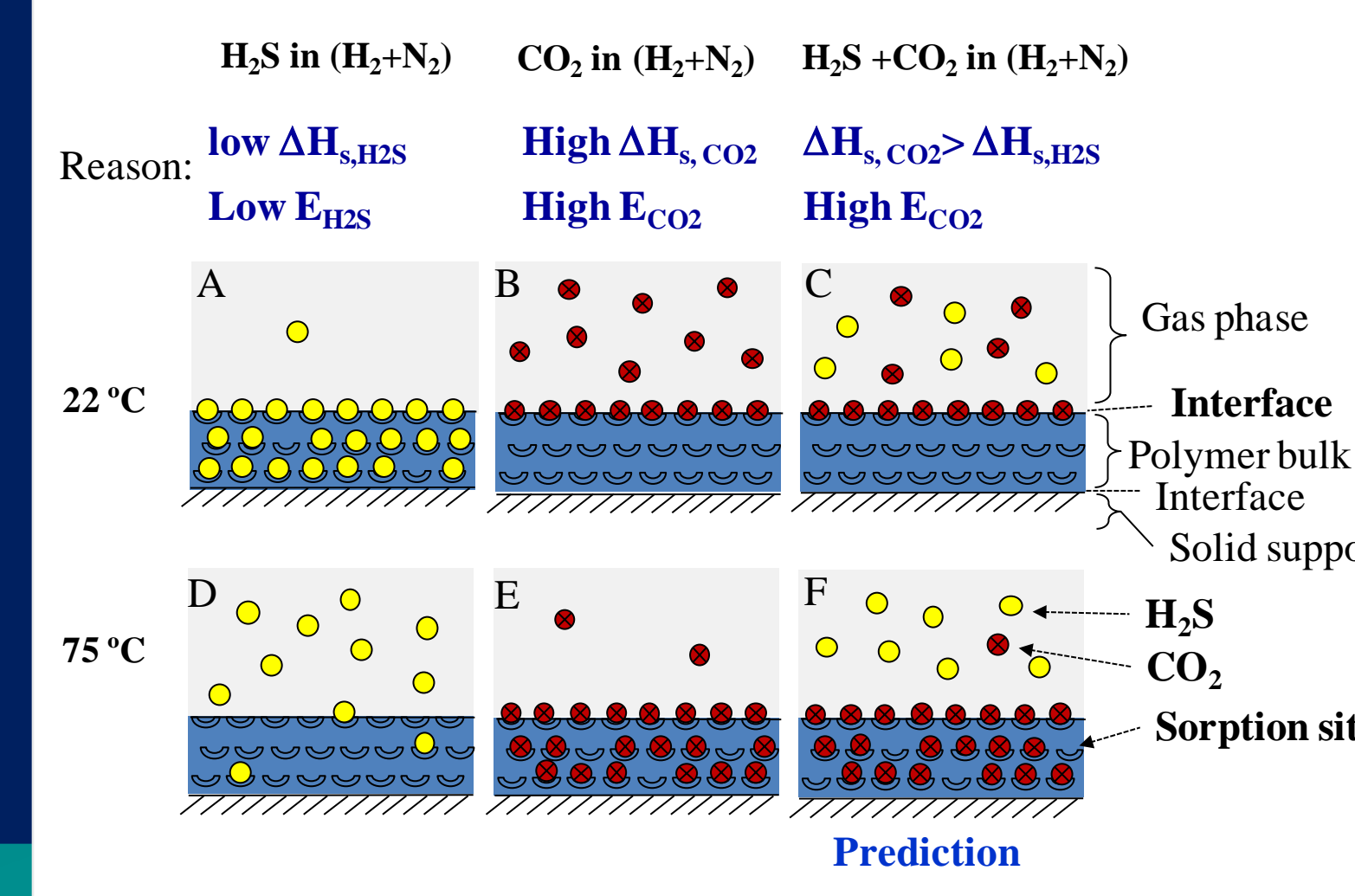


Illustration of Exceptional Dependence



Comparison with Amine Scrubbing

	Amine Scrubbing	Sorption on MBS
Capacity for CO ₂ , mg-CO ₂ /G-sorb at 15 kPa	60	160, 200
Capacity for H ₂ S, mg-H ₂ S/g-sorb at 2000 ppmv	5.0	50
Removing sulfur level, ppmv	1?	<0.060
Removing CO ₂ and H ₂ S	together	separately
Corrosion	yew	no
Gas-sorbent interface area, m ² /m ³	~200	~20,000,000
Sorption/desorption rate	low	high
Regenerability	yes	yes
Working temperature	40-120	25-100
Heat capacity for absorbent/sorbent, kJ/kg	3.5	1.6
Relative energy consumption	100	<50

Wide Applications

Gas cleaning up:

- Biogas
- Landfill Gas
- Coal/biomass Gasification Gas
- Natural Gas
- Reformate
- Syngas

Processes:

- Fixed-bed adsorber
- Fluidized-bed adsorber
- Moving-bed adsorber
- Rotating-bed adsorber

CO₂ capture from flue gas and atmosphere