Sixth Annual Conference on Carbon Capture & Sequestration

Session: Capacity Building

Sorbents and Membranes for CO_2 Capture from Flue Gas

- Ionic liquids, polymers, nanocomposites
- Wyodak Power Plant – Amine benchmark
- Membrane and Zeolite cases

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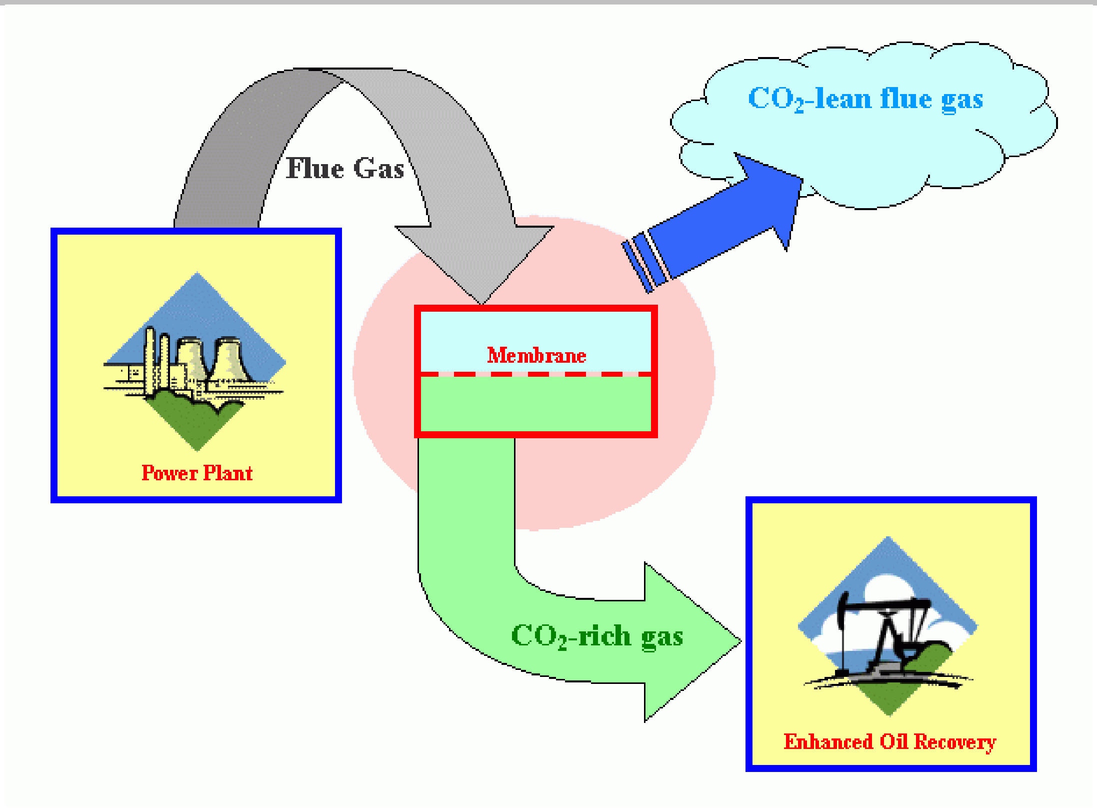
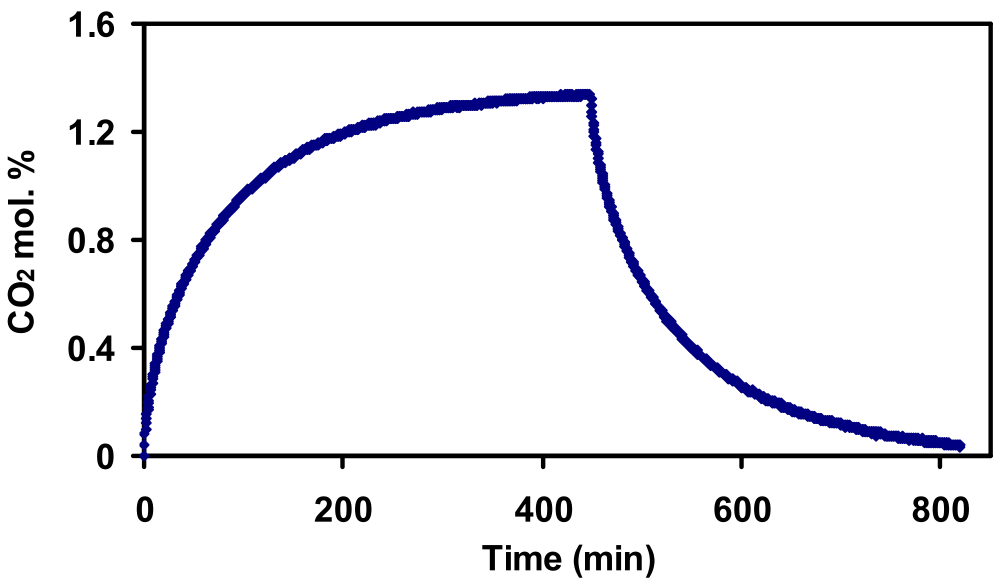
Polyionic, Nanocomposite, Inorganic Materials for CO_2 Recovery from Flue Gas and Natural Gas



Reduce CO2 cost (now about $50/ton)

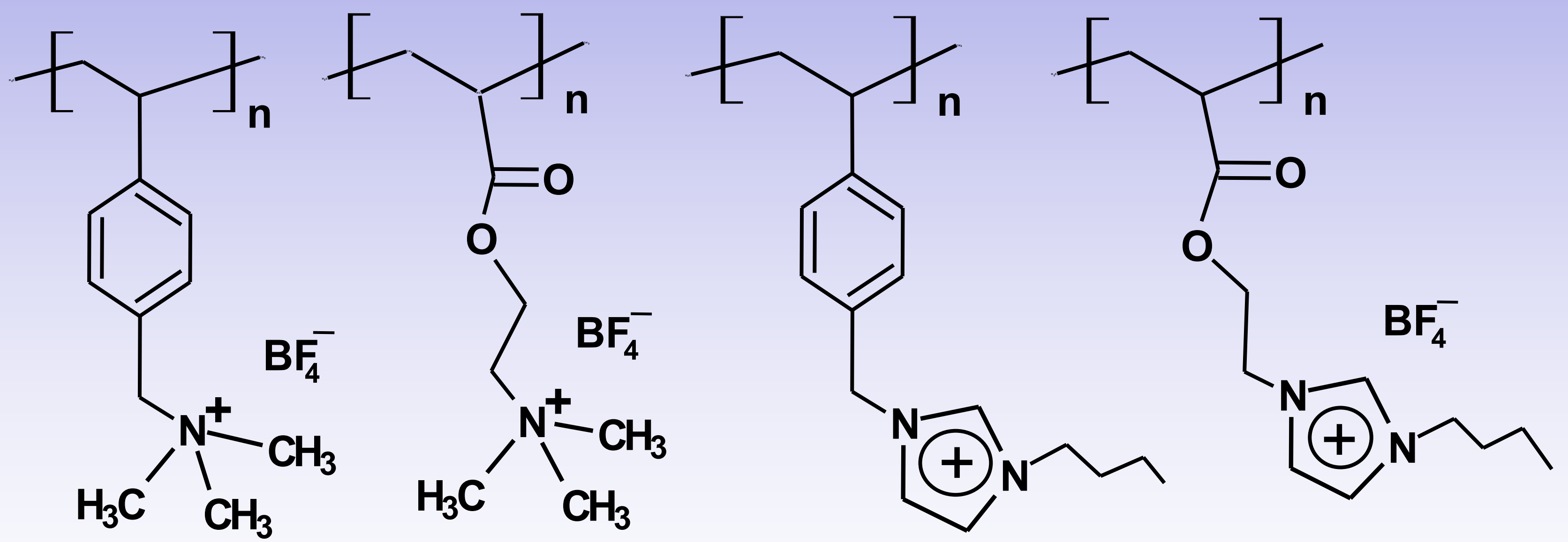
Ionic "liquids" usually…

- Are non-volatile
- Are non-flammable
- Are thermally stable
- Can be hydrophobic or hydrophilic
- Have high ionic conductivity
- Have high microwave absorption
- Have high CO2 affinity (hence high solubility)



…but viscosity is high, rates are low

Polymers from ionic-liquid monomers



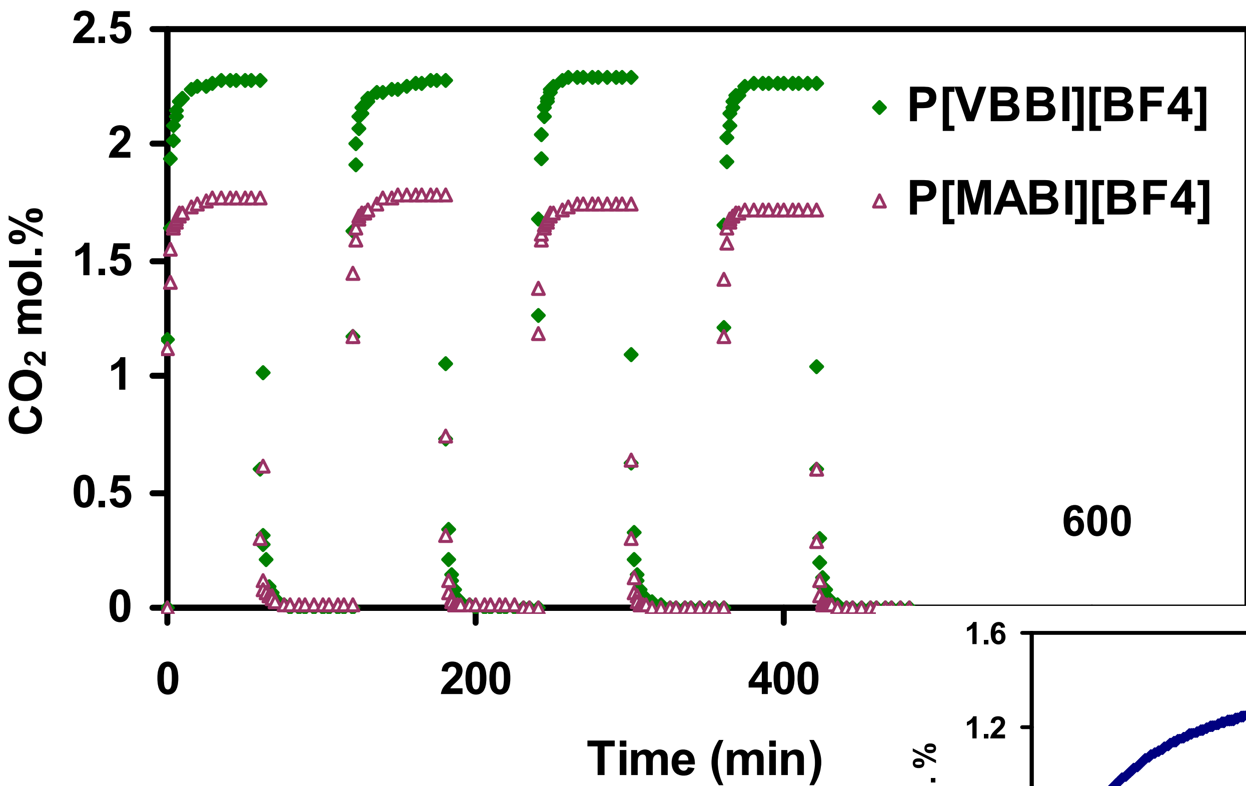
P[VBTMA][BF_4] P[MATMA][BF_4]

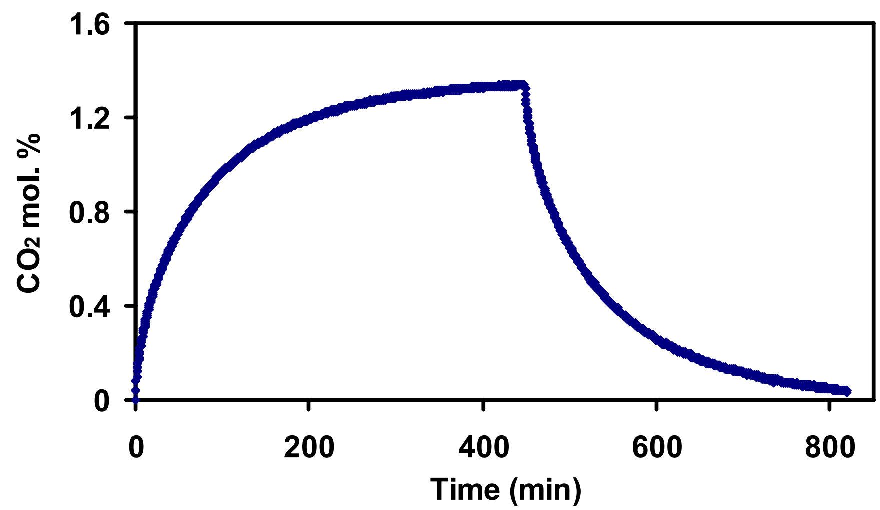
a b

c: BF_4^- P[VBBI][BF_4] P[MABI][BF

d: Tf_2N^- P[VBBI][Tf_2N] e

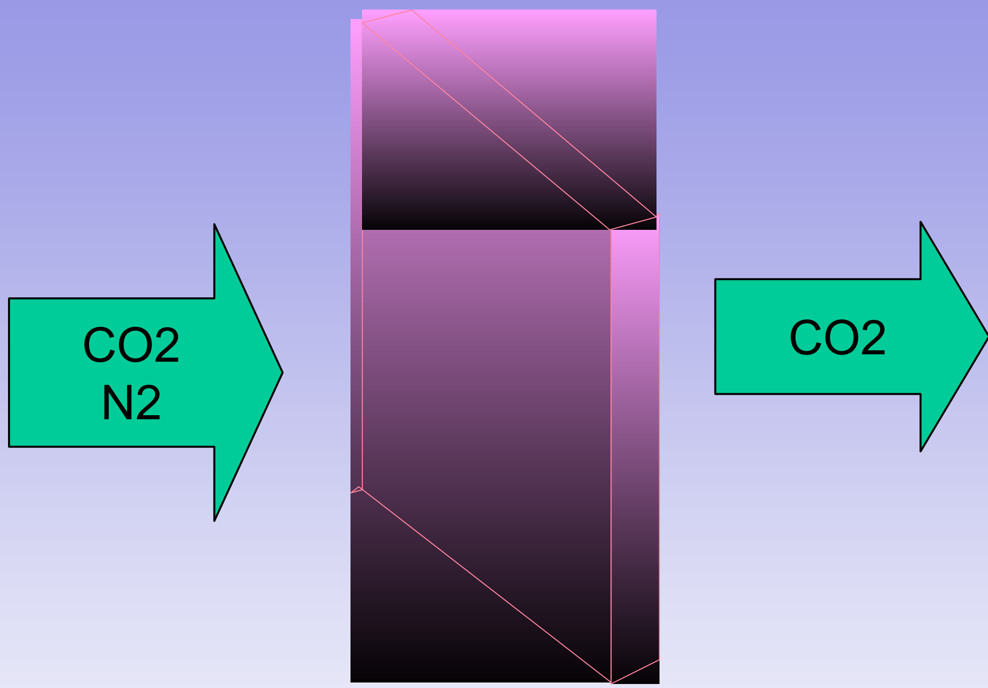
CO_2 sorption and desorption: reproducible capacities and rates





0-592.3 mmHg @22 °C
Mol % - repeat unit basis

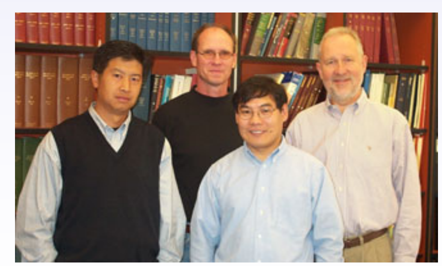
Single-film membrane



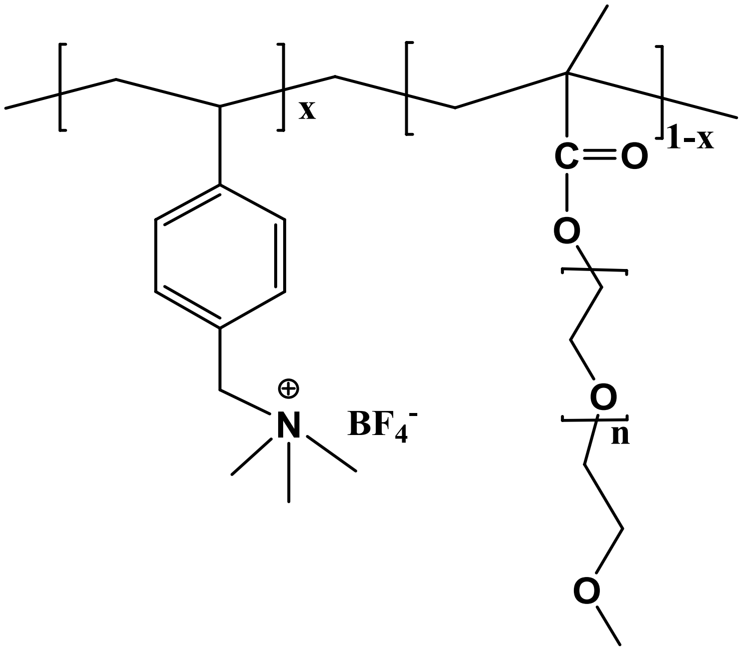
Hollow-fiber membrane

Single-film permeation cells:

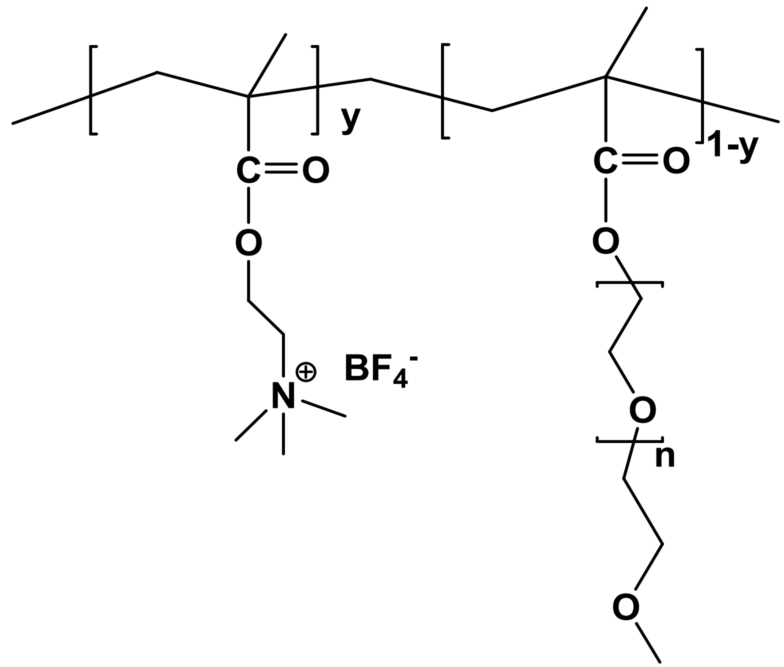
1. **Rate of transport (flux, permeability)**
2. **Degree of separation (selectivity)**



Polyionic -grafted PEG for strong membranes



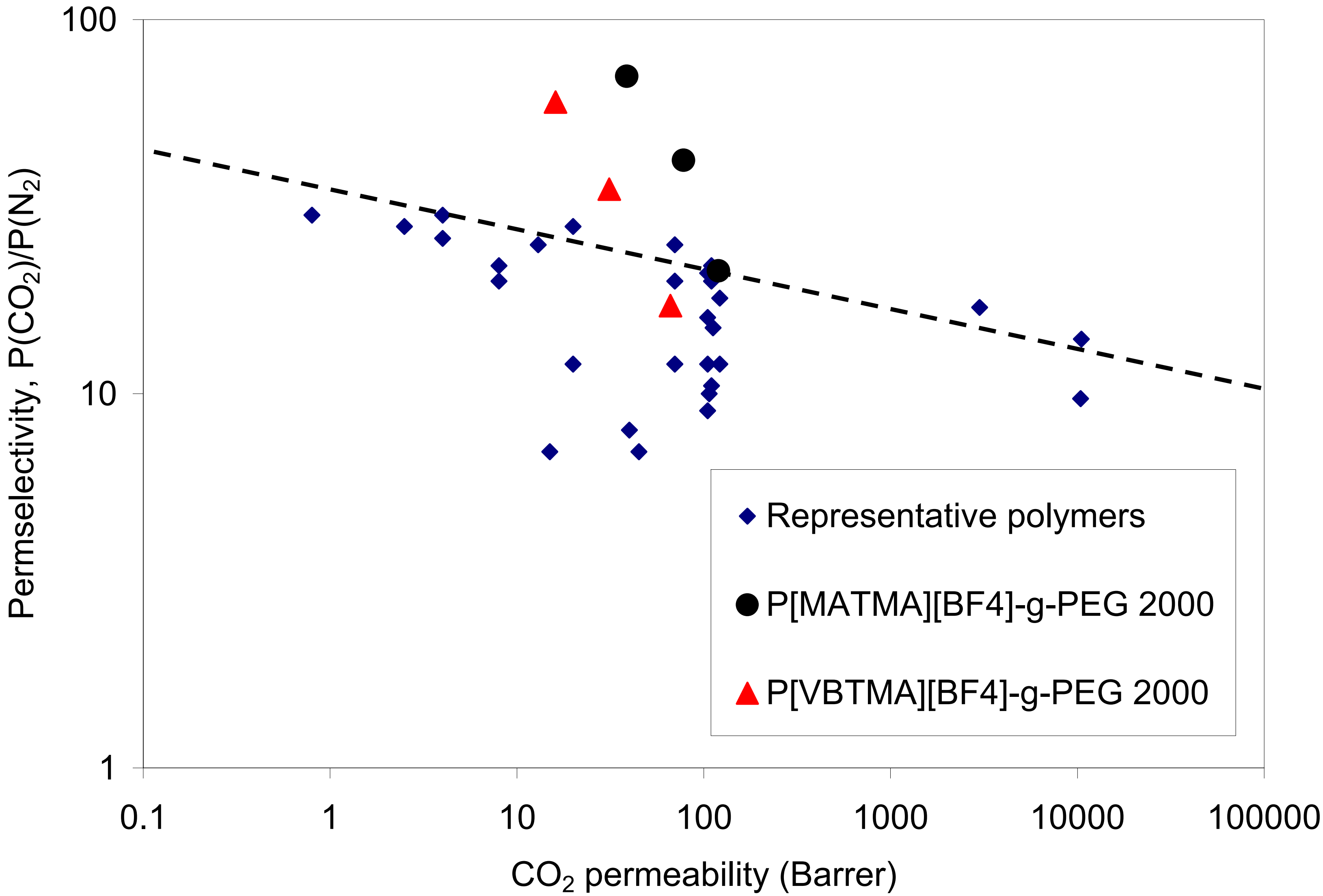
P[VBTMA][BF4]-g-PEG



P[MATMA][BF4]-g-PEG

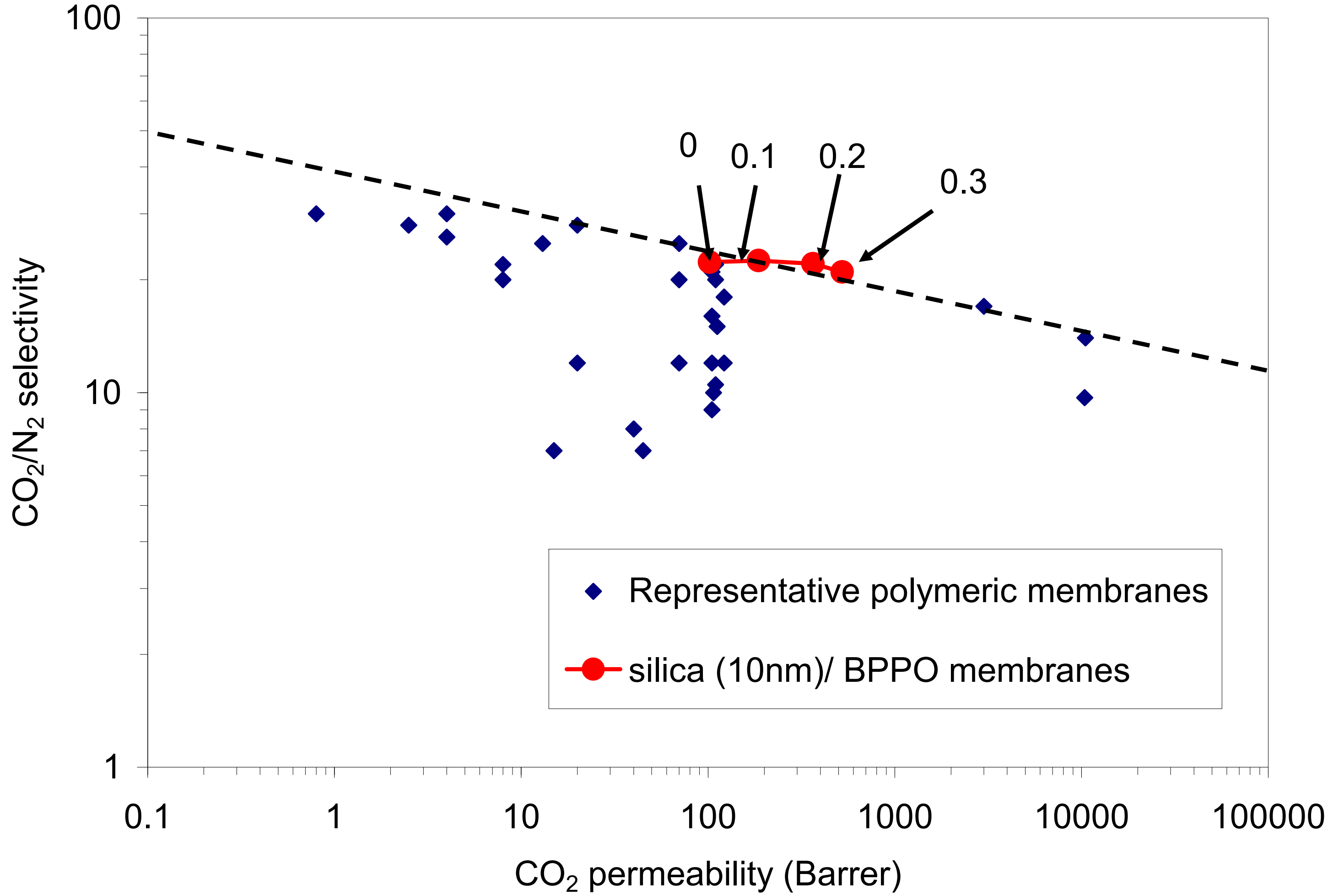
PEG molecular weight, copolymer composition

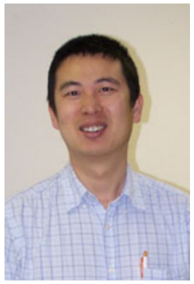
CO_2/N_2 separation



Near the Robeson line: Poly(trimethylsilylpropyne) and Poly(tert-butylacetylene),

CO_2/N_2 Separation with BPPO Nanocomposite





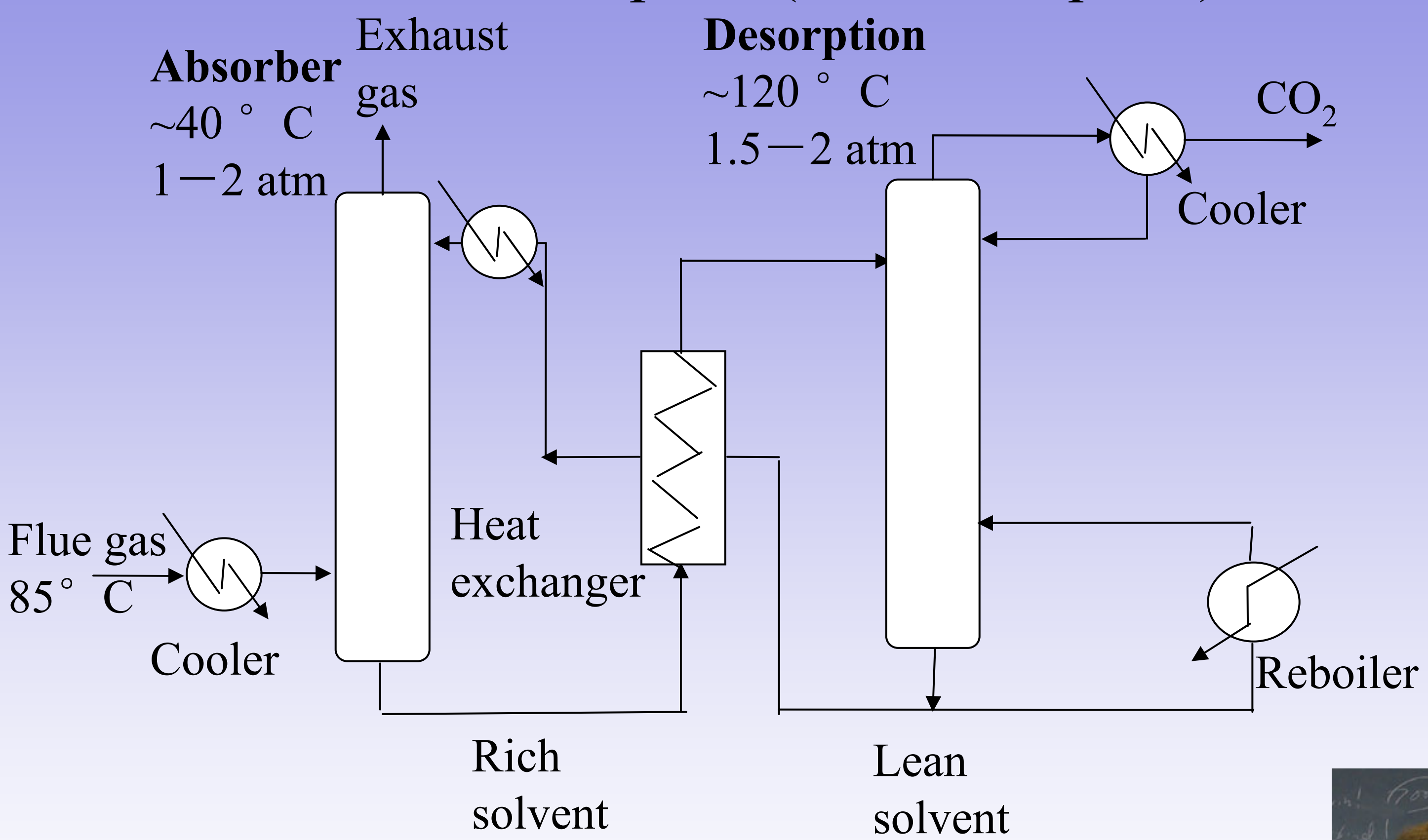
Large stationary point source - Wyodak flue gas

Capacity:	335 MW
Flue gas flow rate:	610 m^3/s (STP)
Flue gas temperature through stack:	85°C
Gas composition in weight percent:	
N_2	67%
CO_2	11.8%
O_2	12%
H_2O	8%
CO	300 ppm
SO_2	180 ppm
NOx	150 ppm

Task: 90% recovery and 95% CO_2 purity

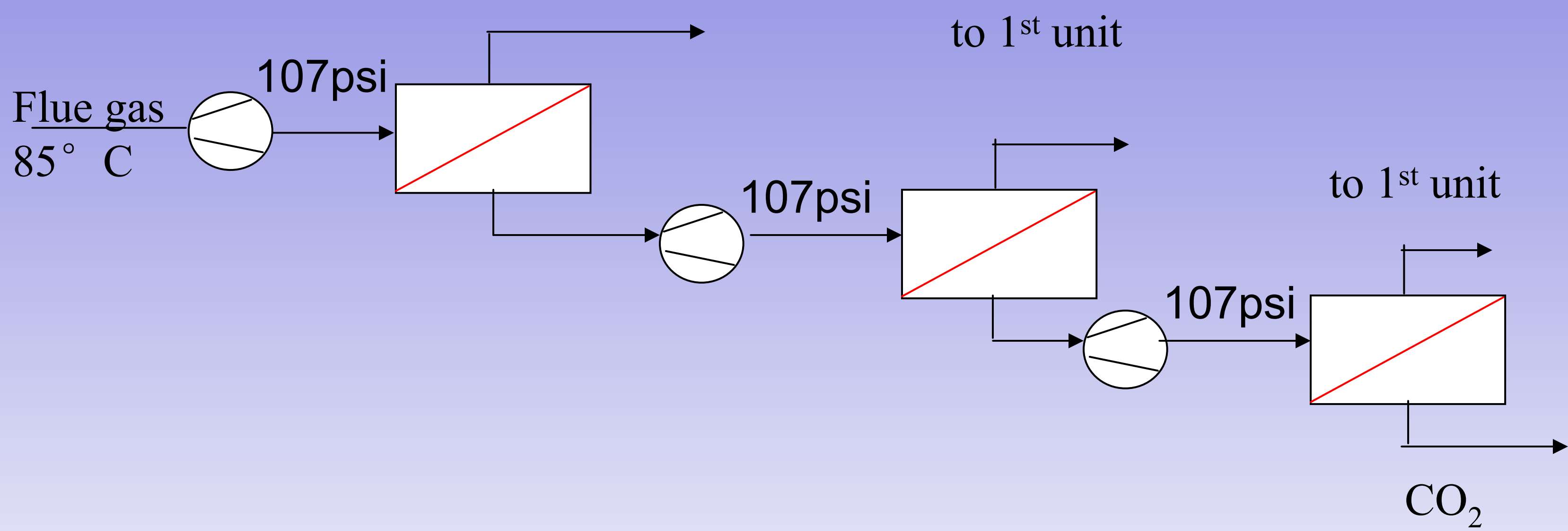
UW Design Report 2006

Amine absorption (Reference point)



Capture cost is $47/ton low-P CO_2

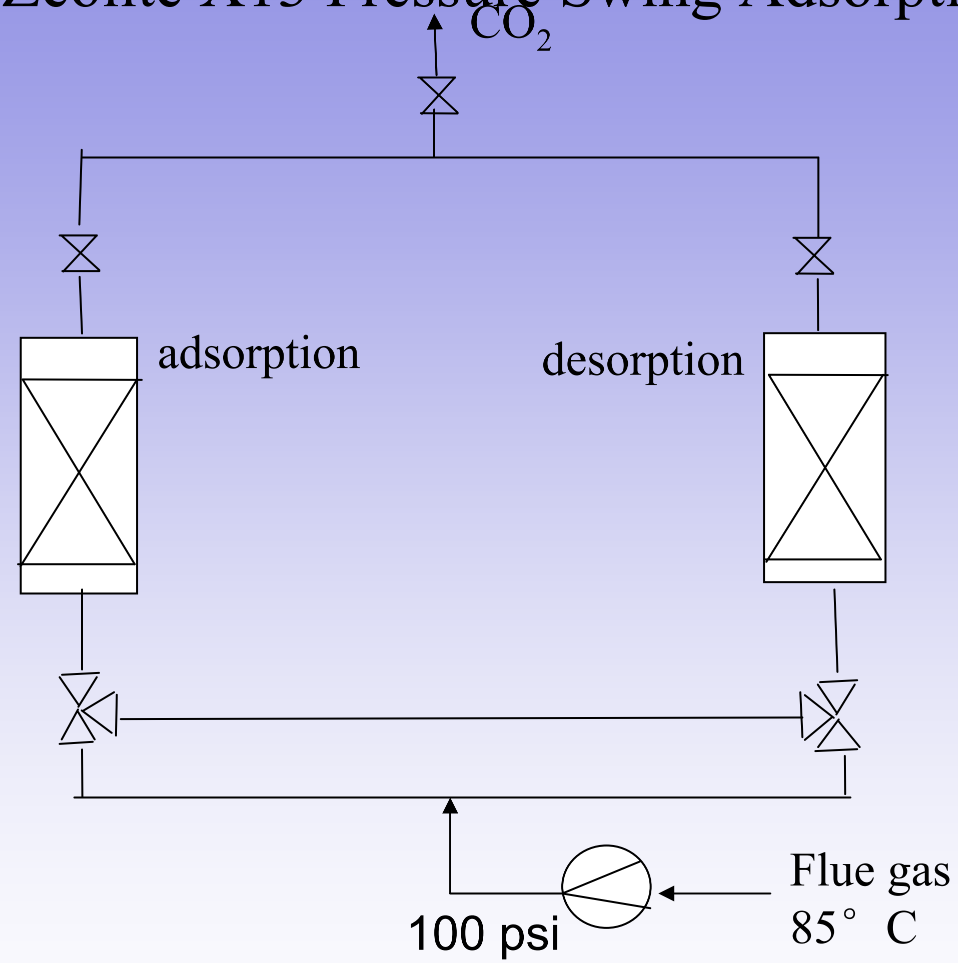
BPPO Nanocomposite Membrane



Cost is about $2,000/ton low-P CO2

Major costs: flue gas compression and membrane material

Zeolite X13 Pressure Swing Adsorption



Cost is about \$64/ton low-P CO_2

Major costs are zeolite and flue gas compression

Sorbents and Membranes for CO_2 Capture from Flue Gas

- Ionic liquids – slow transport
- Polymeric membranes – compression, material costs high
- Zeolite adsorption – compression, material, moisture

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Need an efficient Flue Gas "Filter"

- No expensive compression
- Moisture insensitive
- Picks up NO_x and SO_x as well as CO_2
- Easy to regenerate by heating, hence
- Easy to integrate with power plant
- Inexpensive material
- Makes CO_2 production profitable
- Lower electricity rate?

→ **Carbon-on-Carbon sorption**