



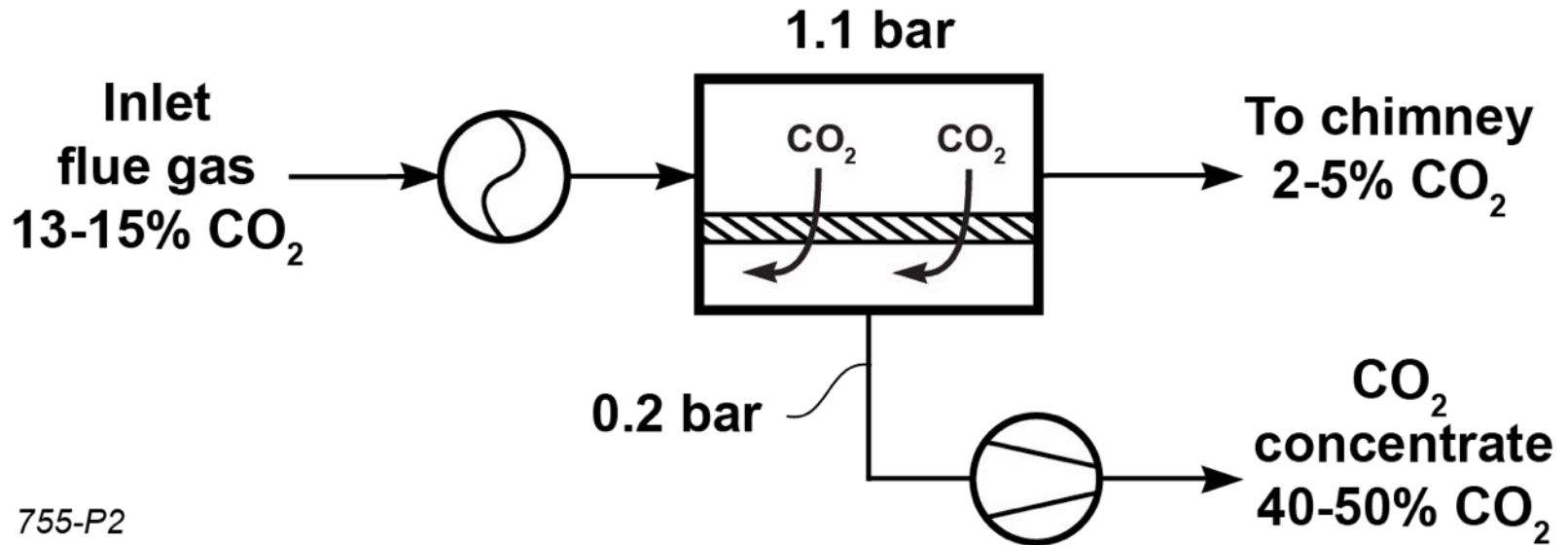
Membrane Post-Combustion CO₂ Capture at a Coal Power Plant

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May 13, 2015

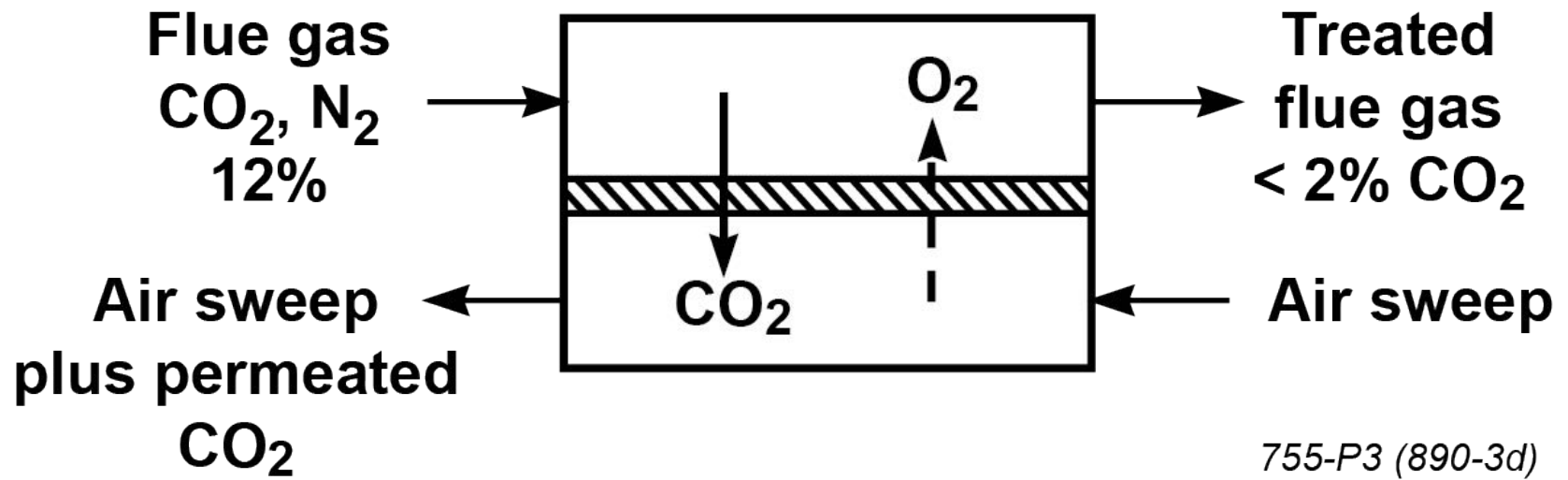


Membrane Separation Basics



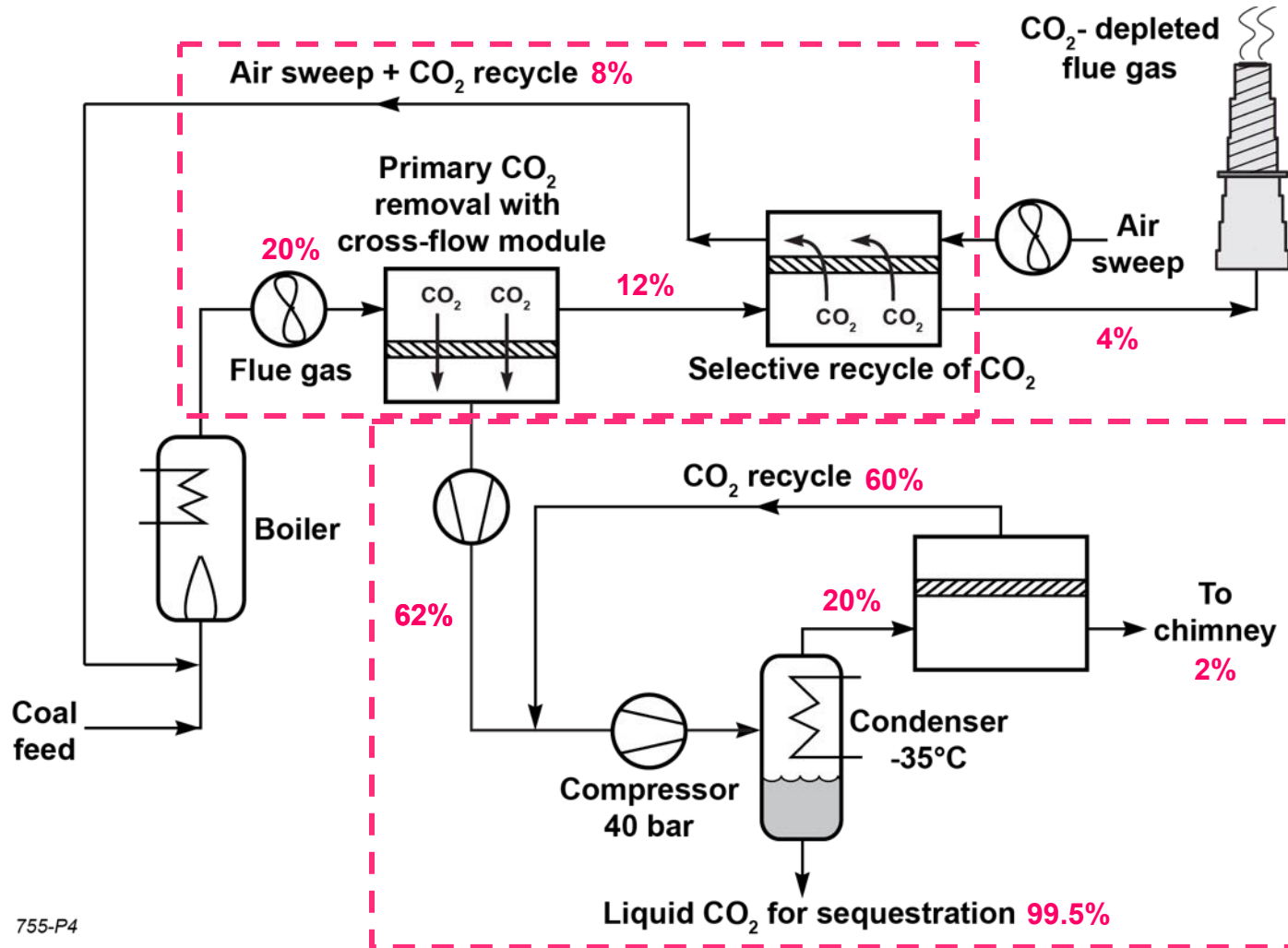
- Permeate vacuum – not feed compression.
- Need very high permeance membrane (1,500 gpu).
- CO₂/N₂ mixed gas selectivity (25).

The MTR Membrane Contactor



A separation is performed at no energy cost.

The MTR CO₂ Capture Design



755-P4

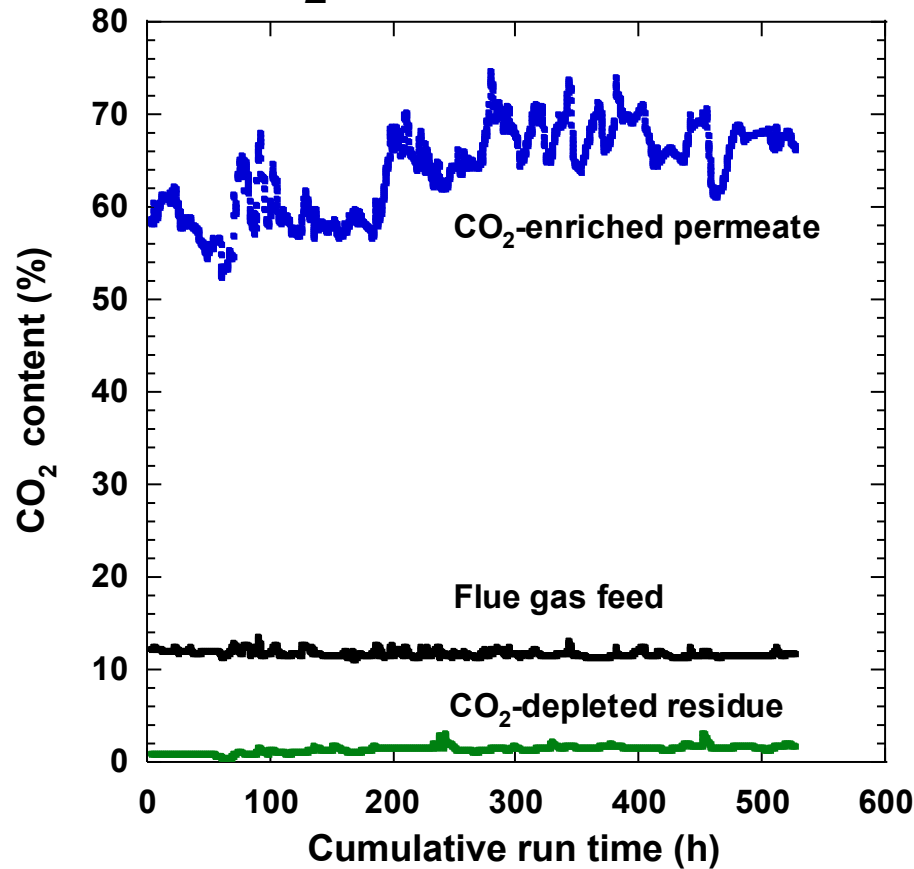
~75% CO₂ capture at 150 bar.

MTR 20 ton CO₂/day (1 MW_e) Test System at NCCC

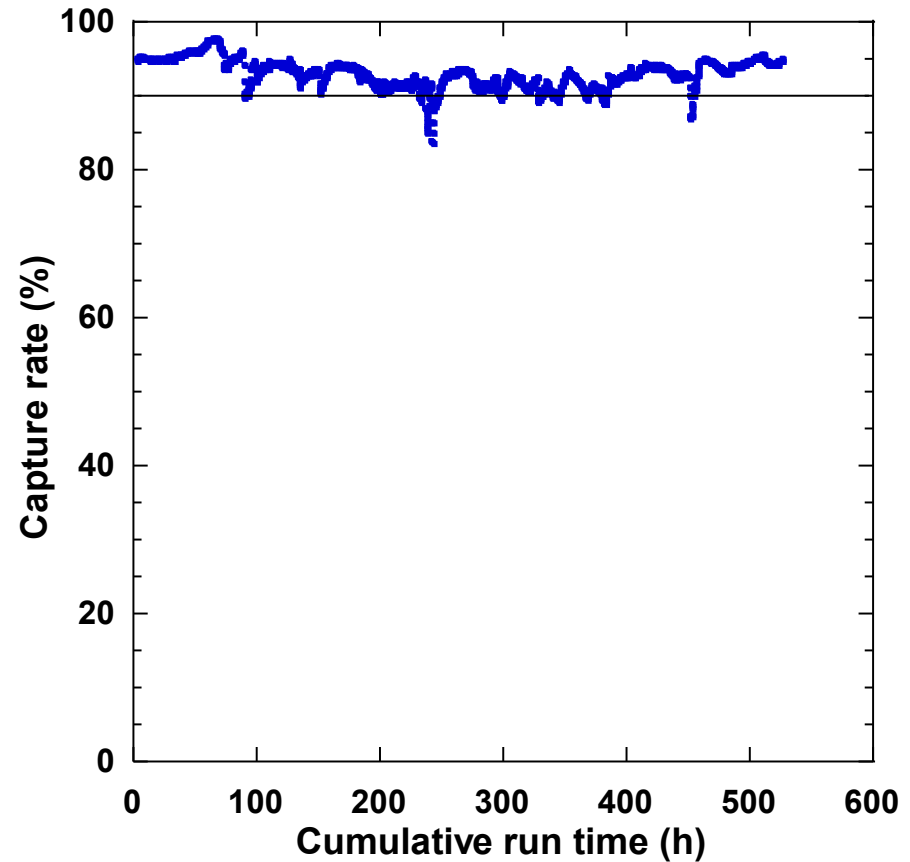


Sample Results From NCCC

CO₂ Concentration

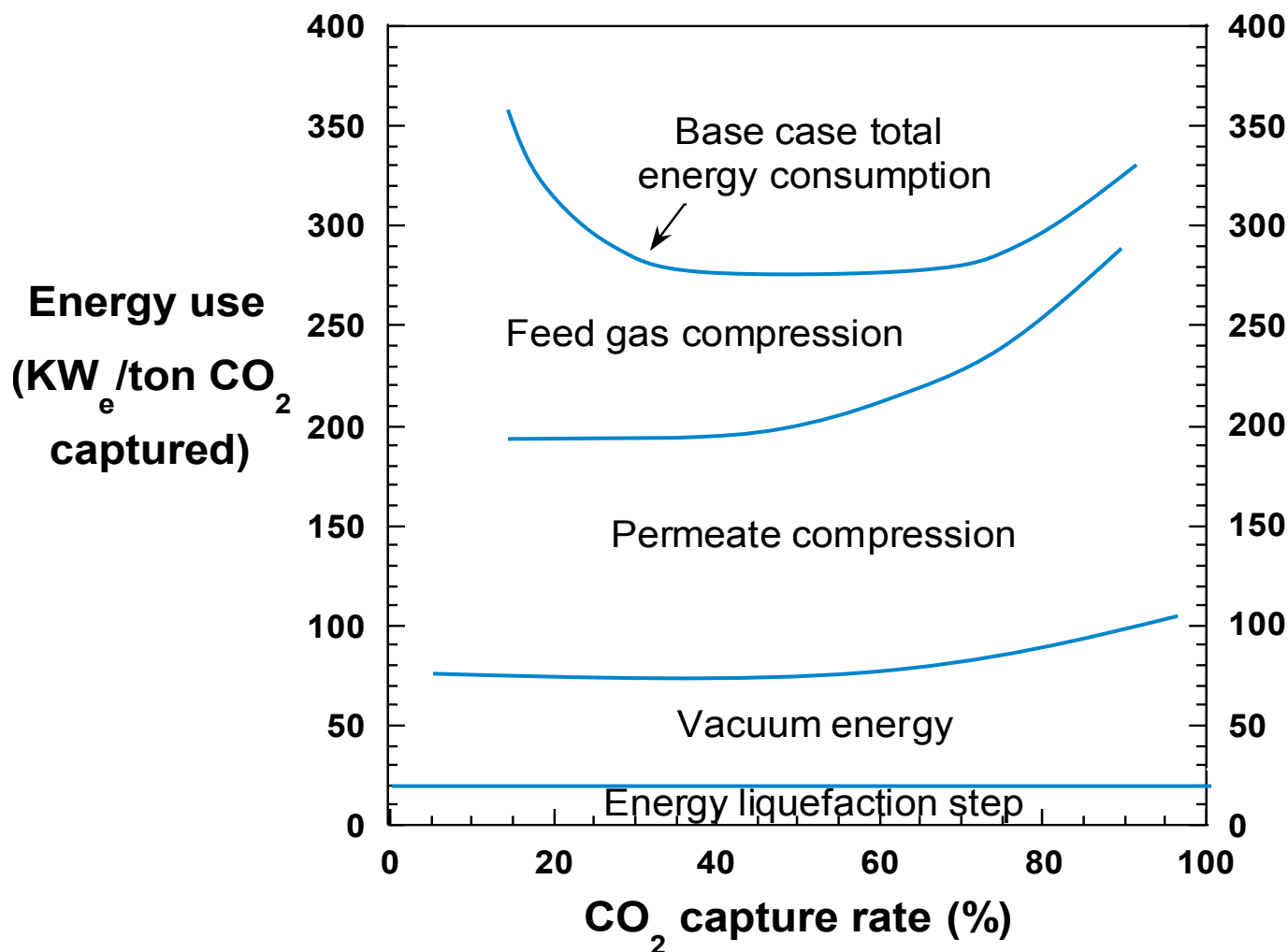


Capture Rate



Most concentration fluctuations are due to changes in ambient temperature.

Where is the Energy Used



Membrane Systems are Compact and Modular



- System installation completed.
- Operation during January-June 2015.

- Membranes are modular.
- Minimal on-site construction.



Photo courtesy of Tony Wu

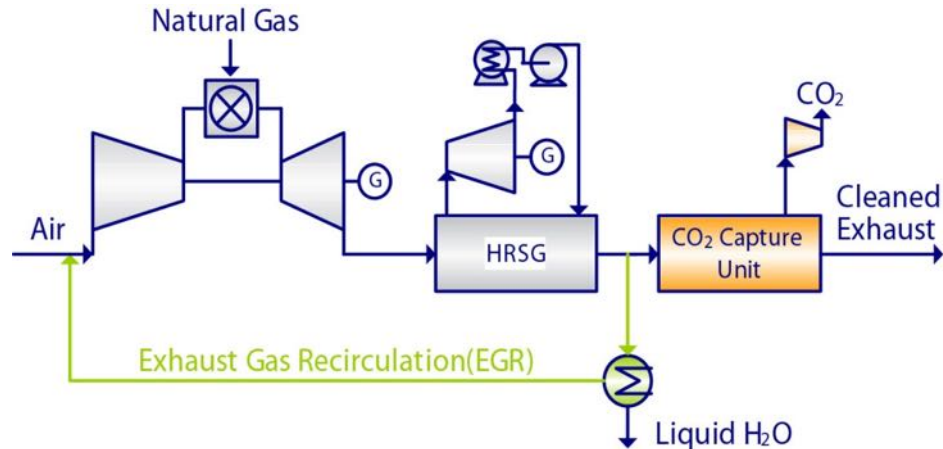
Where Does the Money Go

Estimate cost: ~\$45-\$50/ton CO₂ (99.5% 150 bar)
at 40 to 80% CO₂ capture rate

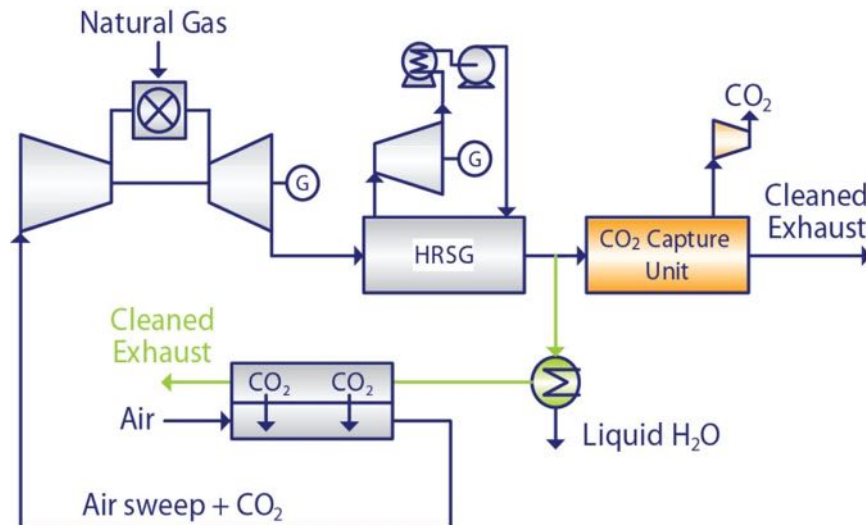
- Membrane skid capex (~1/3)
 - Increase permeance 1,500 to 3,000 gpu
- Power (~1/3)
 - Increase membrane selectivity 25 to 50
- Compression/vacuum equipment capex (~1/3)
 - Reduce vacuum pressure 0.2 bar – 0.1 bar

Membranes for NGCC CO₂ Capture: Selective Exhaust Gas Recycle

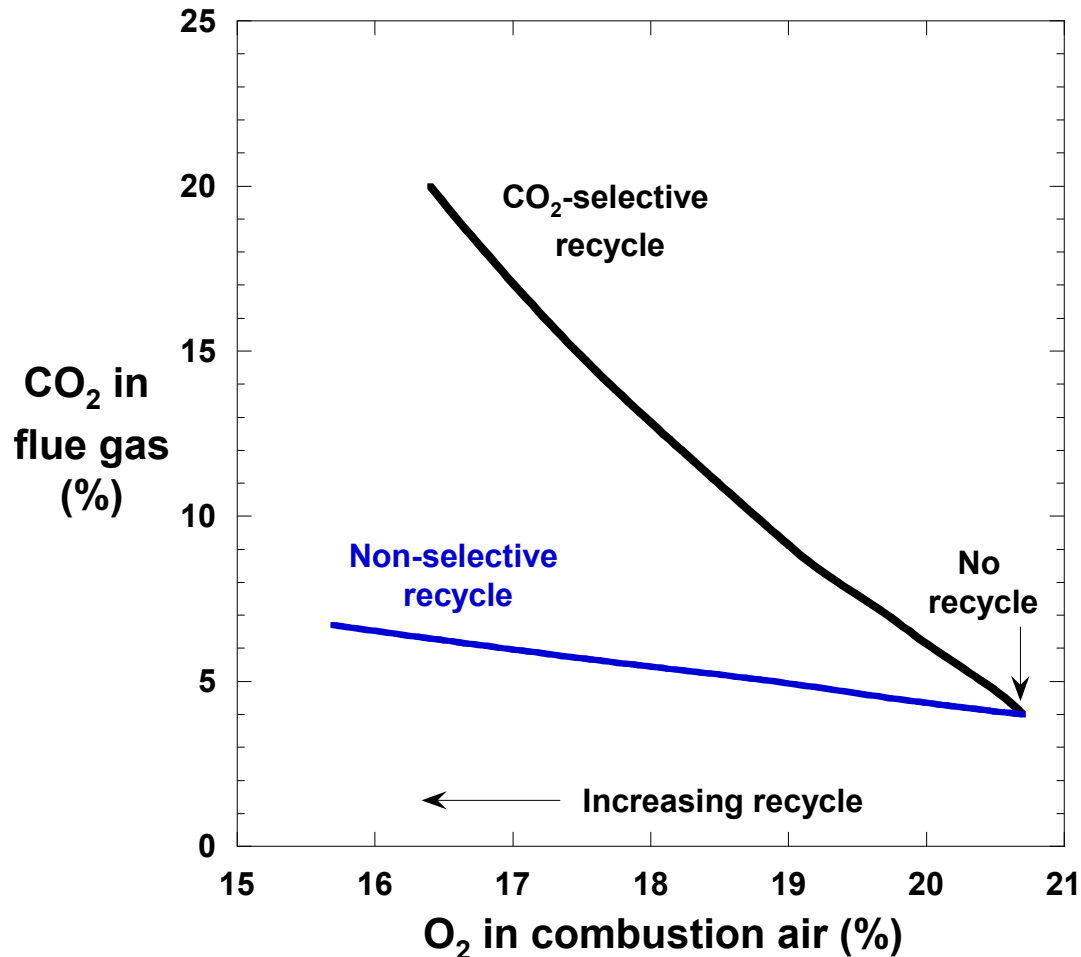
Exhaust gas recycle (EGR)



Selective exhaust gas recycle with a membrane



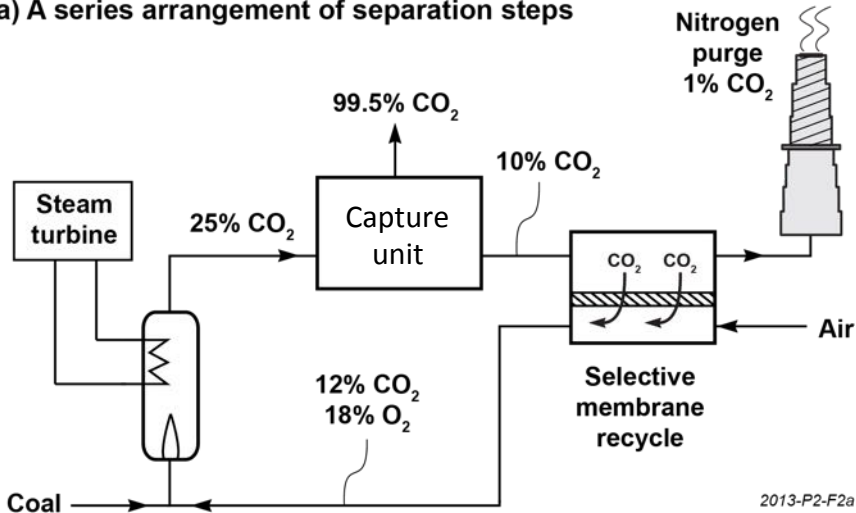
Benefit of Selective Exhaust Gas Recycle



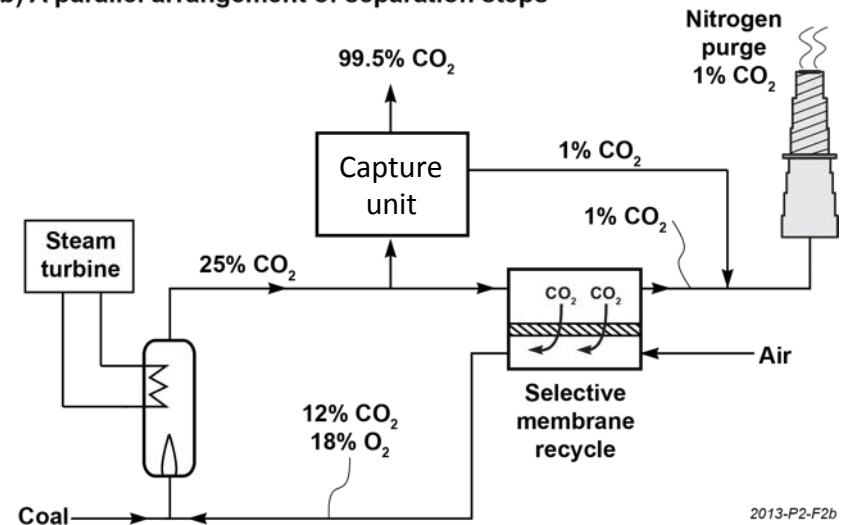
Effect of Exhaust Recycle		
	O ₂ %	CO ₂ %
Non-Selective Recycle	17%	6%
CO ₂ -Selective Recycle	17%	18%

Hybrid Capture Systems

a) A series arrangement of separation steps



b) A parallel arrangement of separation steps



A membrane contactor can change the separation needed.