

# **The Use of Hybrid Membrane/Distillation System for the Ethane/Ethylene Separation in Olefin Plants**



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# Motivations

## □ Ethylene Importance

### World Total Capacity

- 1999                      91 million metric tons
- 2010                      140 million metric tons

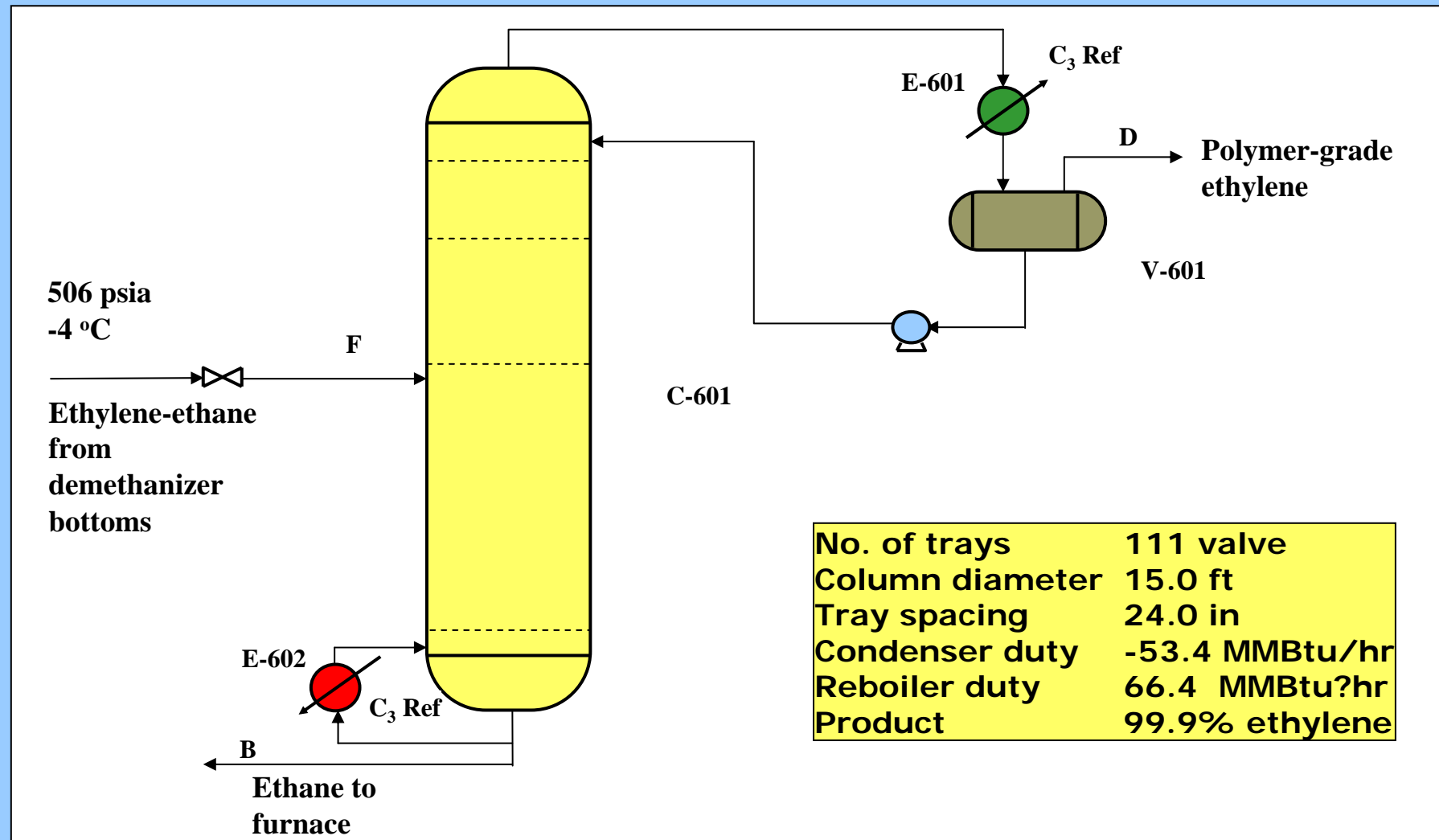
## □ Current Process Technology

Pratt & Foskett – 1946

## □ New Technologies



# Ethane/Ethylene Distillation System

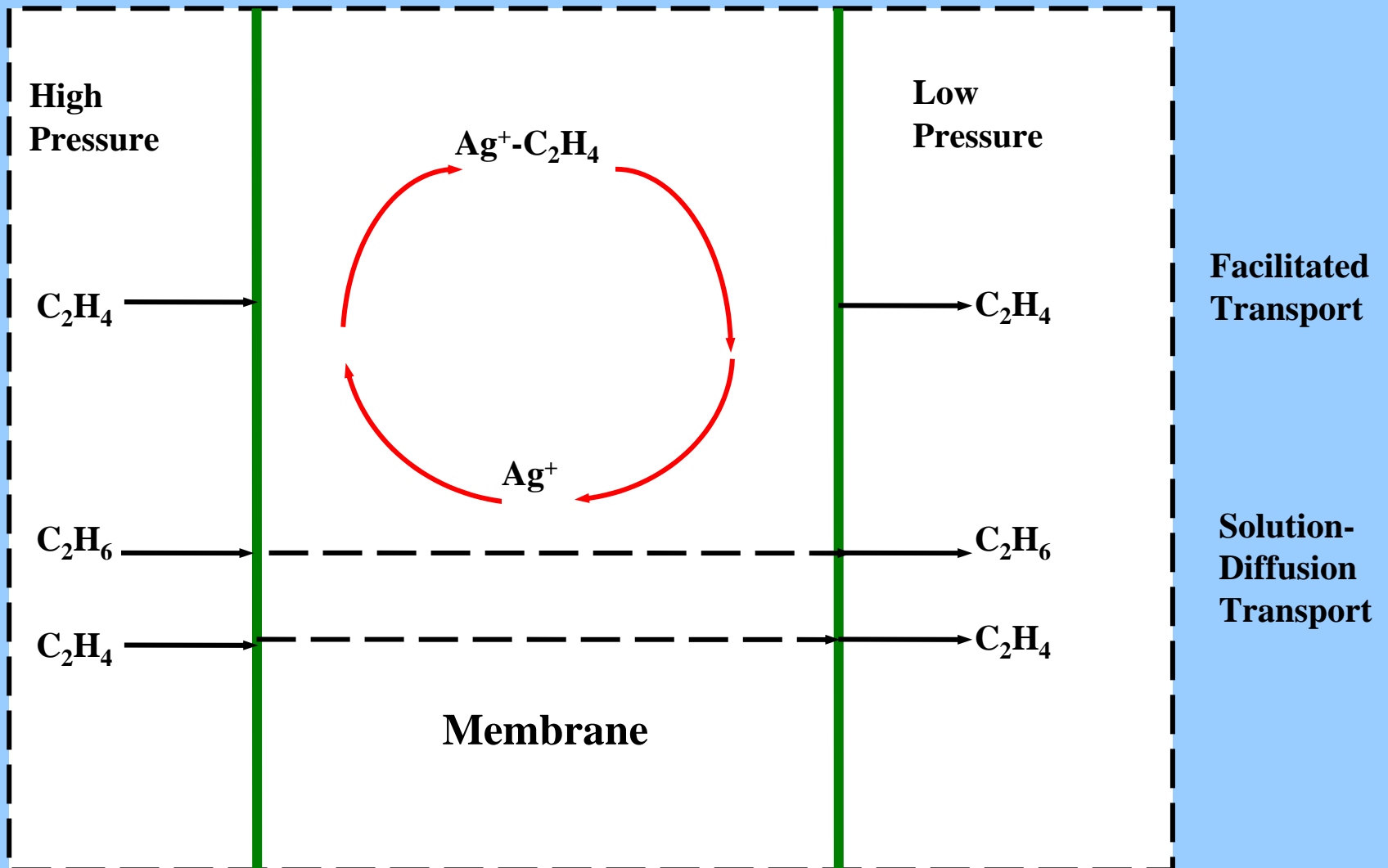


# Membrane Technology

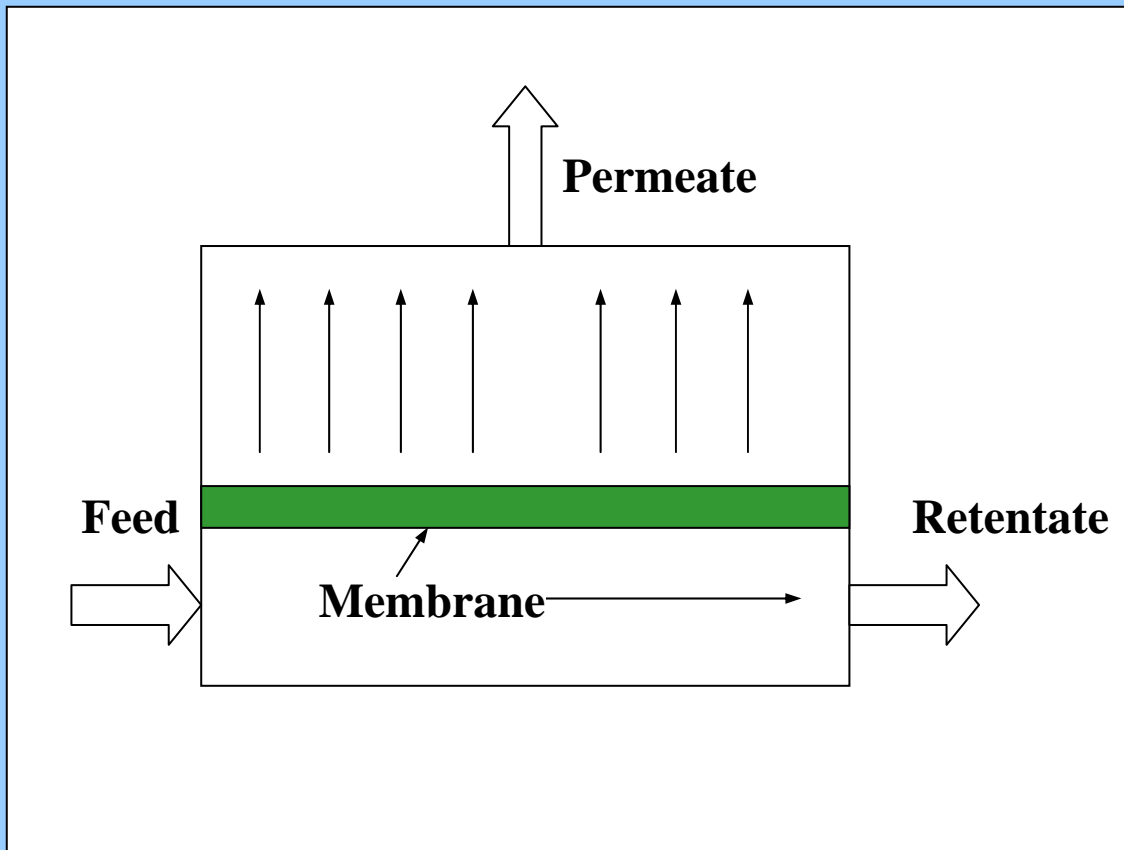
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- ❑ **Separation of low relative volatility mixture**
- ❑ **Simple diffusion membrane**
- ❑ **Facilitated transport membrane**

# Transport mechanism in a facilitated transport membrane



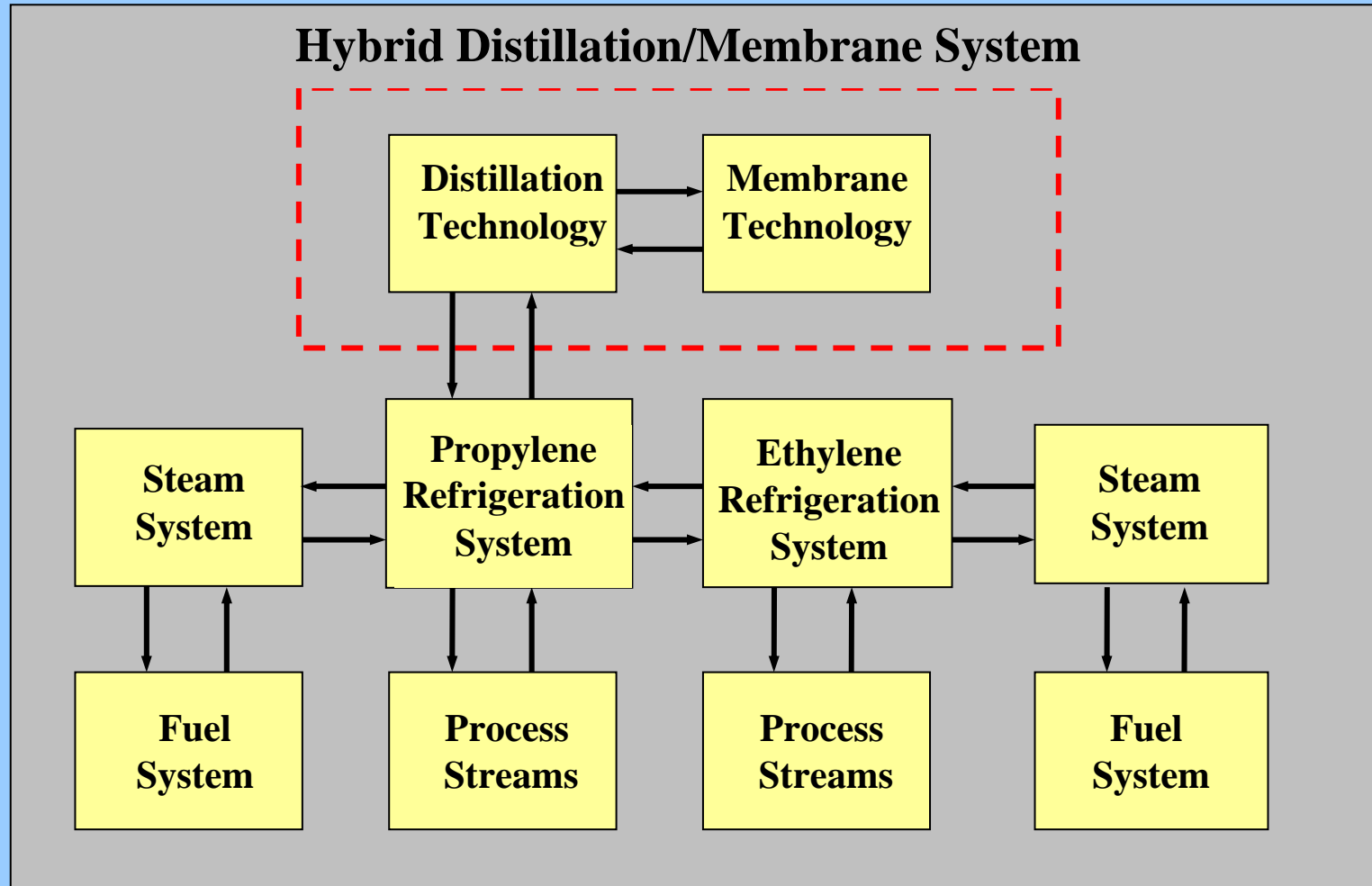
# Membrane Model



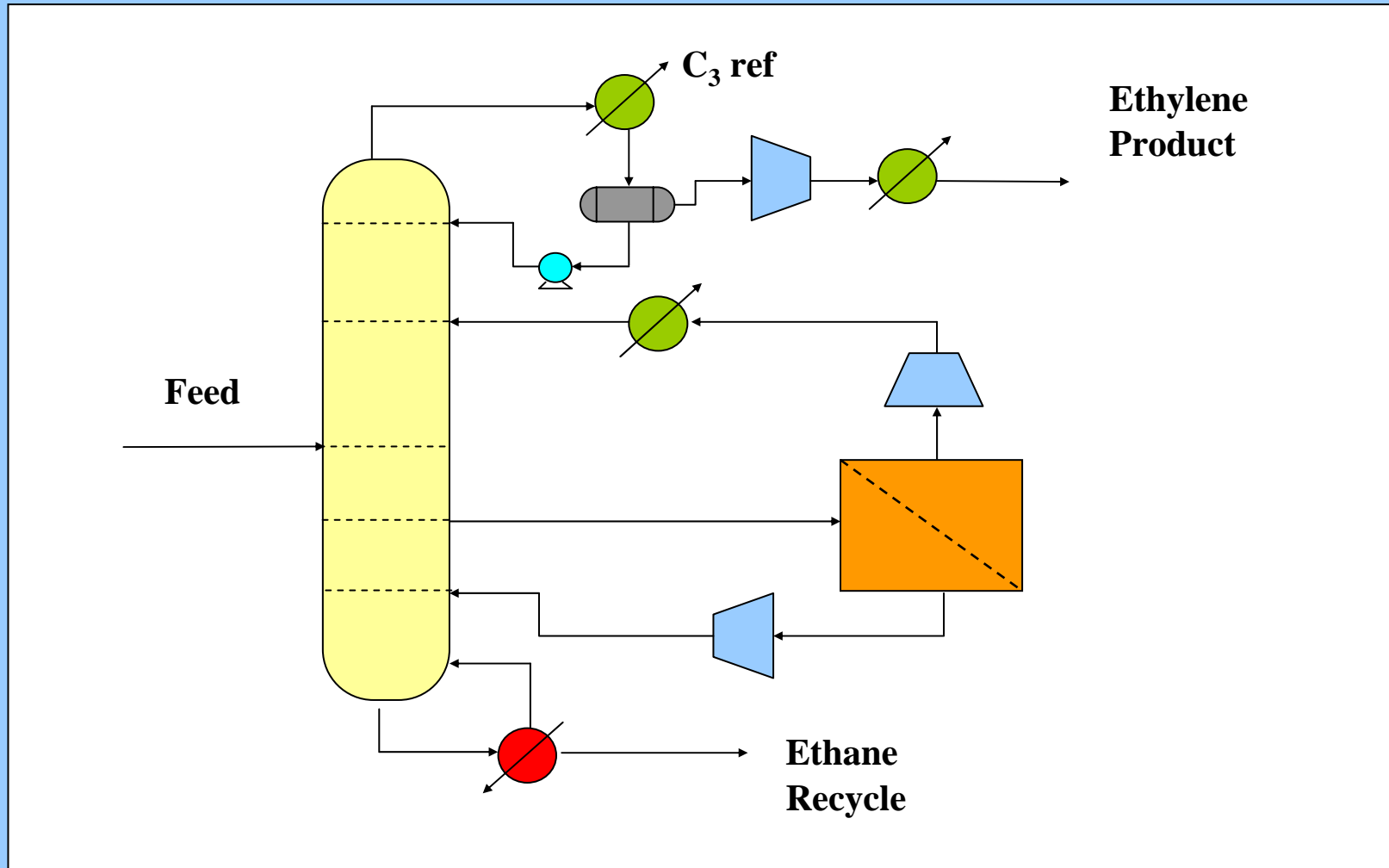
## Assumptions

- **Cross-flow along the permeate side of the membrane.**
- **Plug-flow along the feed side of the membrane.**
- **Negligible pressure drop along either side of the membrane.**
- **Isothermal operation.**

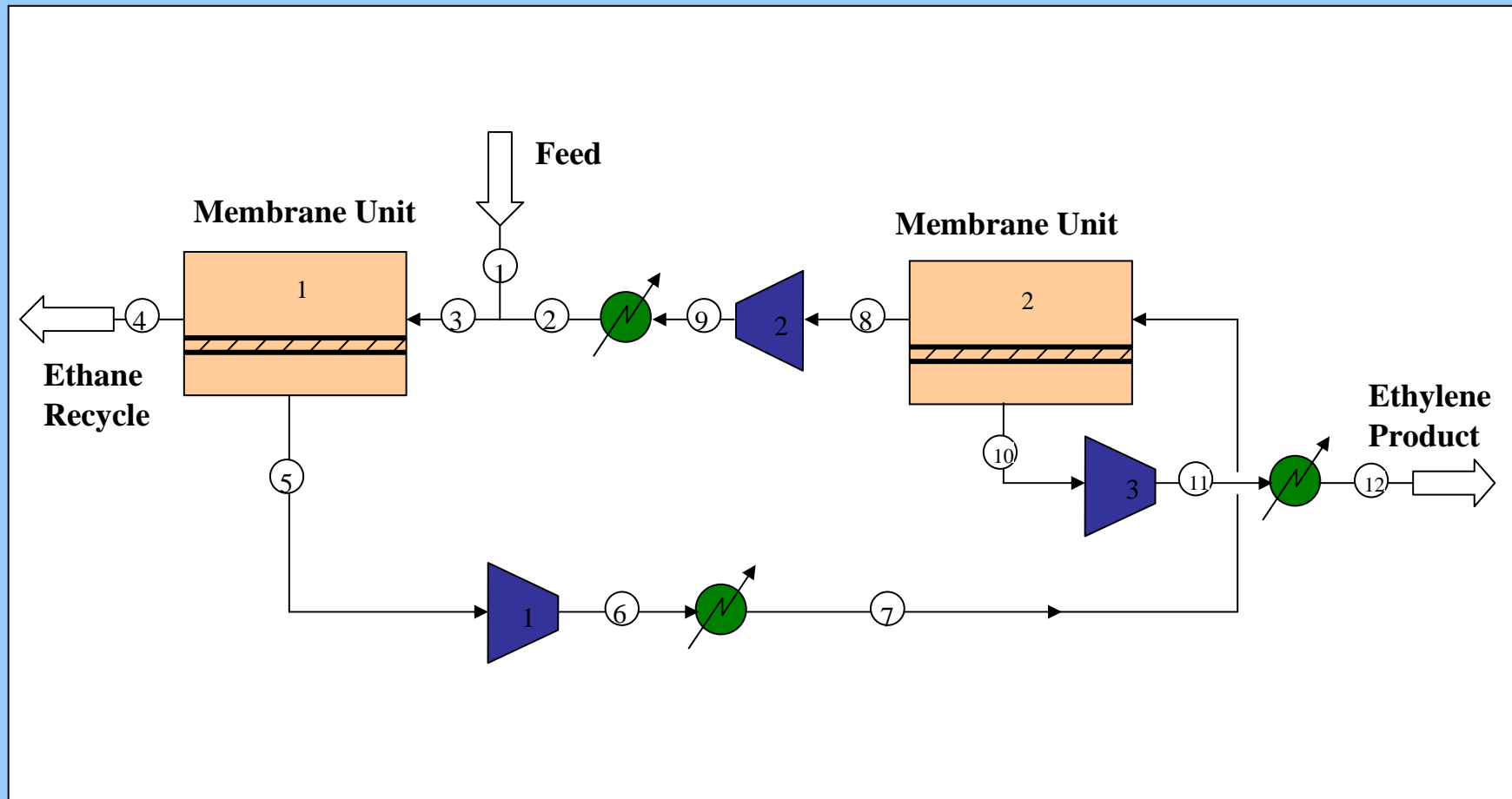
# Hybrid System Process Integration



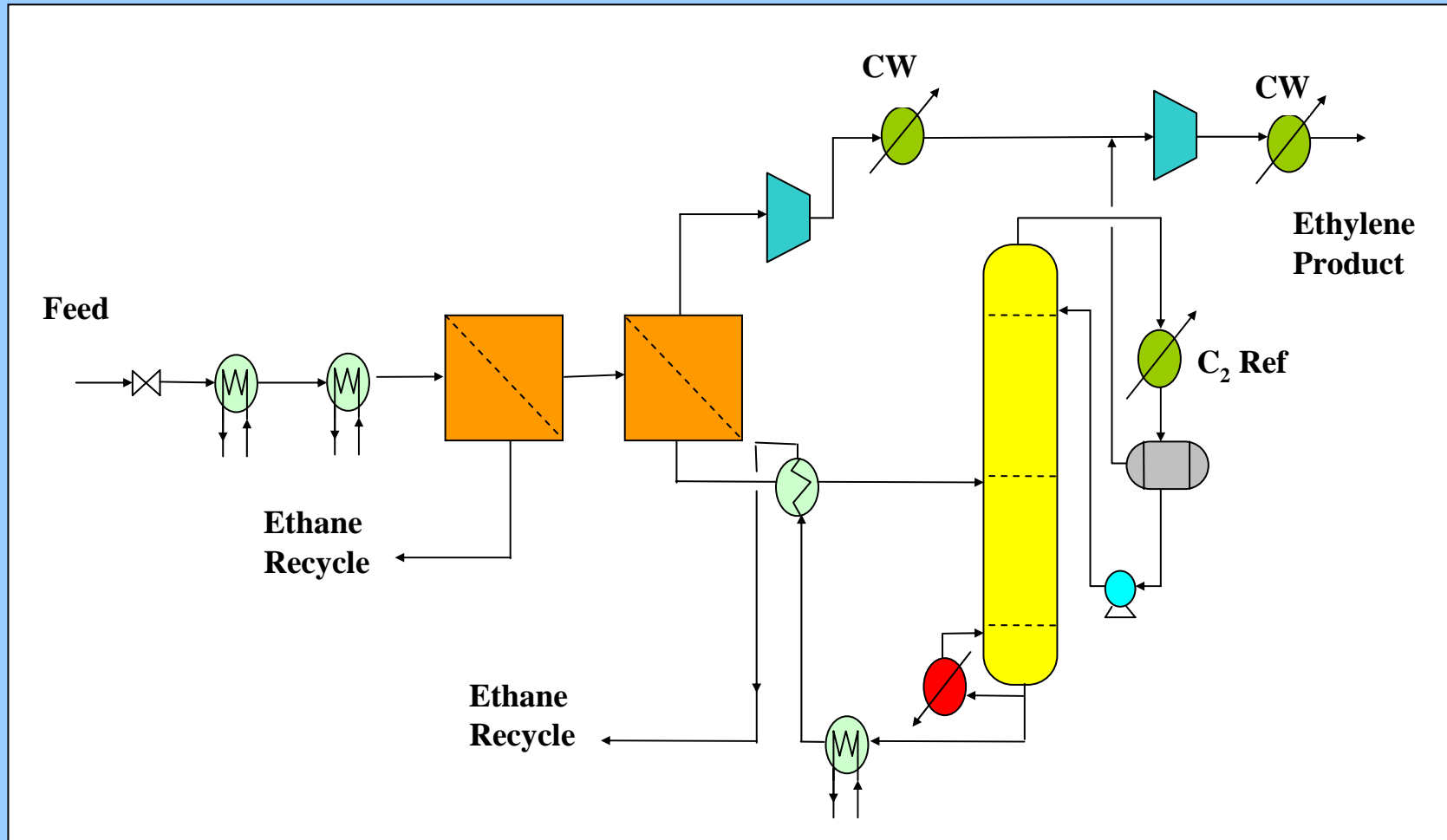
# Parallel Configuration For The Ethane/Ethylene Hybrid Separation System



# Membrane Cascade for Ethane/Ethylene Separation



# Series configuration of the ethane/ethylene hybrid separation system



# Comparisons between the Low-pressure Distillation Column and the Conventional C<sub>2</sub> Splitter

Item	Conventional C <sub>2</sub> splitter	Low-pressure C <sub>2</sub> splitter
Process	Base-case design	Series configuration hybrid system
Number of columns	1	1
Number of theoretical trays	94 valve trays [111 actual]	48 valve trays [57 actual]
Distillation tray efficiency	0.85	0.85
Distillation tray spacing	24.0 in	24.0 in
Column diameter	15.0 ft	5.0 ft
Column pressure	290 psia	95 psia
Column reflux ratio	2.75	3.9
Condenser duty (MM BTU/hr)	-53.4	-10.26
Reboiler duty (MM BTU/hr)	66.4	6.83
Product	99.9% polymer grade ethylene	99.9% polymer grade ethylene
Condenser coolant	Liquid propylene @ -46 °C	Liquid ethylene @ -73 °C