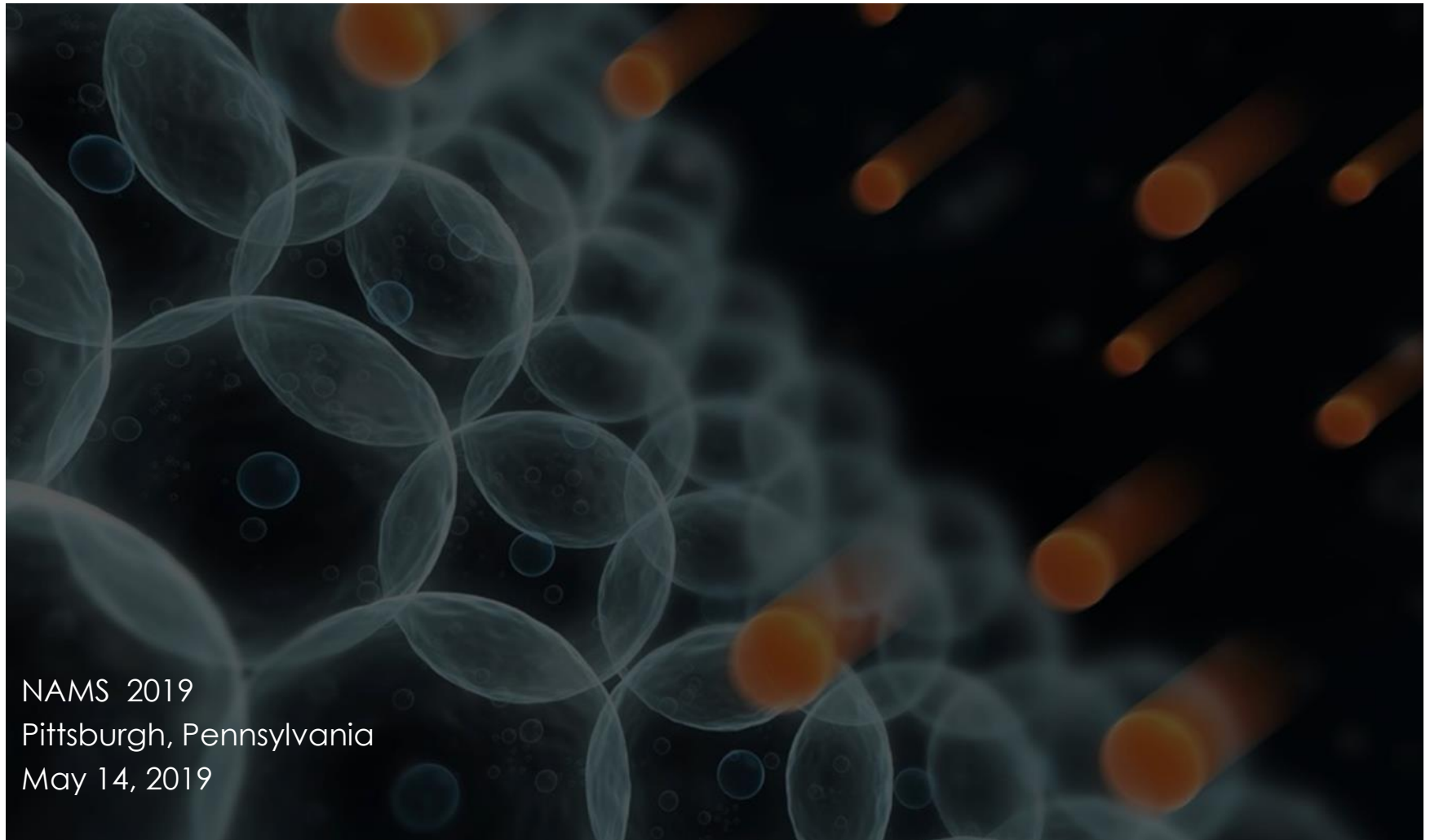


NAMS Presentation 20b



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NAMS 2019 Paper 20b

Hybrid Distillation and Facilitated Transport Membrane Processes for C₃ Splitter Debottlenecking

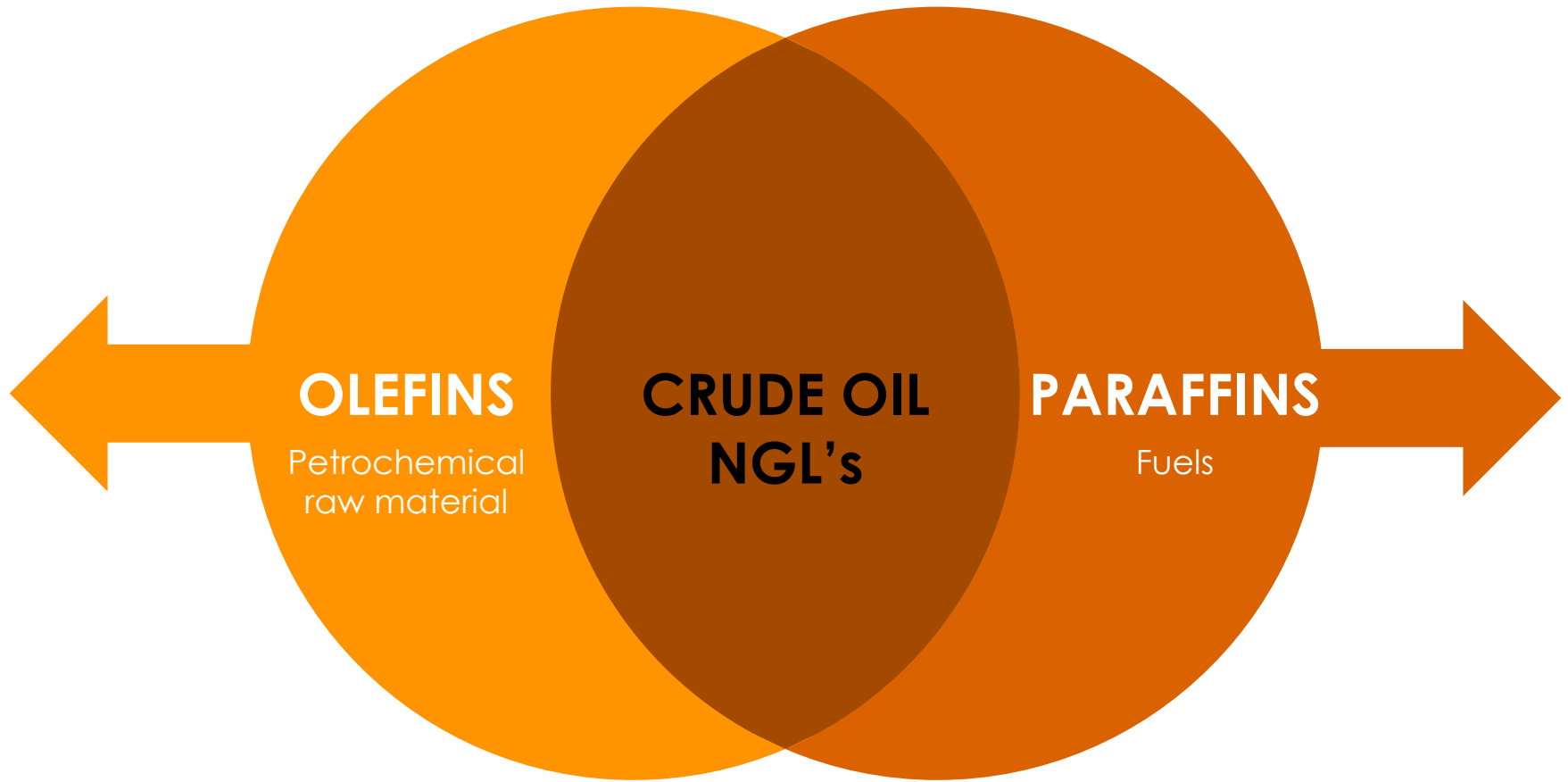
Kenneth Pennisi, Christine Parrish, Sudip Majumdar
Compact Membrane Systems

Today's Agenda

- Overview of Optiperme™ Technology
- Basis of the economic analysis and process background
- Simulation and Economic Analysis Results

Overview of Optiper™ Technology

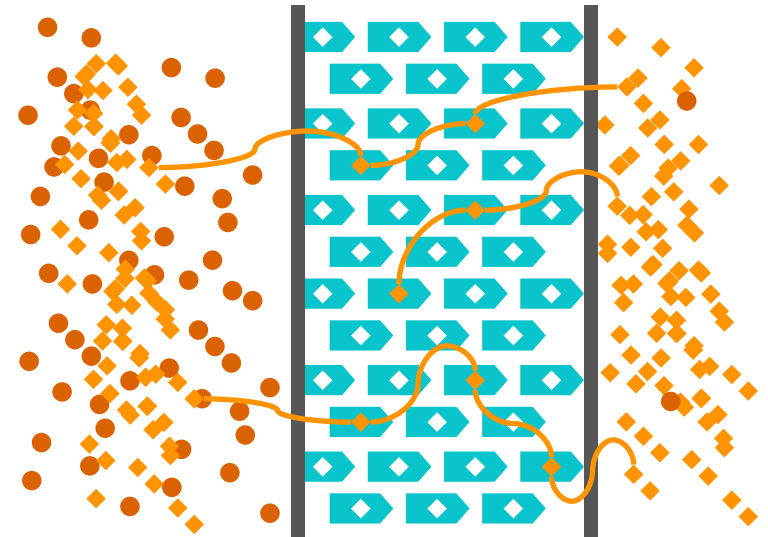
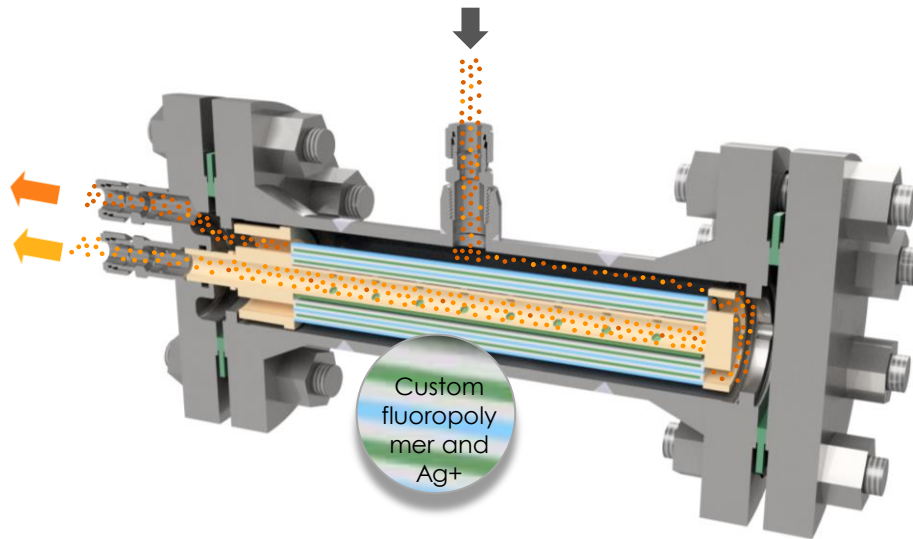
Latest technology focuses on olefin-paraffin separation



Distillation is incumbent technology and current workhorse



Optiper™ membrane is a disruptive technology for O-P separations



Adapted from Cussler E.L.: Facilitated Transport. In: Membrane Separation Systems, vol. 2, US DOE Report, DOE/ER/30133-H1 (1990)

Implications of facilitated transport membrane

- Humidity is required
- Permeance and selectivity are not constant
- Permeance decreases with increasing pressure
- CMS membranes are fluoropolymer based so they can withstand harsh chemical environment

Basis of Analysis and Process Background

Goals

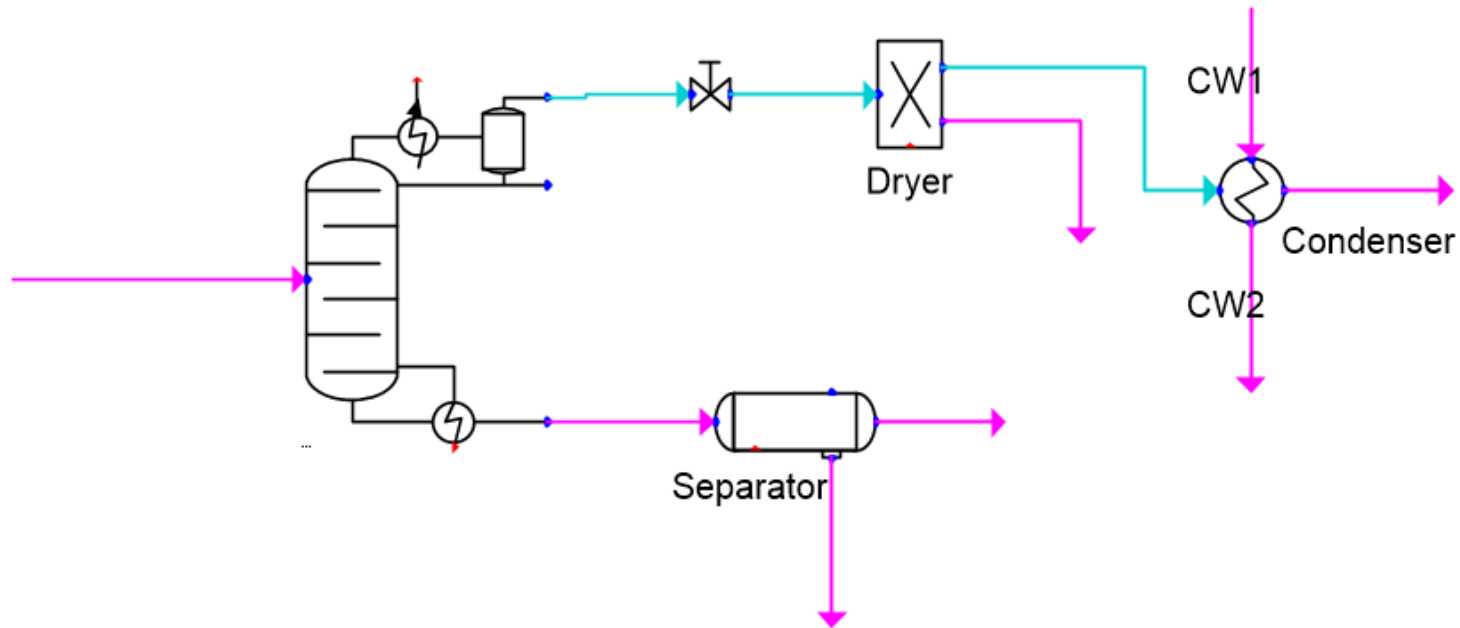
- Unload the column by introducing membranes
- The olefin rich product held fixed at polymer grade propylene
- The bottoms product held fixed at HD-5 propane
- Simulate membrane behavior to determine the optimum place for membrane installation
- Understand how much increased capacity could be gained by using a hybrid system

Basis of Analysis

- Debottleneck base case distillation processing 388,000 tons per year of feed
- Feed stream contains 70% propylene and is saturated with water
- The process was modeled using Symmetry integrated with CMS proprietary membrane models
- Internal rates of return calculated from incremental costs and incremental production rates

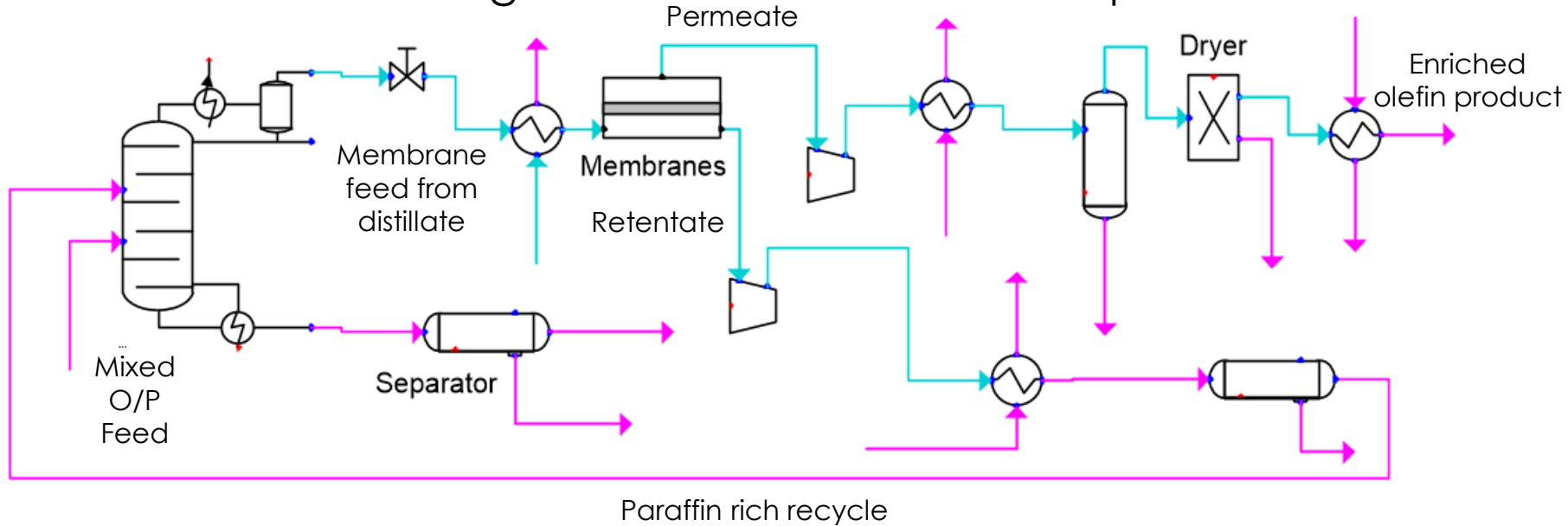
Typical high pressure distillation

- 150 trays
- Reported corresponding reflux ratio is 20
- Symmetry distillation model agrees within 10%
- Top product at 240 psia, 103° F
- Bottom product 250 psia, 122° F



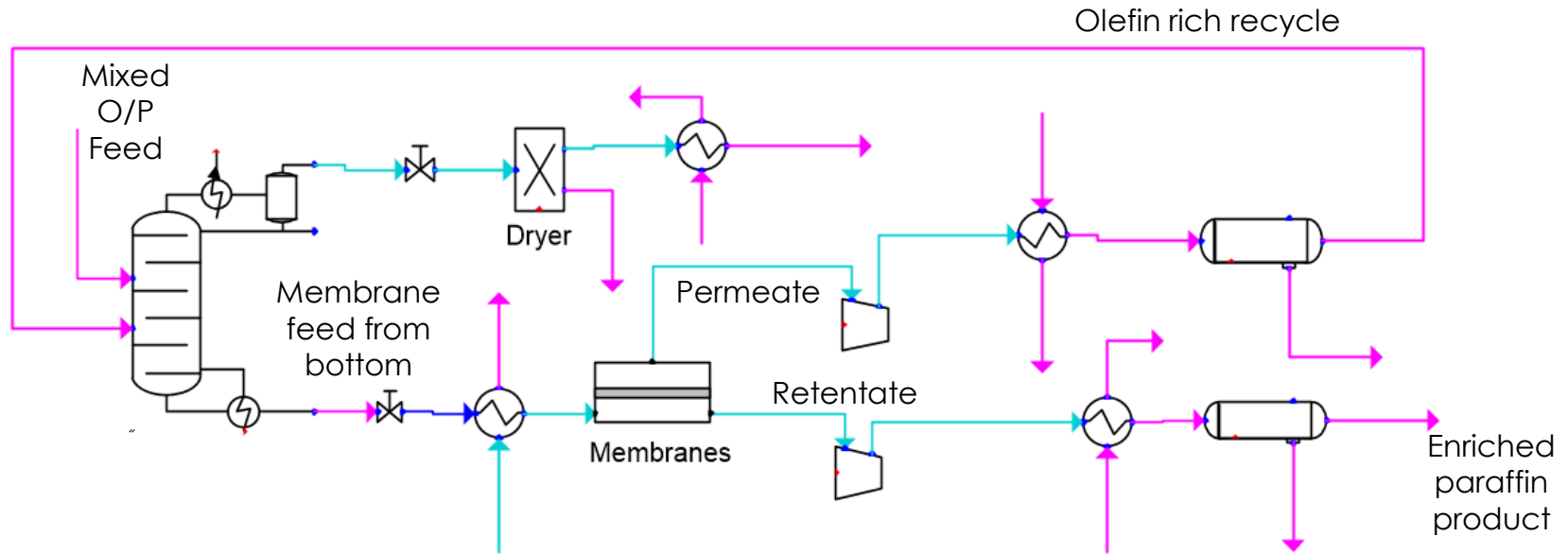
Distillation/Membrane Hybrid Processes Evaluated

Configuration 1: Membrane at top



- Permeate is the product (Polymer-grade propylene)
- Unload the column by decreasing the olefin concentration at the top and using the membrane to take the product to polymer grade propylene
- Still making HD-5 propane at the bottom

Configuration 2: Membrane at bottom



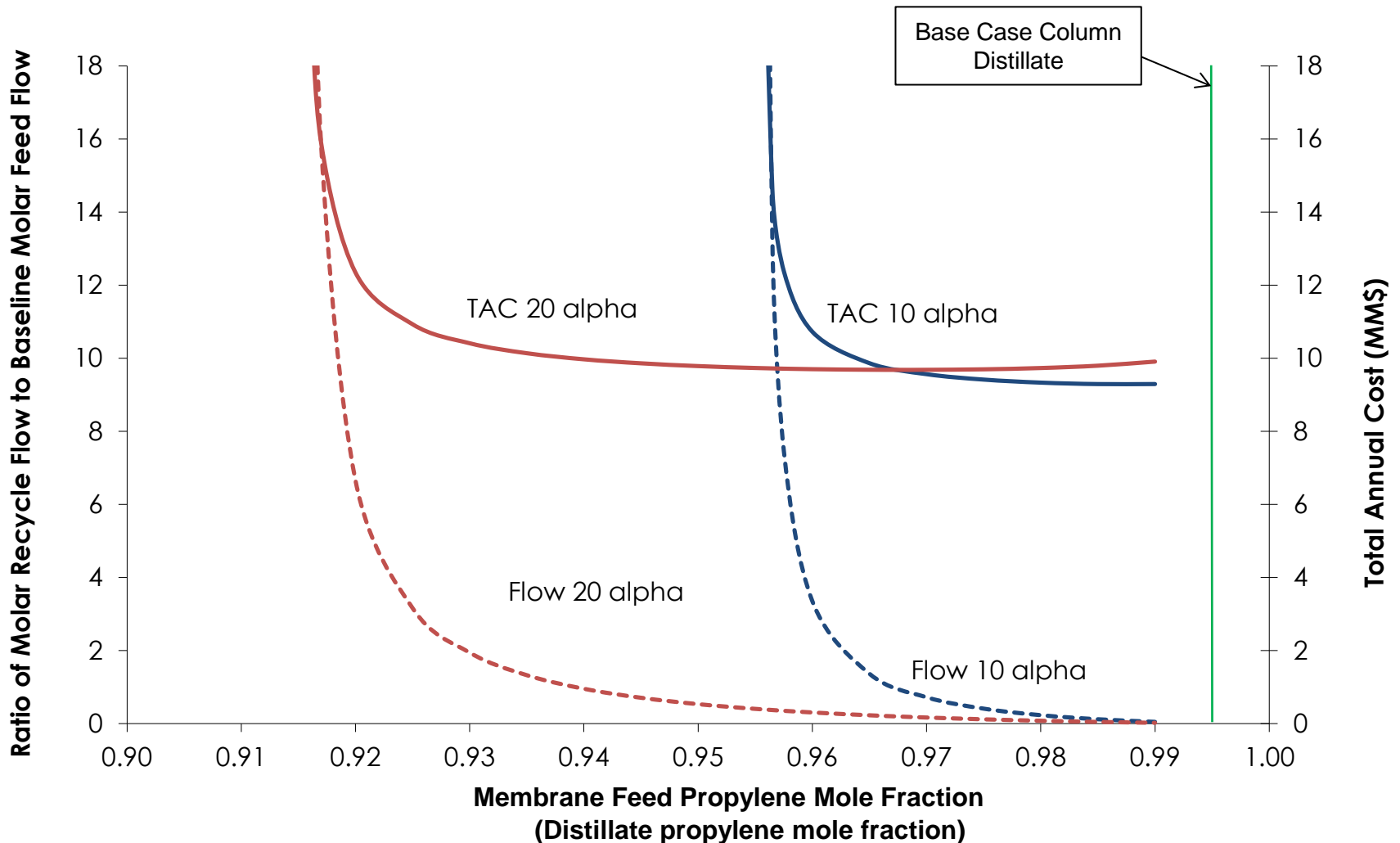
- Retentate is the product (HD5 propane)
- Unload the column by decreasing the paraffin concentration at the bottom and using the membrane to take the product to HD-5 propane
- Still making polymer grade propylene at the distillate (top)

Simulation and Economic Analysis Results

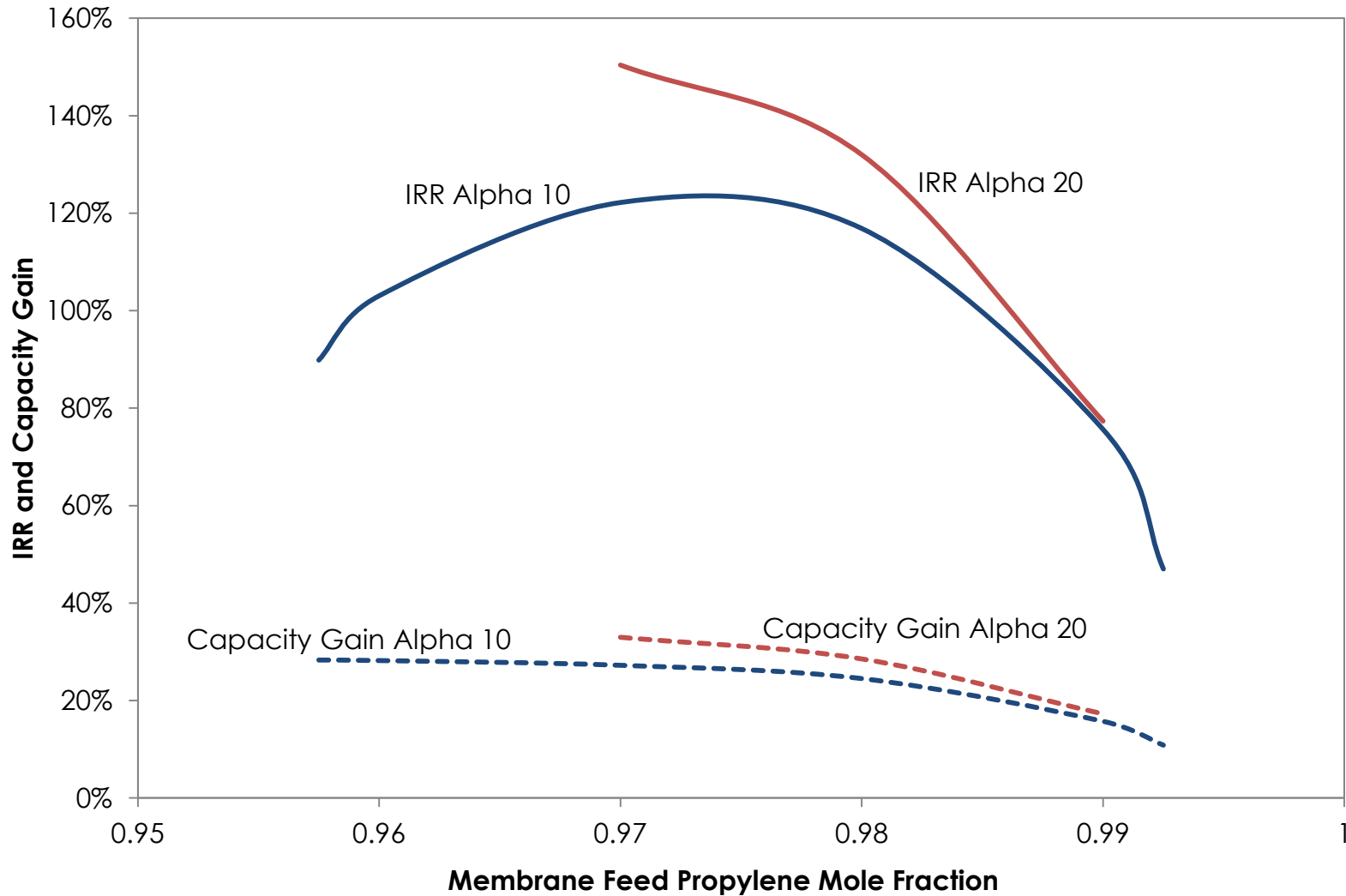
Configuration 1

Membrane at the top (Distillate)

Below a certain distillate composition, cost and recycle rate increase dramatically for membrane at column top



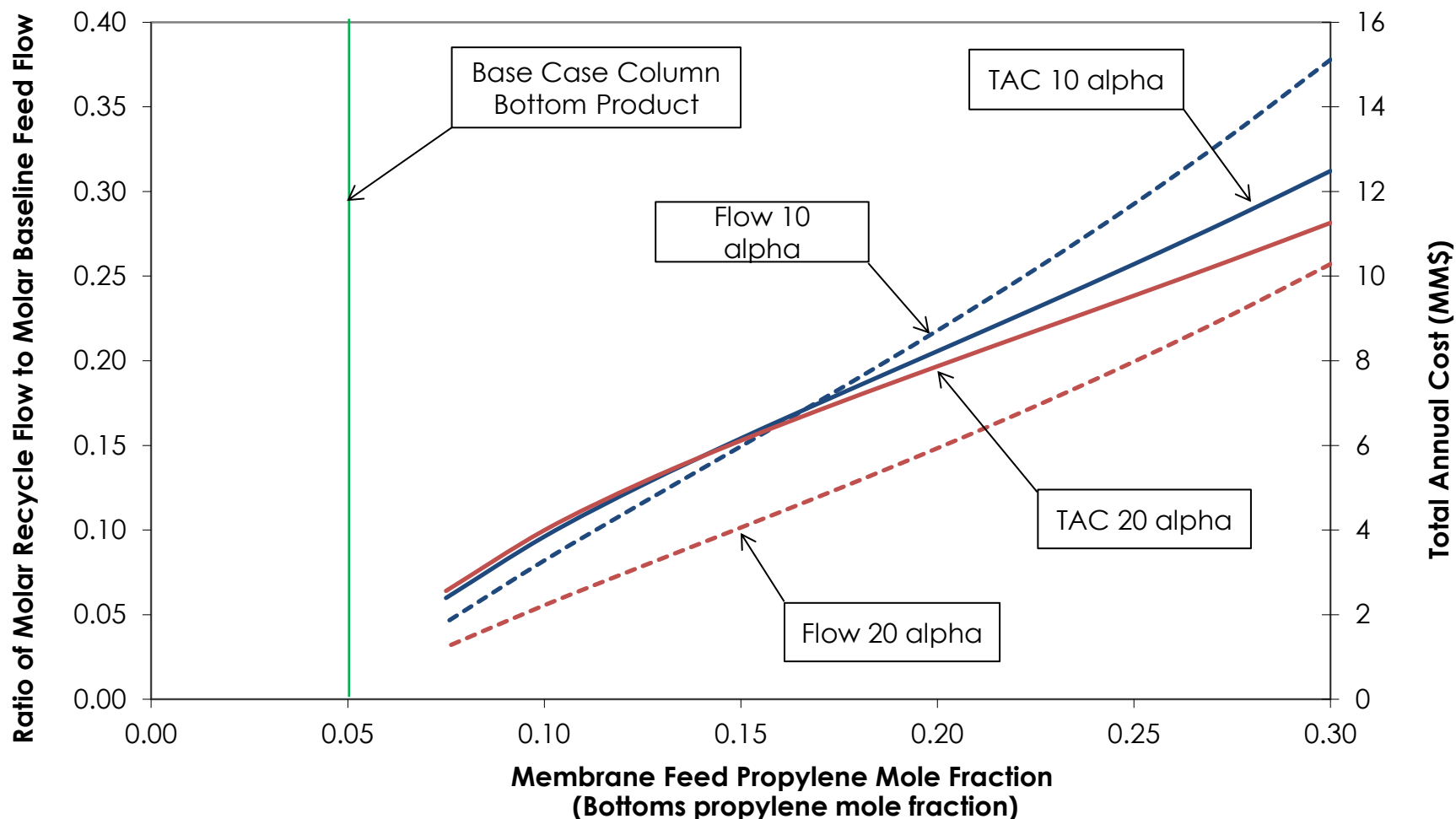
IRR has maximum point for membrane at column top depending on membrane selectivity



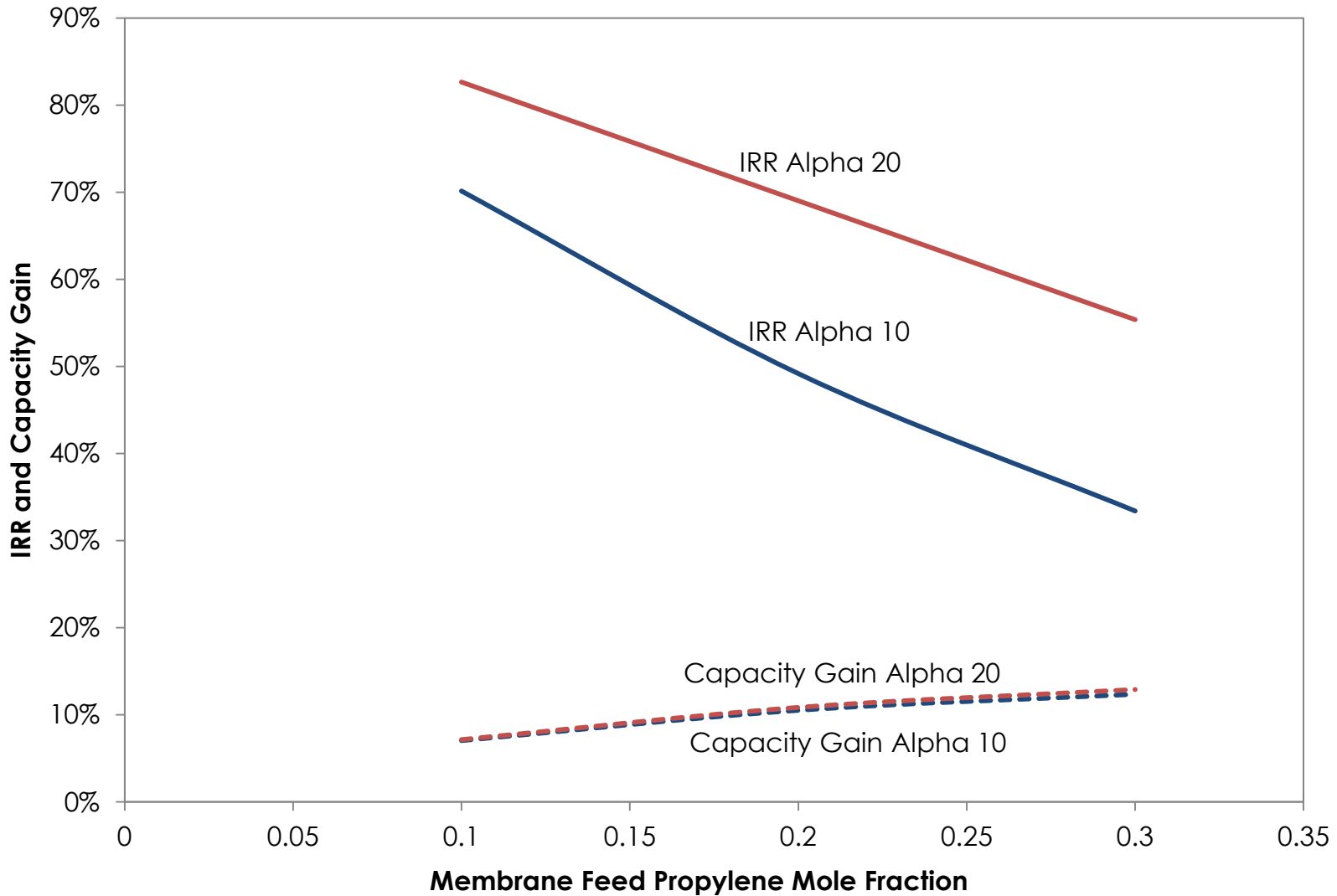
Configuration 2

Membrane at the bottom

Cost and recycle rate increase as bottoms propylene composition increases for membrane at column bottom

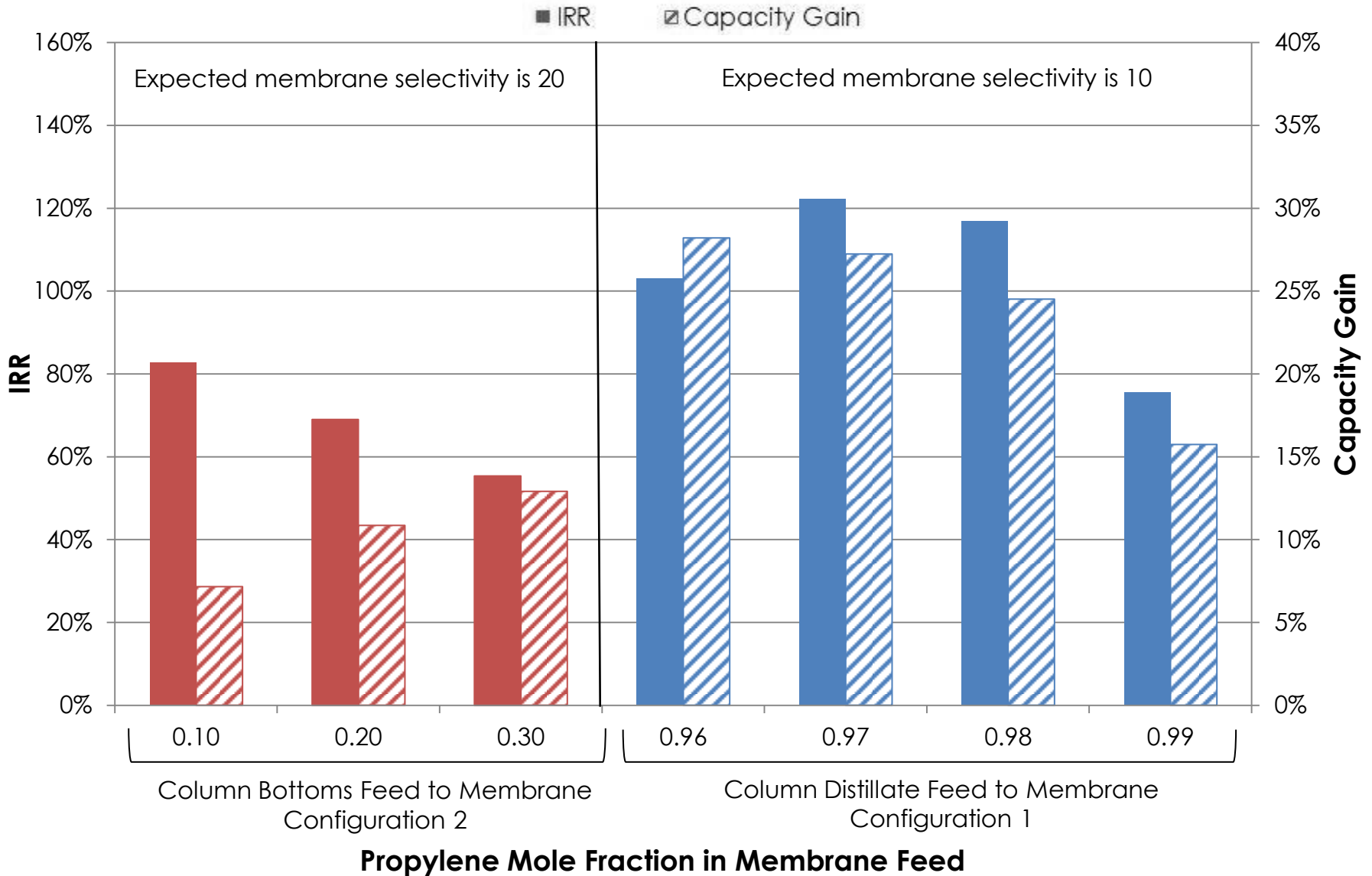


IRR decreases for membrane at column bottom as propylene in bottom product increases

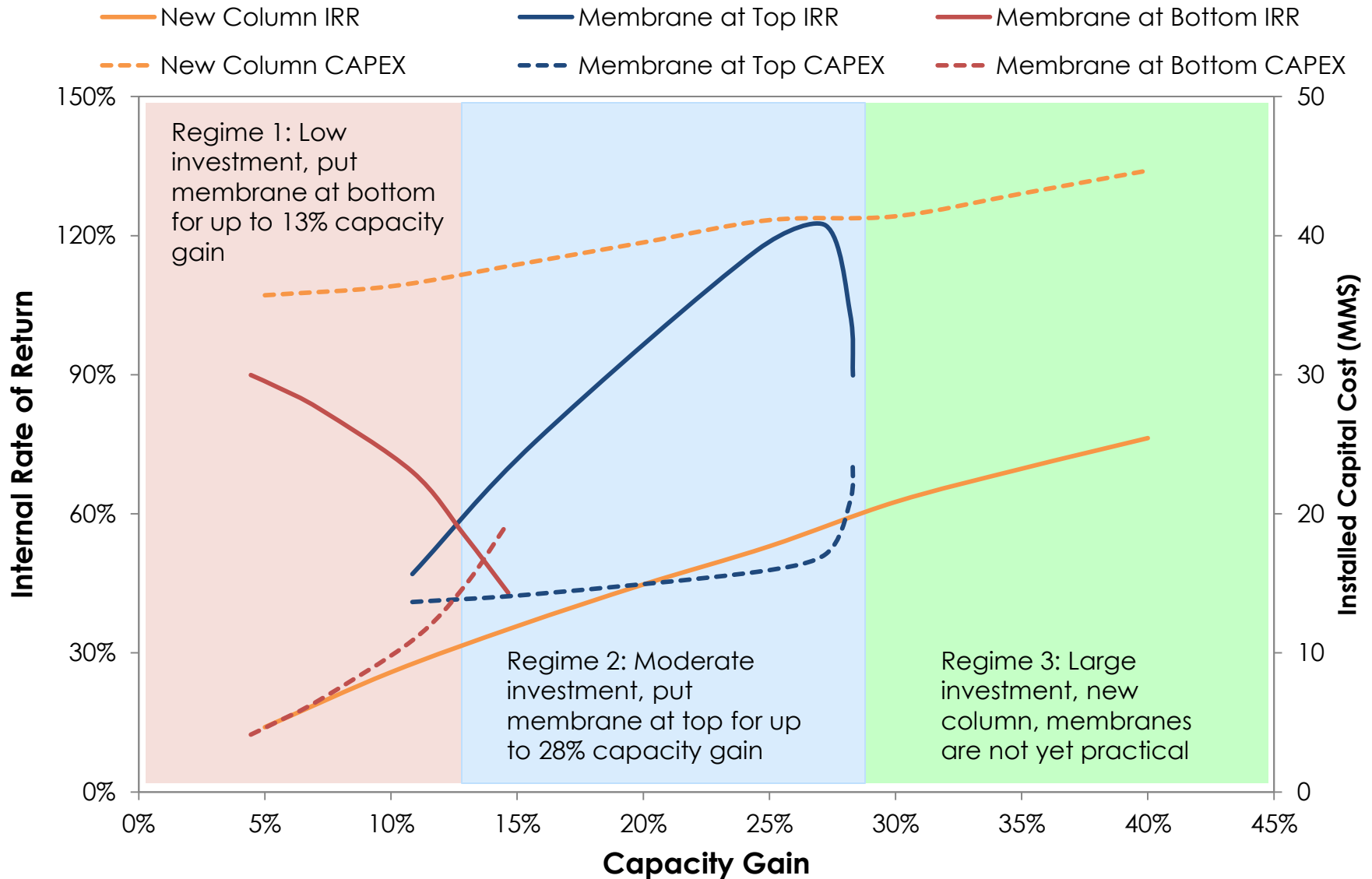


Comparison of the configurations

Comparison of achievable capacity gains and IRRs for two distillation/membrane hybrid configurations



Membrane retrofit requires less capital investment than column replacement and provides superior returns



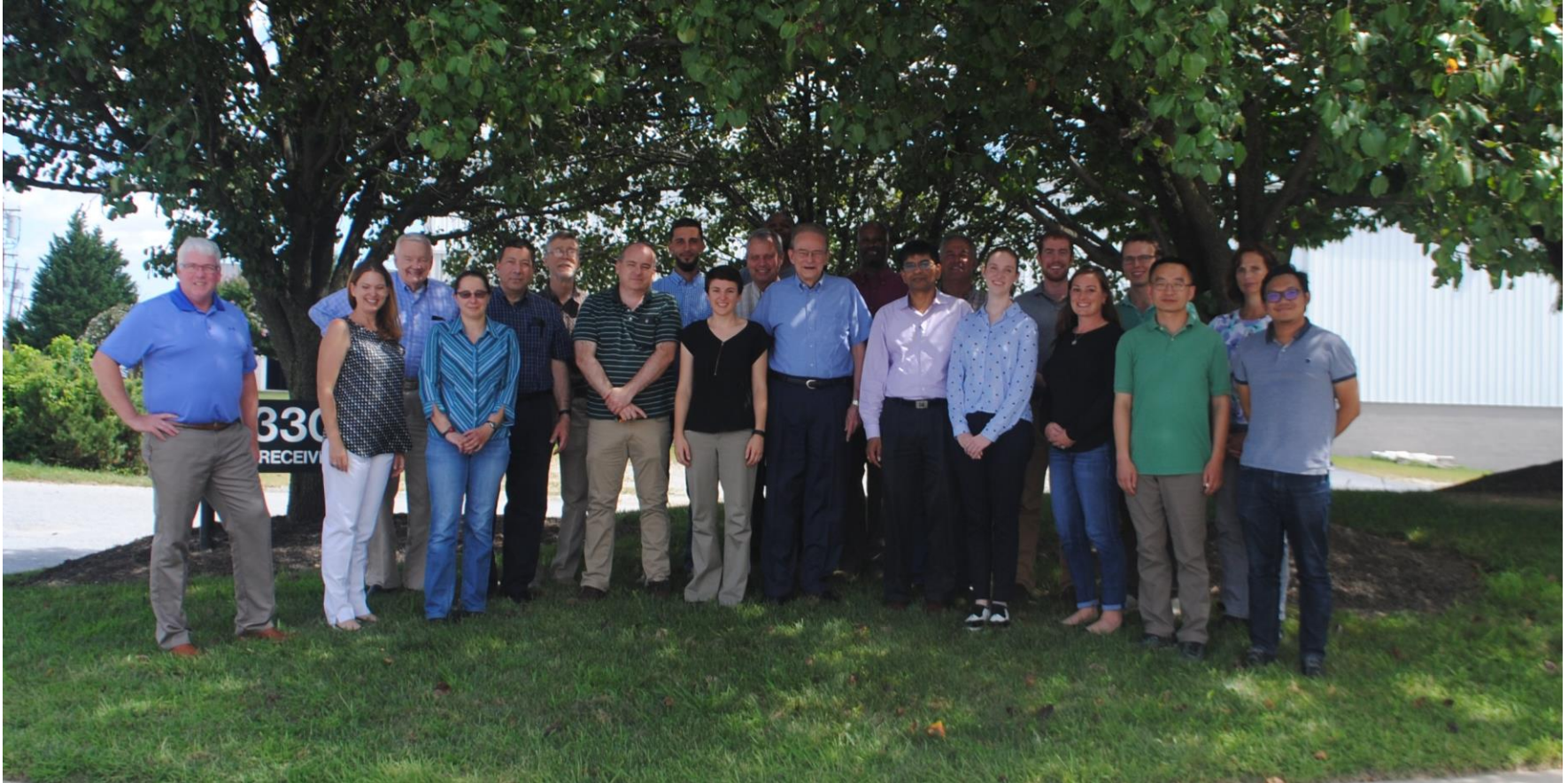
Concluding remarks

- Optiperme™ membranes are a cost effective means of increasing C3 splitter capacity up to about 28%.
- For capacity increases in the range of 13% to 28%, the membranes should be installed at the column top.
- For capacity increases up to 13%, the membranes should be installed at the bottom of the column.

Possible future work:

- Membrane expansion at both top and bottom of column

Thank you for Attending! Questions?



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