



Energy research Centre of the Netherlands

Integration of distillation with membrane technologies for Paraffin/Olefin separation

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Integration of distillation with membrane technologies for Paraffin/Olefin separation

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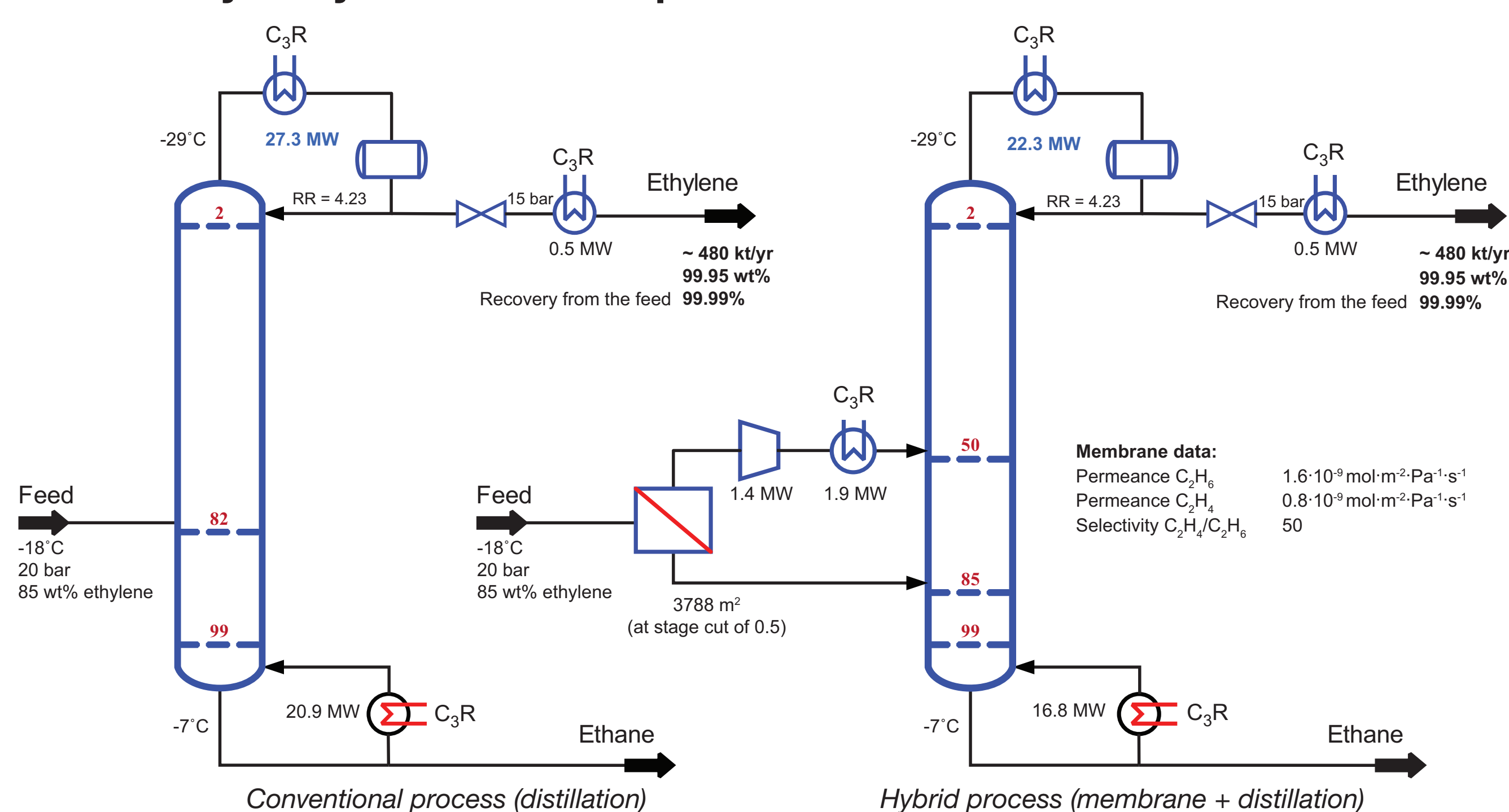
Objective

- Reduce utility consumptions (energy) in paraffin/olefin separation processes.
- Debottleneck these separations (when applicable).
- Identify the required membrane selectivity for an economically attractive separation.

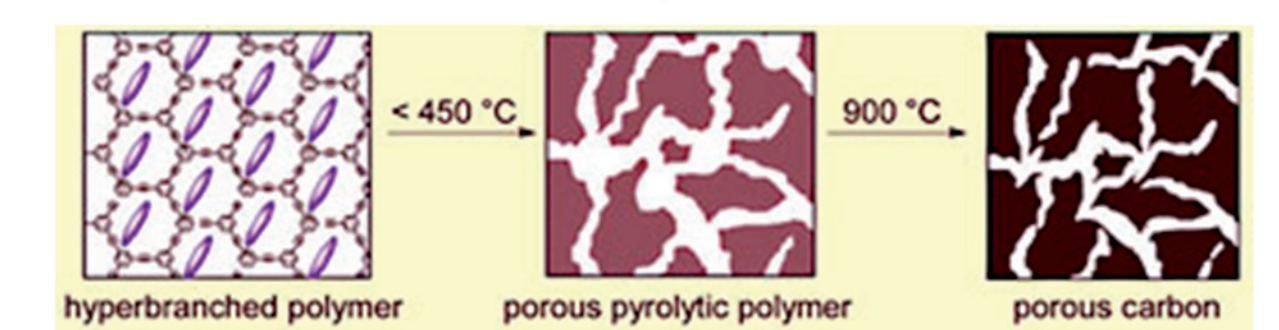
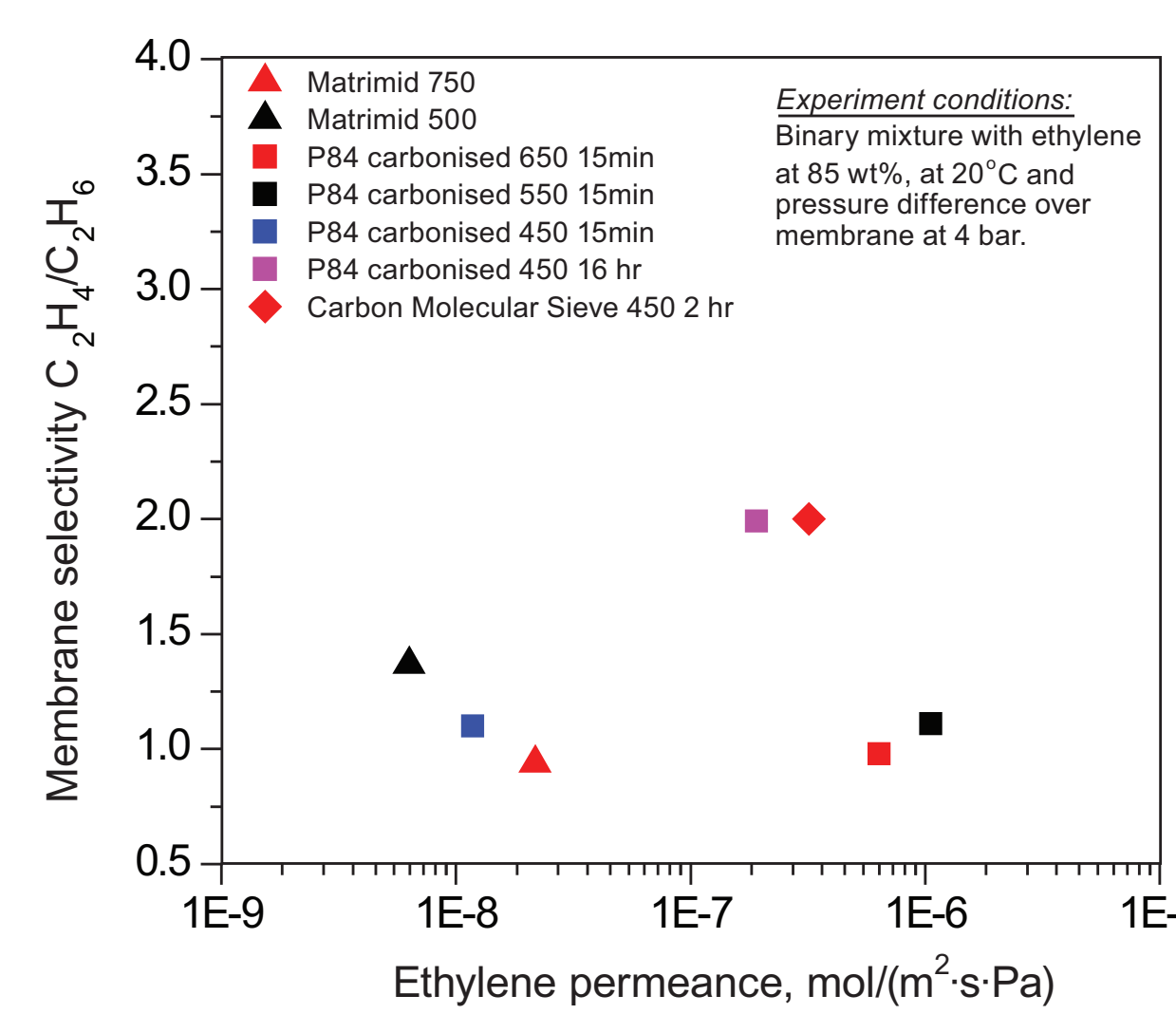
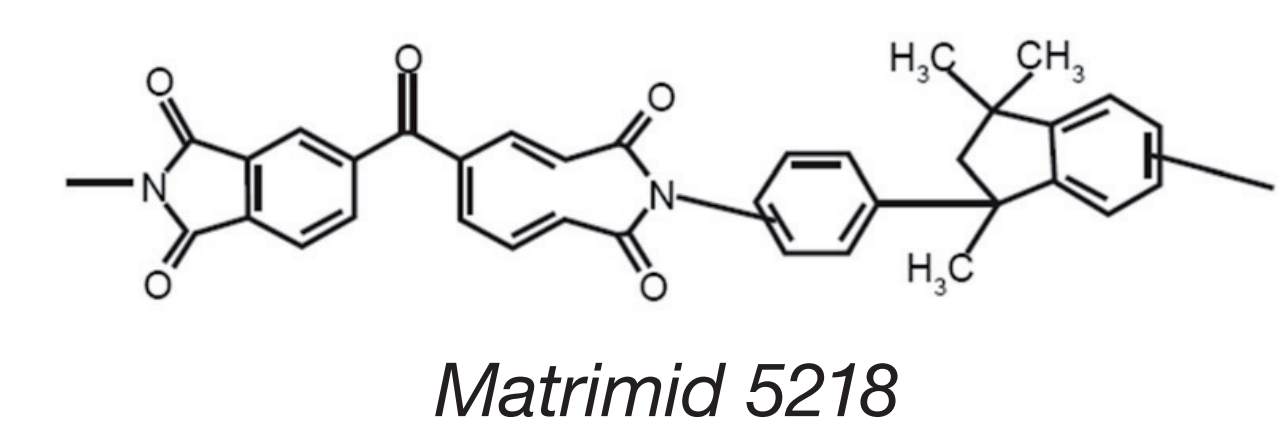
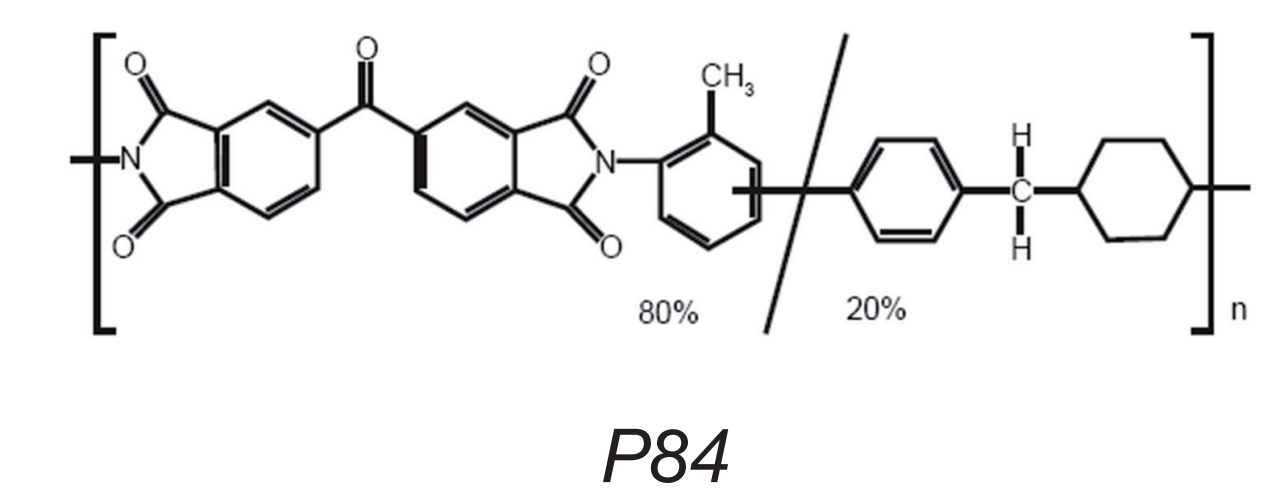
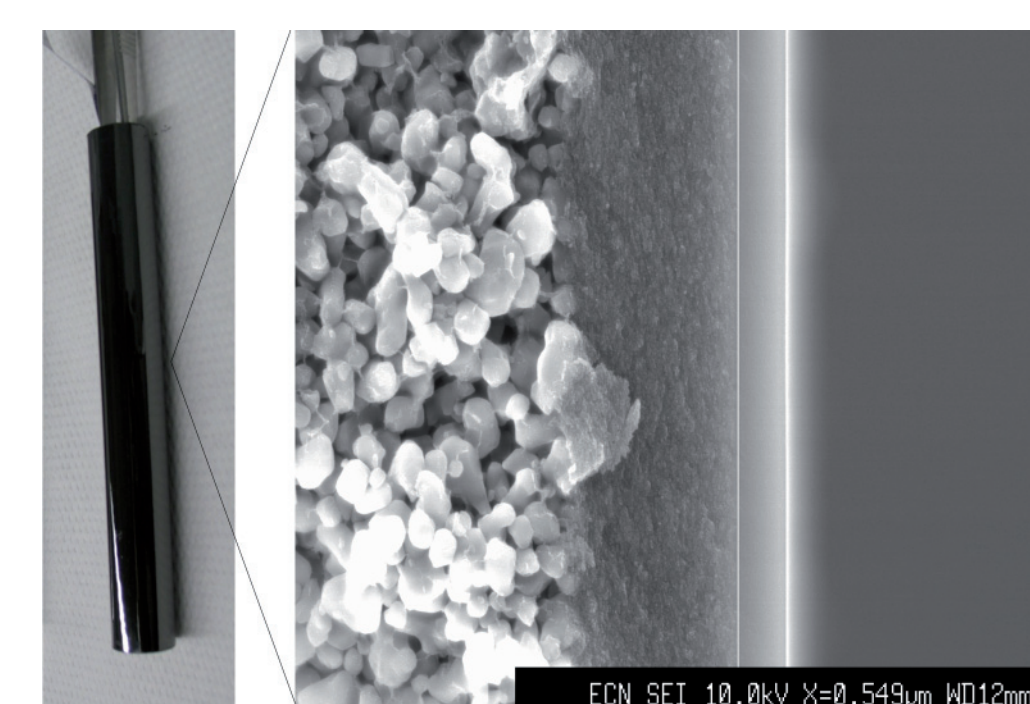
Background information

- Olefins (ethylene, propylene, butadiene) are the most produced intermediates in petrochemical industry (worldwide capacity is 120, 60, and 11 mln ton/yr).
- Olefin separation from paraffins, typically is (very)expensive in both capital and operating cost. The main reason – small difference in volatility of components of the mixture.
- In an existing olefin plant, this separation often becomes a bottleneck in the production process [1].

Case study: Ethylene/Ethane separation

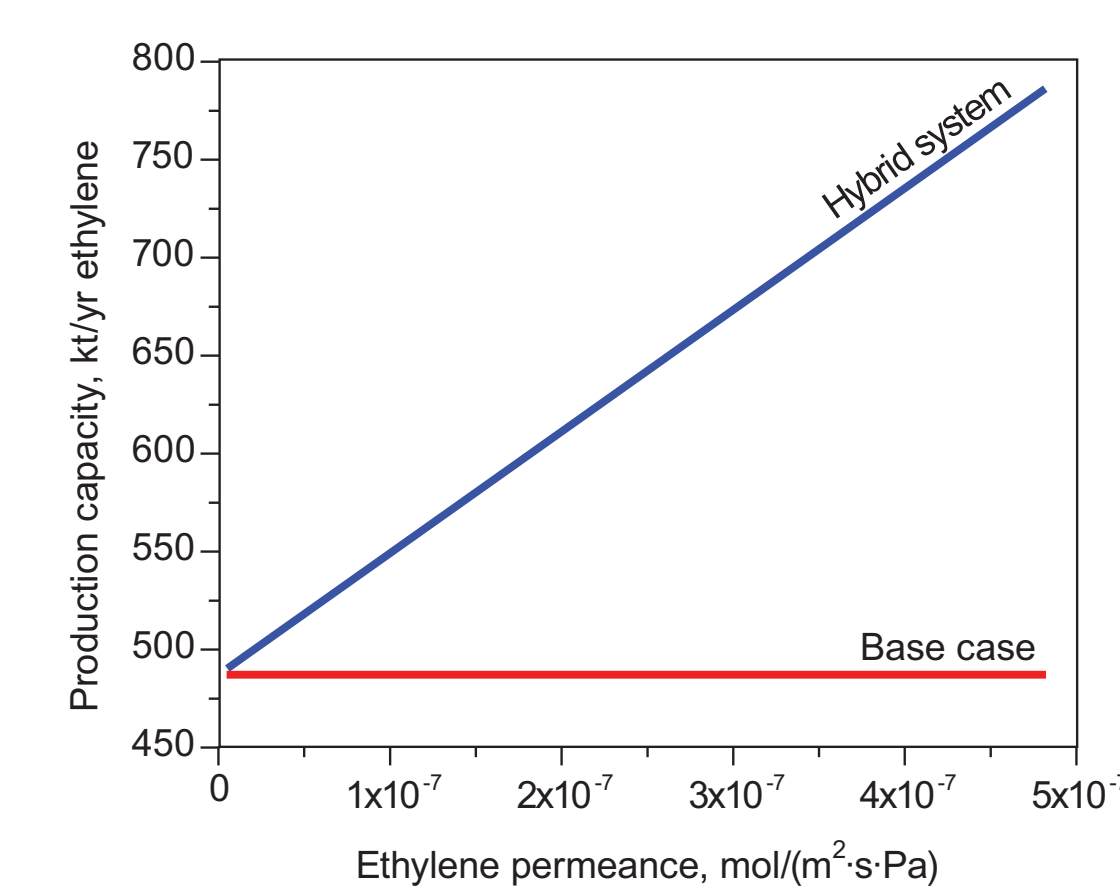
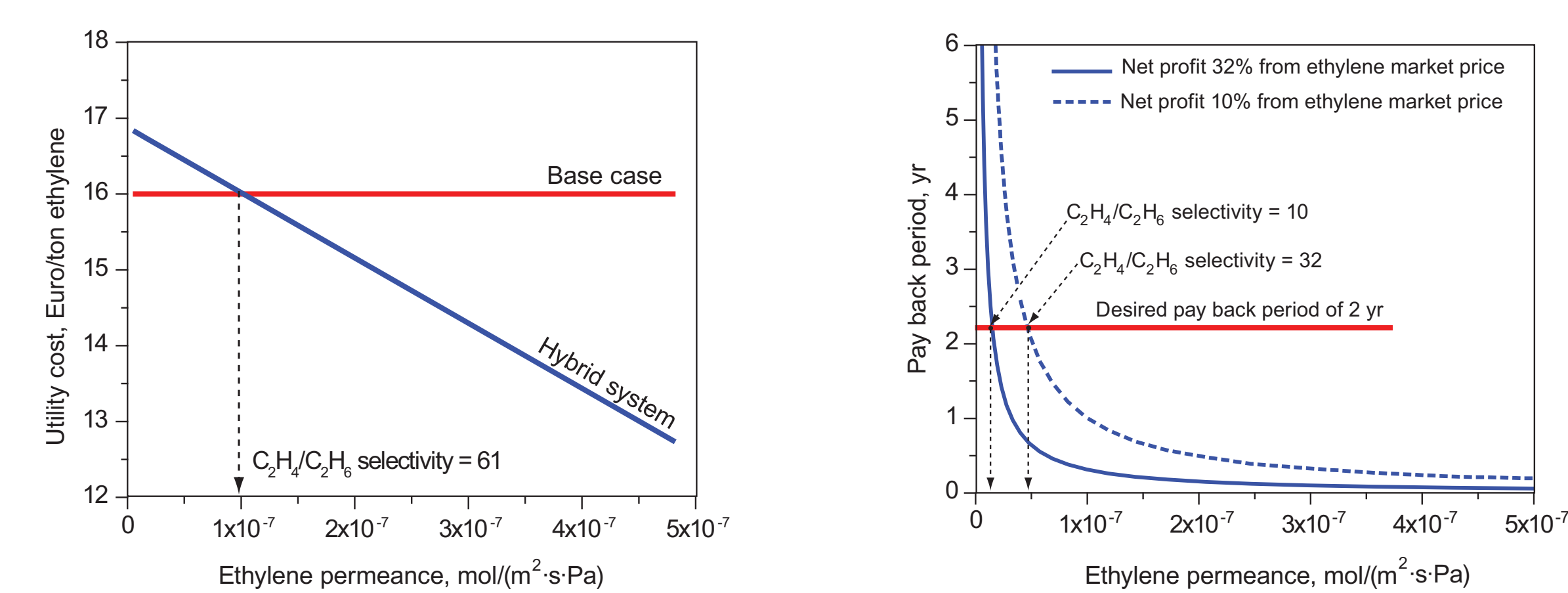


Membrane material development



Permeance targets
($>10^{-9}$ mol·m⁻²·Pa⁻¹·s⁻¹) are met, while selectivity targets (>10) not yet.

Sensitivity of ethylene permeance



Ethane permeance of 1.6 · 10⁻⁹ mol·m⁻²·Pa⁻¹·s⁻¹ is assumed constant; ethylene permeance has been increased to determine the sensitivity on operation cost, capacity and pay back period of the membrane system.

Operation cost includes the cost of utilities (electricity and cooling water) and membrane replacement cost (every 3 yr).

Membrane is a gas separation membrane that functions without the aid of a liquid carrier (e.g. AgNO₃) that facilitates the transport. The assumption is that the membrane is selective for ethylene.

Discussions

- A membrane leads to a reduction in utility use, if the membrane has a selectivity for ethylene > 61 and permeance of $9.8 \cdot 10^{-8}$ mol·m⁻²·Pa⁻¹·s⁻¹. For example, at selectivity of 100 only 3.3% reduction in operating cost can be expected.
- A hybrid process leads to lower reflux ratio of the column. This is an incentive to debottleneck the existing columns and increase the ethylene production capacity.
- Using this capacity increase a membrane with a selectivity of 10 is enough attractive investment (pay back period ~ 2 yr). A more conservative estimation shows that selectivity of 32 is needed for a 6.5% increase in production capacity.

Conclusions

- A gas separation membrane combined with distillation column leads to reduction in utility use and capacity increase.
- Currently available membranes do not meet the required selectivities.
- In general, any separation method can be used instead of membrane, provided that at least one of the outlet streams has a higher concentration in ethylene (or ethane) than the feed stream.

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Partners

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