

PermSMBR - A New Hybrid Technology Application to the Ethyl Lactate Green Solvent Production

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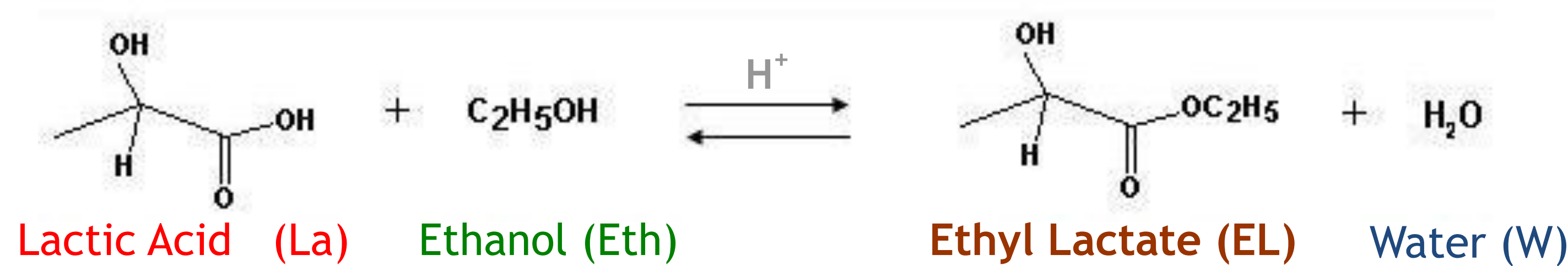


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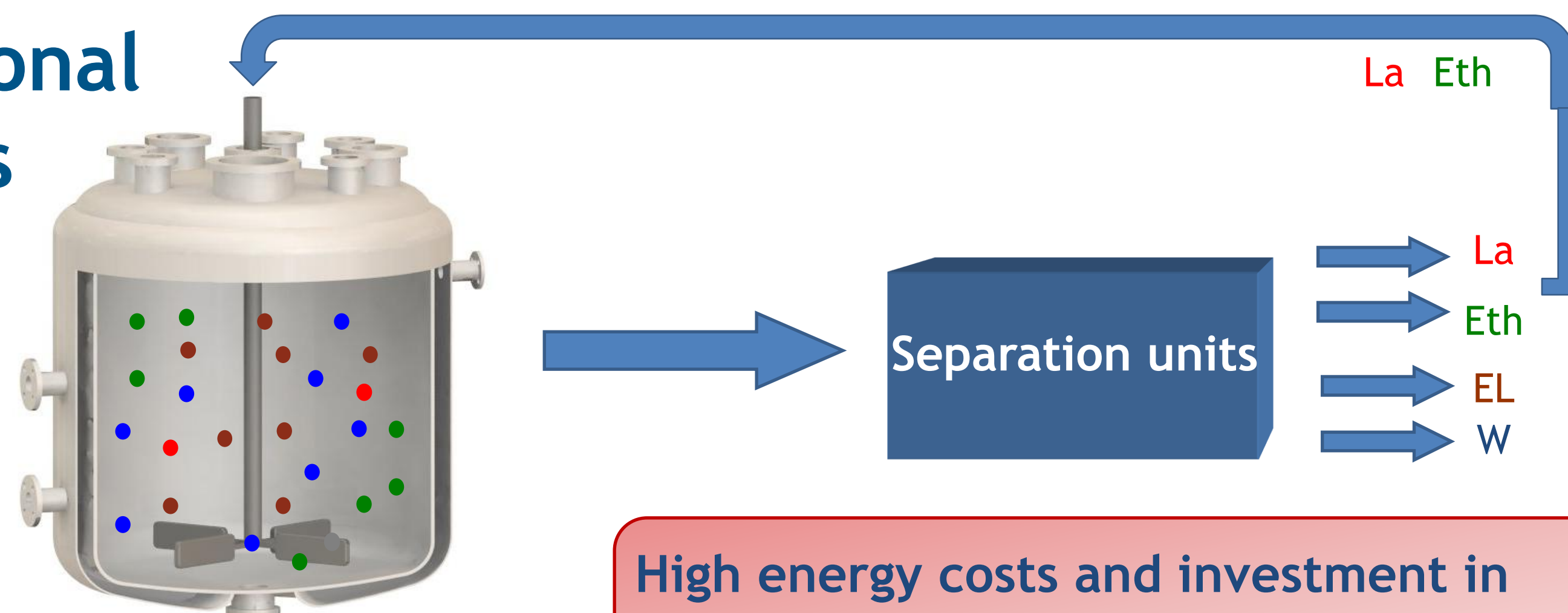
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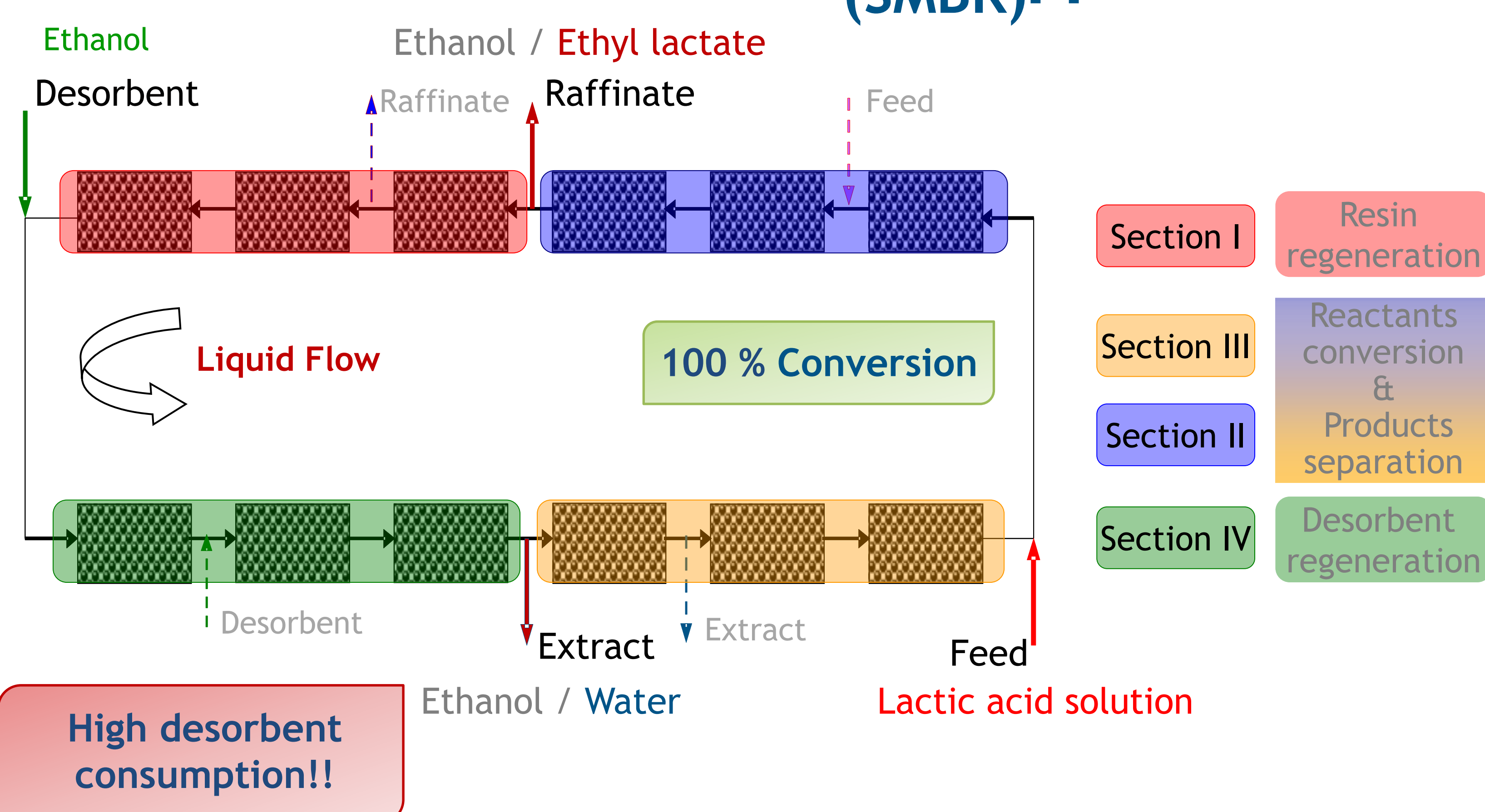
Green Solvent: Ethyl Lactate



Tradicional Process



Process Intensification: Simulated Moving Bed Reactor (SMBR)^[1]

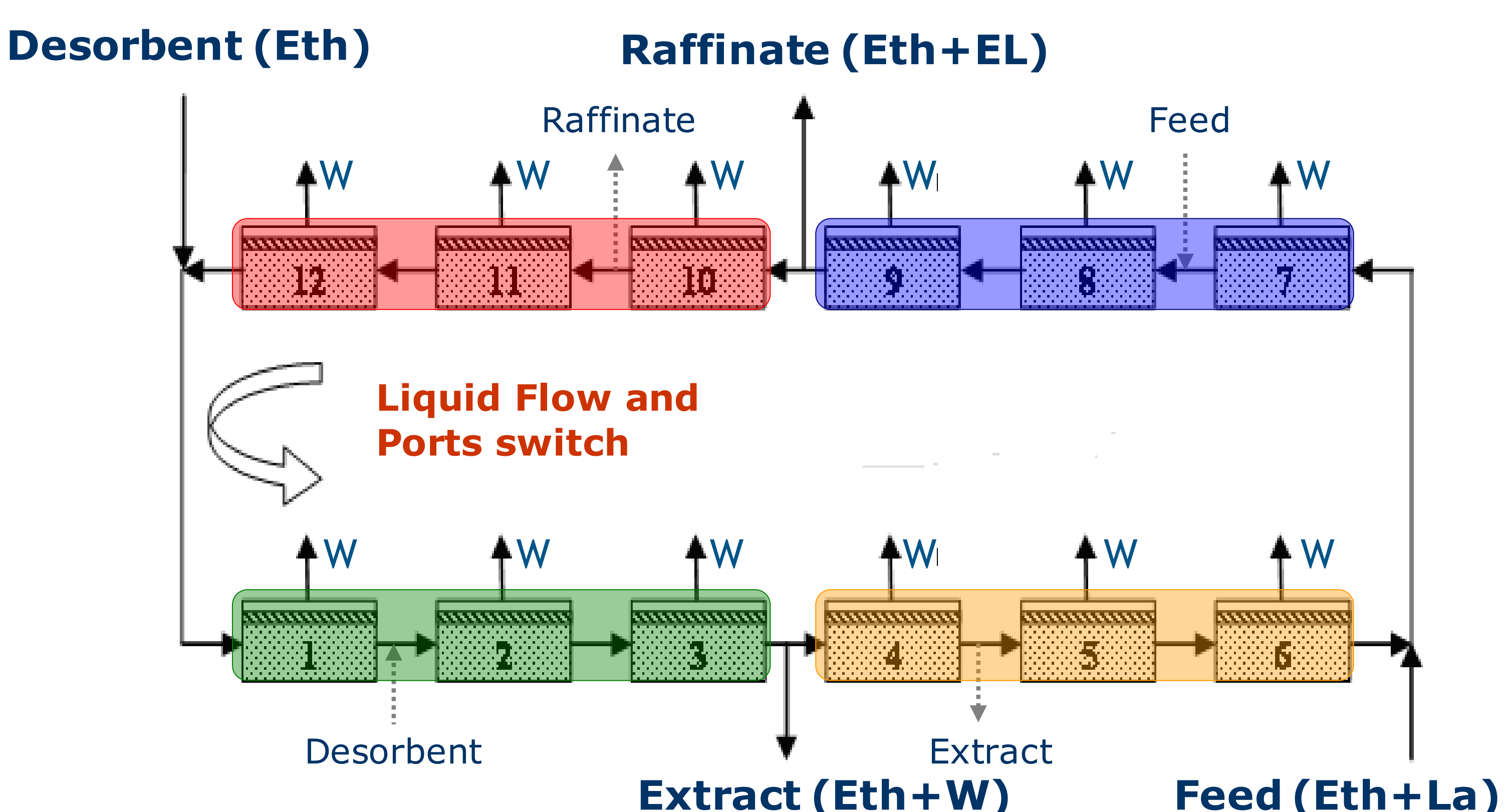


Motivation

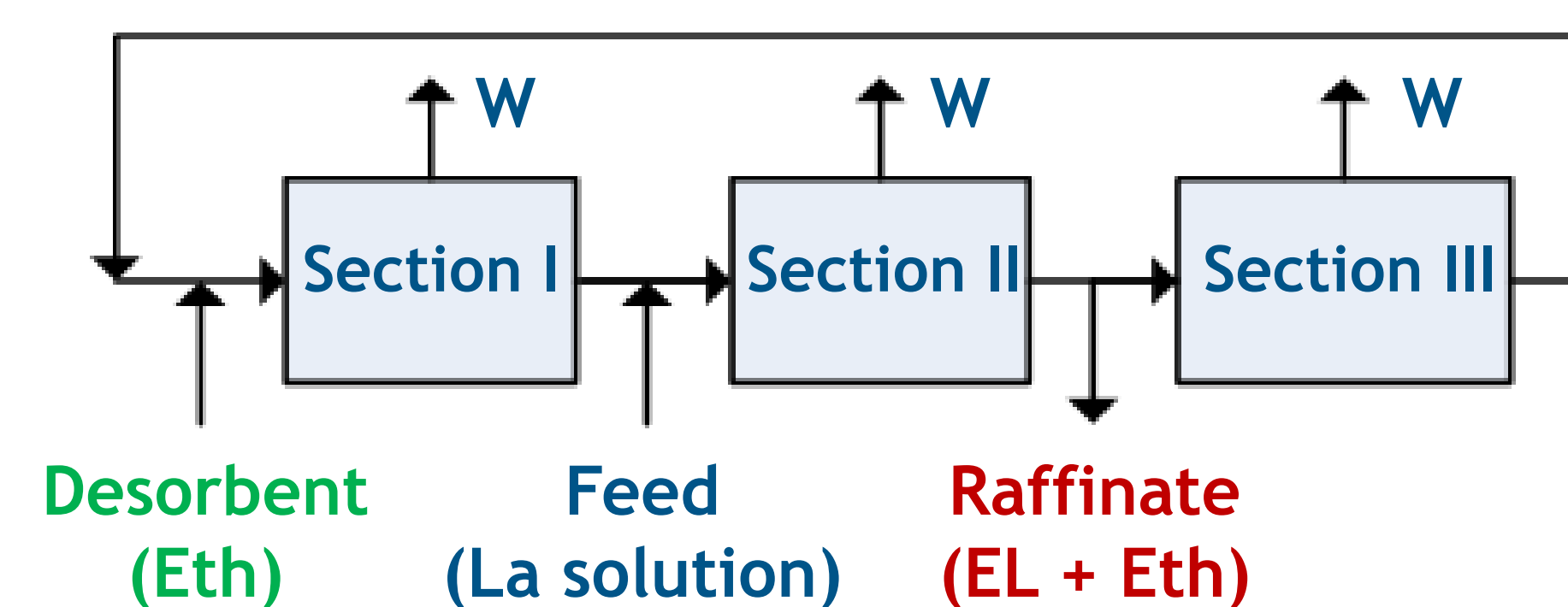
Reactor integrated with two different separation techniques:

- Chromatography (Simulated Moving Bed-SMB)
- Selective permeable membrane (Pervaporation)

PermSMBR: Simulated Moving Bed Membrane Reactor^[2]

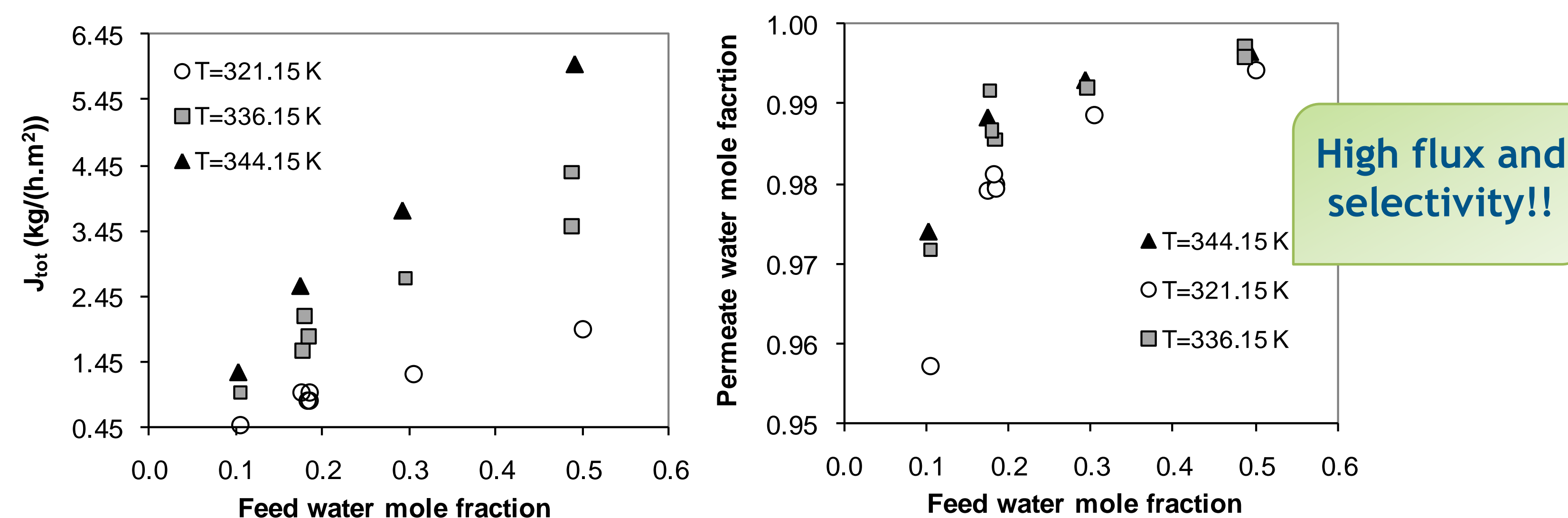


PermSMBR with 3 sections (PermSMBR-3s): Extract stream elimination



New Hybrid Technology

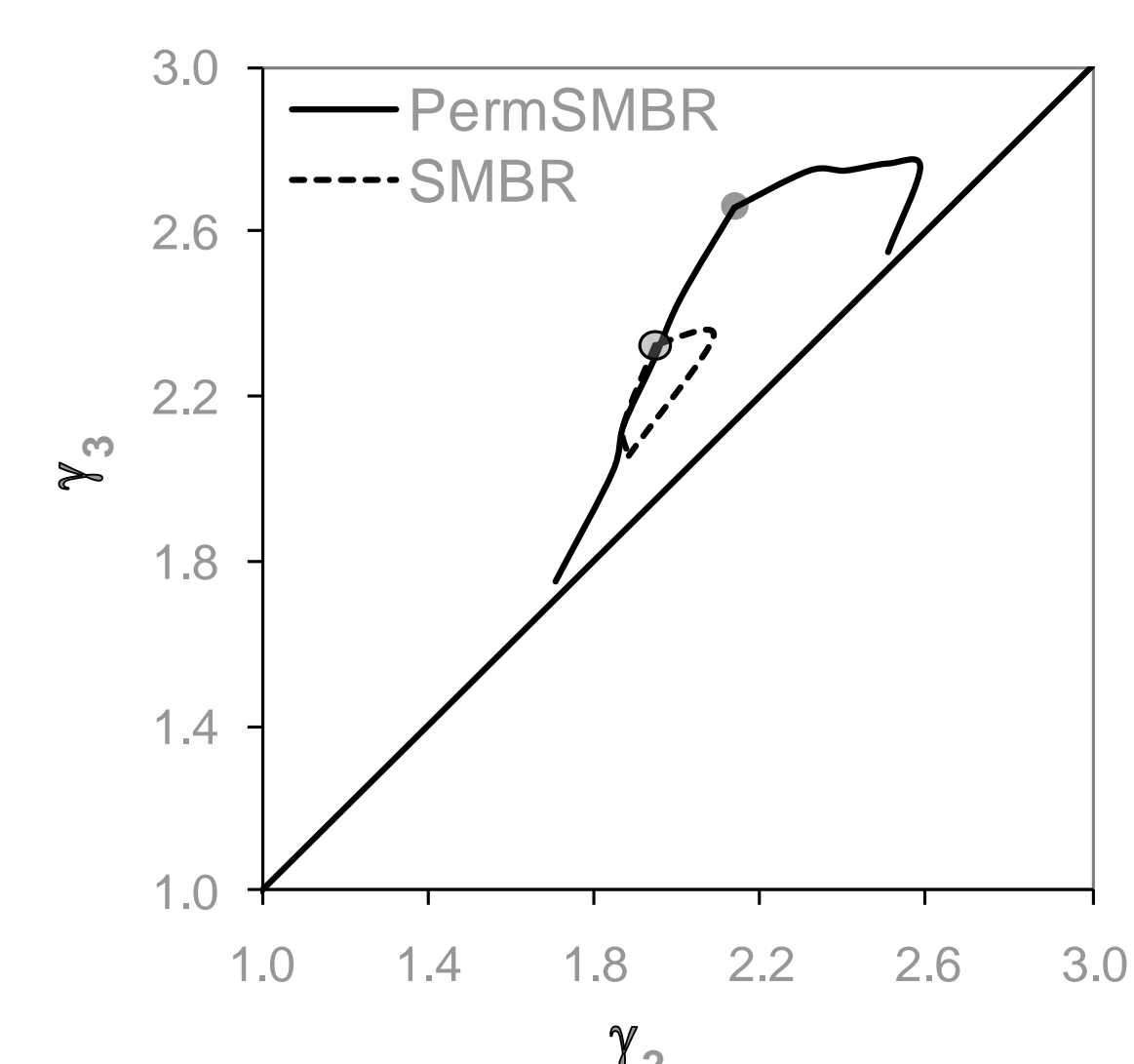
Hydrophilic Silica Membrane (Pervatech)^[3]



Reactive Separation Region^[4]

criteria: 95 % extract, raffinate purity and lactic acid conversion.

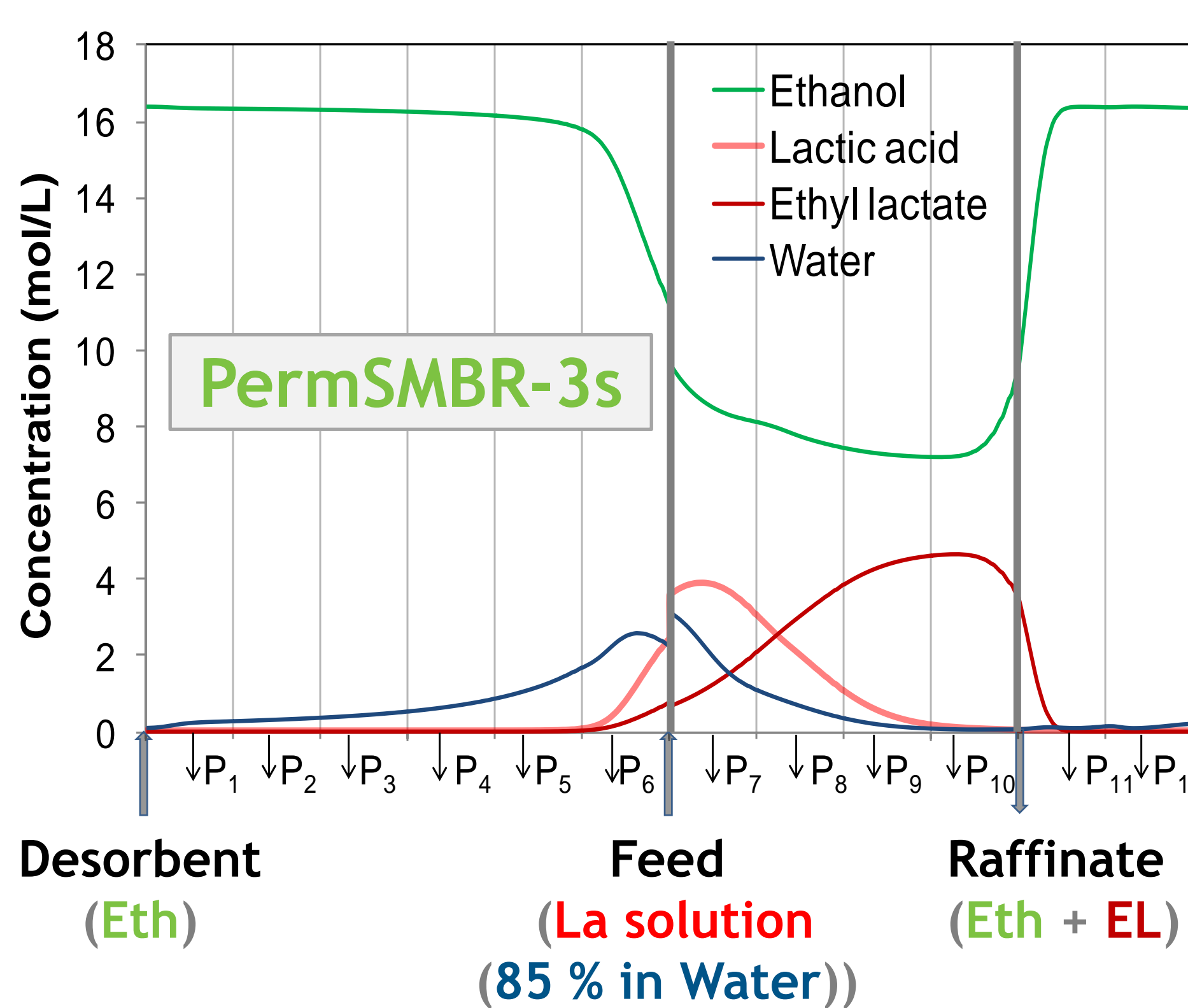
Performance parameters at the optimal operating points.



	Productivity (kg _{EL} ·L _{resin} ⁻¹ ·day ⁻¹)	Desorbent Consumption (L _{Eth} /kg _{EL})
SMBR	18.1	4.75
PermSMBR	24.2	3.41

34 % higher productivity
28 % less ethanol consumption

Operating conditions: Q_D = 58 mL/min; Q_{recycle} = 27 mL/min; t*_{PermSMBR} = 2.323 min; t*_{SMBR} = 2.1 min; Configuration: 3-3-4-2; P_{perm} = 10 mbar; T = 50°C.



Operating conditions: Q_D = 58 mL/min; Q_{recycle} = 27 mL/min; t*_{PermSMBR} = 2.323 min; Configuration: 6-4-2; P_{perm} = 6 mbar; T = 50°C.

La Conversion : 99.18 %
EL Purity: 96.15 %
Productivity: 16.5 kg_{EL}·L_{resin}⁻¹·day⁻¹

Ethanol Consumption 1.96 L_{Eth}/kg_{EL}

SMBR (4 sections) → Ethanol Consumption: 5.20 L_{Eth}/kg_{EL}

62 % higher desorbent consumption!!

PermSMBR vs. SMBR

PermSMBR - Promising technology that allows:

High Productivity

Low Solvent Consumption

Lower downstream costs associated to the separation units

Extract stream elimination : PermSMBR -3s

Even higher decrease on the desorbent consumption and reduction of capital cost (relative to extract stream separation).



Desorbent Consumption

References:

- [1] Pereira CSM, Zabka M, Silva VMTM, Rodrigues AE. A novel process for the ethyl lactate synthesis in a simulated moving bed reactor (SMBR). Chem. Eng. Sci. 2009;64(14):3301-3310.
- [2] Silva VMTM, Pereira CSM, Rodrigues AE. Simulated Moving Bed Membrane Reactor, new hybrid separation process and its applications. PCT/IB2010/051510, April 2010.
- [3] Pereira CSM, Silva VMTM, Pinho SP, Rodrigues AE. Batch and continuous studies for ethyl lactate synthesis in a pervaporation membrane reactor. J. Membr. Sci. 2010;361(1-2):43-55.
- [4] Silva, V.M.T.M., C.S.M. Pereira, and A.E. Rodrigues, PermSMBR - A new hybrid technology: Application on green solvent and biofuel production. AIChE Journal, in press, 2010.

Acknowledgments:

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Conclusions

