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Dynamics and Control of Chemical Processes

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Lab #6: Introduction to HYSYS

Exercise 1

A mixture of N_2, CO_2, methane, and ethane is sent to a centrifugal compressor to increase its pressure to 4 atm. Then, the compressed stream is sent to a flash tank and then cooled up to 35°C. Finally, the outlet stream is divided into two, so that one of them contains 2/3 of the original mass flow. You are asked to simulate the entire process.

Initial conditions:

Temperature (°C)	50
Pressure (atm)	1
Molar flow (kmol/h)	100

	Molar fraction
N_2	0.05
CO_2	0.04
CH_4	0.61
C_2H_6	0.30

Suggested fluid package: Peng-Robinson

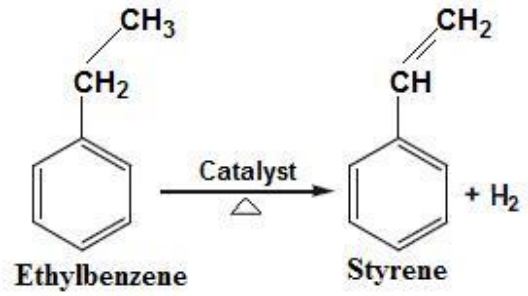
Exercise 2

Determine the height and diameter of a 10-stage absorption column operating at 60°C and 60.1 atm, to remove CO_2 from a CH_4/CO_2 mixture. Consider 1186 m^3/h of propylenecarbonate as solvent and 7000 kmol/h of the gas (with 20% molar of CO_2). Assume that there is no pressure drop through the column.

Suggested fluid package: Sour Peng-Robinson

Exercise 3

Consider the reaction of ethylbenzene dehydrogenation to produce styrene.



Assume a kinetic behavior according to the next rate expression:

$$r_E = -4240 \frac{gmol}{V_{Reactor}(l) \cdot kPa \cdot s} p_E(kPa) \cdot exp\left[-\frac{21708 \frac{cal}{gmol}}{\left(1.987 \frac{cal}{gmol \cdot K}\right) T}\right]$$

In Aspen Hysys, introduce an adiabatic PFR reactor of 6 m length and 0.77 m^3 volume. Associate it with the above kinetics (in vapor phase), Peng-Robinson fluid package, and with an inlet material stream at these conditions:

	Ethylbenzene
Molar flow (gmol/s)	152.2
Temperature (K)	880
Pressure (bar)	1.378
Composition	Pure Ethylbenzene

After the reaction occurs, the product is cooled and then flashed at 333K. A full reflux distillation column concentrates the styrene to obtain 205 kmol/h, according to the following conditions:

Number of stages	16
Inlet stage	8
Reflux ratio	9.2
Condenser pressure	1.02 bar

Simulate the whole process, report the conditions of the PFR outlet, and plot the molar flow of the components versus the length of the reactor. How can the recovery of styrene be improved?