Øving 4

Purpose:

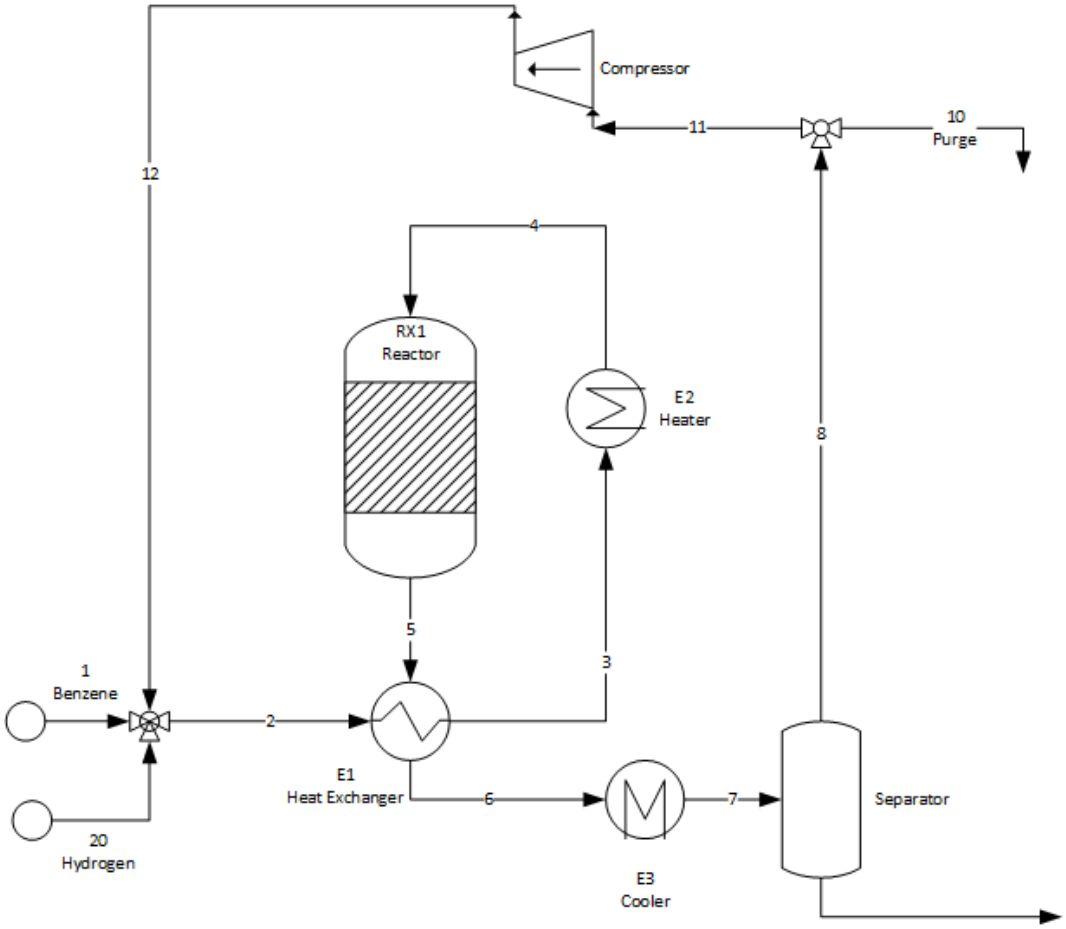
- Flowsheet calculation
- Hysys simulation
- Design specification

Problem 1

Cyclohexane may be produced by hydrogenation of benzene according to the reaction

$$C_6H_6 + 3\,H_2 = C_6H_{12}$$

The structure of the synthesis part of the process is shown on the flowsheet below:



Stream	Amount	Temperature	Pressure
Benzene (1)	15 m^3/h	100 F	540 psig
Hydrogen (20)	ca 550 kmol/h	100 F	540 psig
Hydrogen recycle (12)	ca 1700 kmol/h	150 F	540 psig

The hydrogen feed, stream 20, contains 2.75 mol% methane.

Unit	Temperature (F)	Pressure loss (psi)
E1, hot side		5
E1, cold side		10
E2, out	300	5
E3, out	120	5
RX1, out	435	15

The heat exchanger E1 has area of 60 m^2, $U = 625$ W/(m^2C). The benzene conversion over the reactor is to be 99.9%.

Design specifications are:

- The maximum allowed concentration of methane (inert) is 10 mol % in the recycle stream, stream 12 or 11.
- Reactor feed, stream 4, should have a molar hydrogen/benzene ratio of 12:1

The possible variables to be adjusted are

- The amount of hydrogen feed; stream 20
- The purge; stream 10
- or the recycle flow, stream 11 and 12

Hints: Using the Spreadsheet, you may import data from the streams in the flowsheet and use these for calculation of certain parameters to control the process, using Adjust.

a) Before you do any simulation in Hysys, estimate approximate values for amounts and composition of the main flows in the flow sheet. Assume perfect split in the separator; only H_2 and methane over top. Vary the divider split ratio and see the effect on recycle composition. You may use hand calculations or a Python (Matlab) script.

b) Plan the simulation by adding the units that you may need in addition to the ones shown on the flow sheet. Where would you put Adjust to obtain the wanted result?

c) Do the simulation in Hysys and submit a printout of the results.