

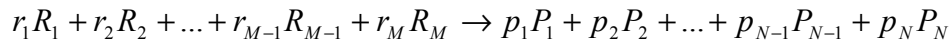
Reactor Design I: Tutorial 2. Reactor Systems

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Question 1

Develop the stoichiometric table for case of a single reaction in which M reactants with varying stoichiometric coefficients react to product N products (also with varying stoichiometric ratios). The reaction may therefore be represented as follows:



You may assume that the reaction is elementary.

Determine the mole fraction of each reactant as a function of conversion, if conversion is defined based on the amount of the first reactant (R_1) and if:

- the reactor operates in the liquid phase (CSTR and PFR)
- the reactor operates in the gas phase at less than 15 bar (CSTR and PFR)

Question 2

Consider the following reaction: $A + 2B \rightarrow C$ which has a reaction rate constant $k = 0.23$ and the reaction is elementary.

The reactor is fed with 50 mol/s of A and 150 mol/s of B. All components remain in the liquid phase, and it may be assumed that the reaction mixture density is approximately that of water. The molar mass of A is 0.025 kg.mol⁻¹ whereas C is 0.060 kg.mol⁻¹.

- If a tank of volume 5.4 m³ containing a high speed mixer is available, what conversion is possible in the reactor?
- If 3 tanks, each having a volume of 5.4 m³ containing a high speed mixers are available, what is the maximum possible conversion?

Question 3

Consider the following reaction: $2A + B \rightarrow 2C$ which has a reaction rate constant $k = 1 \times 10^{-7}$, and it is known that the reaction is elementary. The reaction is to occur in a tubular packed (with catalyst) bed reactor.

The molar masses of A and B are 0.035 kg/mol and 0.015 kg/mol respectively. Density of the catalyst is 2500 kg.m⁻³, particle diameter is half a centimeter, diameter of a tube is 5 cm, bed porosity is 0.55, reaction temperature 112°C, rate constant is 1×10^{-7} , gas viscosity is 3×10^{-5} Pa.s.

Reactant feed: $[F_A, F_B, F_C] = [100 \ 50 \ 0]$. The feed flow to the reactor is at a pressure of 12 atm.

Develop the conversion and pressure profiles over a 20 kg catalyst tube.