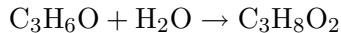


This problem is adapted from Text Exercise 4.8. It considers a different initial condition for the constant mass case.

Propylene glycol is produced by the hydrolysis of propylene oxide according to the following reaction



In the presence of excess water, the reaction has been found to be first-order in propylene oxide

$$r = k c_{\text{PO}}$$

and the rate constant is

$$k = k_0 e^{-E_a/RT} \quad k_0 = 4.71 \times 10^9 \text{ s}^{-1} \quad E_a = 18.0 \text{ kcal/mol}$$

Methanol is added as a solvent, and the reaction is performed in a 1000 L CSTR operating at 60 °C. The feed conditions and physical properties are as follows

Component	Density (g/cm <sup>3</sup> )	Mol. wt. (g/mol)	Inlet feedrate (L/hr)
propylene oxide	0.859	58.08	1300
water	1.000	18.02	6600
propylene glycol	1.0361	76.11	0
methanol	0.7914	32.04	1300

Assume the mixture is ideal so that

$$1 = \sum_j c_j V_j^\circ$$

in which  $V_j^\circ = M_j/\rho_j^\circ$  are the pure component specific molar volumes. Neglect any change in the pure component densities with temperature in the temperature range 25–60 °C.

(a) Compute the steady-state concentrations of all components,  $Q$ , and  $V_R$  for the following two situations.

1. A float in the top of the tank is used to adjust  $Q$  to maintain reactor volume constant at 1000 L.
2. The reactor is initially charged with unreacted feed in proportion to the feedrates listed above, and a differential pressure measurement is used to adjust  $Q$  to maintain constant reactor mass.

(b) Explore what happens if you assume constant density, which leads to constant volume and constant volumetric flow.