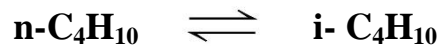


Q1. Consider the following isomerisation reaction of n-butane to i-butane in a PFR as



The reaction is to be carried out adiabatically in the liquid phase under high pressure using essentially trace amounts of a liquid catalyst which gives a specific reaction rate of 31.1 h^{-1} at 360 K. Calculate the PFR and CSTR volumes necessary to process 100,000 gal/day (163 kmol/h) at 70% conversion of a mixture 90 mol % n-butane and 10 mol % i-pentane, which is considered an inert. The feed enters at 330 K.

Additional information:

$$\Delta H_{\text{Rx}} = -6900 \text{ J/mol.butane}$$

$$\text{Activation energy} = 65.7 \text{ kJ/mol}$$

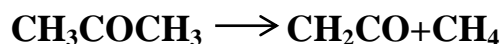
$$K_c = 3.03 \text{ at } 60^\circ\text{C}$$

$$C_{\text{Ao}} = 9.3 \text{ g-mol/dm}^3$$

n-butane	i-butane	i-pentane
$C_p = 141 \text{ J/mol.K}$	$C_p = 141 \text{ J/mol.K}$	$C_p = 161 \text{ J/mol.K}$

Isobutane is a valuable product that is used in the manufacture of gasoline additives. e.g., isobutane can be further reacted to form iso-octane. The 2004 selling price of n-butane was 72 cents per gallon, while the price of iso-butane was 89 cents per gallon.

Q2. Vapour-phase cracking of acetone to ketene and methane is one of the key steps in the design of an acetic anhydride manufacturing facility, the reaction is given as:



It is stated further that this reaction is first-order with respect to acetone and that the specific reaction rate can be expressed by

$$\ln k = (34.34 - (34.222/T))$$

where k is in reciprocal seconds and T is in kelvin. In this design it is desired to feed 8000 kg of acetone per hour to a tubular reactor. The reactor consists of a bank of 1000 1-inch schedule 40 tubes. Consider the two cases:

1. The reactor is operated adiabatically.
2. The reactor is surrounded by a heat exchanger where the heat-transfer coefficient is $110 \text{ W/m}^2\text{-K}$, and the ambient temperature is 1150 K.

The inlet temperature and pressure are the same for both cases at 1035 K and 162 kPa (1.6 atm), respectively. Plot the conversion and temperature along the length of the reactor in both cases.