The kinetics for the reactions are as follows:

 $C_{3}H_{6} + C_{6}H_{6} \xrightarrow{k_{1}} C_{9}H_{12}$ propylene benzene cumene $r_{1} = k_{1}c_{p}c_{b} \quad \text{mole/g cat sec}$ $k_{1} = 3.5 \times 10^{4} \exp\left(\frac{-24.90}{RT}\right)$ $C_{3}H_{6} + C_{9}H_{12} \xrightarrow{k_{2}} C_{12}H_{18}$ propylene cumene p-diisopropyl benzene $r_{2} = k_{2}c_{p}c_{c} \quad \text{mole/g cat sec}$ $k_{2} = 2.9 \times 10^{6} \exp\left(\frac{-35.08}{RT}\right)$

where the units of the activation energy are kcal/mol, the units of concentration are mol/l, and the temperature is in Kelvin.

For a shell-and-tube packed bed, the recommended configuration, the following data may be assumed:

catalyst particle diameter $d_p = 3 \text{ mm}$ catalyst particle density $\rho_{cat} = 1600 \text{ kg/m}^3$ void fraction $\varepsilon = 0.50$ heat transfer coefficient from packed bed to tube wall $h = 60 \text{ W/m}^{2\circ}\text{C}$ use standard tube sheet layouts as for a heat exchanger if tube diameter is larger than in tube sheet layouts, assume that tube cross sectional area is 1/3 of shell cross sectional area