

Exercise 05-01: Criticality classes**Exercise 1: Condensation**

A condensation reaction is to be performed in a stirred tank reactor in the semi-batch mode. The solvent is acetone; the industrial charge (final reaction mass) is 2500 kg and the reaction temperature is 40 °C. The vapour tube has a diameter of 250 mm. The second reactant is added in stoichiometric amount at constant rate during two hours. Under these conditions, the maximum accumulation is 30 %.

The condenser has a cooling capacity of 200 kW.

Data:

Reaction: $Q'_r = 230 \text{ kJ}\cdot\text{kg}^{-1}$ $c_p' = 1.7 \text{ kJ}\cdot\text{kg}^{-1}\cdot\text{K}^{-1}$ $q'_{rx} = 20 \text{ W}\cdot\text{kg}^{-1}@40^\circ\text{C}$

Decomposition: $Q'_{dc} = 150 \text{ kJ}\cdot\text{kg}^{-1}$ $T_{D24} = 130^\circ\text{C}$

Physical data : Acetone $T_b = 56^\circ\text{C}$ $\Delta H_v = 523 \text{ kJ/kg}$ LIE: 1.6%

Questions:

1. Evaluate the thermal risk linked with the performance of this reaction at industrial scale
2. Determine the criticality class of the reaction
3. Are measures required to cope with the thermal risk?