Buckles and McGrew [J. Am. Chem. Soc. 88, 1966] have studied the dimerization of phenyl isocyanate in liquid solution in the presence of a catalyst.

\[
\begin{align*}
  &\begin{array}{c}
    \text{N} \\
    \text{N}
  \end{array} 
  \quad \begin{array}{c}
    \text{O} \\
    \text{O}
  \end{array} 
  \quad \begin{array}{c}
    \text{N} \\
    \text{N}
  \end{array} 
  \quad \begin{array}{c}
    \text{O} \\
    \text{O}
  \end{array} \\
\end{align*}
\]

The forward reaction is third-order (second-order with respect to monomer and first-order with respect to catalyst). The reverse reaction is second-order overall (first-order with respect to both catalyst and dimer). The reaction is catalyzed by tributylphosphine at a concentration of 0.05 moles/liter. The following data relative to the reaction at 25 C are available:

- \( K_c = 0.178 \)
- \( k_1 = 1.15 \times 10^{-3} \text{ L}^2 / (\text{mol} \cdot \text{s}) \)
- \( E_1 = 1.12 \text{ kcal/mol} \)
- \( E_2 = 11.6 \text{ kcal/mol} \)

If a monomer solution at a concentration of 1 mol/L is fed to a MFR at 0 C, determine the space time necessary to achieve a conversion corresponding to 90% of the equilibrium value. If the reactor volume is 100 L, what is the corresponding volumetric flowrate?