1. In a batch reactor 70% of a liquid reactant is converted in 13 min. What contact time will be needed to obtain this removal efficiency in a plug flow reactor and a completely mixed flow reactor.

2. Given a reaction \( A \rightleftharpoons B \) with \( r_A = -kC_A \), determine the time \((t/t_{HRT})\) to achieve 95% of the steady-state value for a step increase in influent concentration from 0 to \( C_{Ao} \) for (a) a single CMFR and (b) three CMFRs in series. Assume the value of \((k*t_{HRT})\) is 1.8.

3. The concentration of ultimate BOD in a river entering the first of two lakes connected in series is equal to 20 g/m\(^3\). If the first-order BOD rate coefficient \( k \) is 0.35 d\(^{-1}\) and each lake behaves as a CMFR, determine the BOD concentration in the outlet of each lake. The steady-state river flow rate is 4000 m\(^3\)/d and the lake volumes are 20,000 and 12,000 m\(^3\), respectively.

4. A liquid phase reaction:

\[
A \rightleftharpoons R, \quad r_A = kC_A
\]

 takes place with 50% conversion in a CMFR. What will be the conversion if this reactor is extensively baffled to closely approximate plug flow (\( V \) is constant)?