Exercise 17

A novel type of loop reactor is tested by carrying-out a second-order reaction. The reaction is performed in two distinct solvents with significantly different viscosities. The residence time distribution of the loop reactor corresponds closely to the RTD of an ideal CSTR. The energy dissipation rate, the space-time and the first Damköhler number are kept constant for both reaction systems.

Data

$A_1 + A_2 \rightarrow P \qquad r = kc_1c_2$

$DaI = 20 \qquad M = 1$

$\tau = 2\ s \qquad \varepsilon = 0.5\ W\ kg^{-1}$

	Reaction system 1	**Reaction system 2**
Viscosity $(\boldsymbol{Pa \cdot s})$	10^{-3}	$5 \cdot 10^{-2}$
Density $\left(\boldsymbol{kg \cdot m^{-3}}\right)$	1000	1000
Diffusion coefficient $\left(\boldsymbol{m^2 \cdot s^{-1}}\right)$	$5 \cdot 10^{-9}$	$3 \cdot 10^{-10}$

Questions

Calculate the mixing time for both systems using the engulfment model and the shear elongation & diffusion model. Determine which mechanism is controlling. Calculate the conversion of reagent A_1. Find out if the reaction is affected by mixing. If yes, determine the energy dissipation rate required to reach 98% of the conversion that would be reached in an ideally "micromixed" CSTR.