SOLUTION TO PROBLEMS OF NON IDEAL REACTORS 61-78

61. a) Fraction which remains: 0.289 ; b) $\xi_A = 0.917$

62. Segregation model: $\xi_A = 0.606$ ; Maximum mixedness model: $\xi_A = 0.565$

63. a) $t_m = 0.50 \text{ min}$ ; b) $E(t) = \frac{3}{8} (t - 2)^2$, $E(\theta) = \frac{3}{16} (0.5\theta - 2)^2$, $F(t) = \frac{t^3}{8} - \frac{3}{4} t^2 + \frac{3}{2} t$ for $0 \leq t \leq 2$ $(0 \leq \theta \leq 4)$ ; c) $\xi = 0.350$ ; d) Dispersion model: $\frac{D_r}{uL} = 0.586$

64. a) Dispersion model: $\frac{D_r}{uL} = 0.130$ , $\xi = 0.679$ ; b) Tanks-in-series model: $n = 4.4$ tanks, $\xi = 0.676$ ; c) Ideal PFR: $\xi = 0.722$ ; d) Segregation model: $\xi = 0.675$ ; e) Ideal CSTR: $\xi = 0.562$

65. a) Dispersion model: $\frac{D_r}{uL} = 0.393$ , $\xi = 0.929$ ; b) Tanks-in-series model: $n = 2$ tanks, $\xi = 0.908$ ; c) With experimental $E(t)$: $\xi = 0.911$ ; d) Ideal CSTR model: $\xi = 0.821$

66. a) With the new stirrer: $\xi = 0.90$ ; b) Macrofluid: CSTR with dead volume, $\xi = 0.75$ ; CSTR without dead volume, $\xi = 0.90$

67. a) Yes, since calculated $M_0$ is 150 g ; b) Fraction $\epsilon_L = 0.916$ ; c) $E(t) = 2C(t)$ ; d) The liquid is partially recirculated by gas bubbles; e) Macrofluid: $\xi = 0.701$

68. a) $E(t) = 2 \exp(-2t)$, $t_m = 0.50 \text{ h}$ ; b) $F(t) = 1 - \exp(-2t)$, $1-F(1) = 0.135$ ; c) eg with complete segregation: $\xi = 0.332$ ; d) Segregation and maximum mixedness models: $\xi = 0.268$ ; e) Ideal CSTR ($C_{A0} = 0.001 \text{ mol/L}$): $\xi = 0.333$ , Ideal CSTR ($C_{A0} = 1 \text{ mol/L}$): $\xi = 0.268$

69. a) $C_A = 0.661 \text{ mol/L}$ ; b) $C_A = 0.182 \text{ mol/L}$ ; c) $C_A = 0.328 \text{ mol/L}$ ; d) $C_A = 0.473 \text{ mol/L}$ ; e) Ideal CSTR: $C_B = 1.310 \text{ mol/L}$, $R_B = 0.524$, $S_B = 0.713$ ; Ideal PFR: $C_B = 1.833 \text{ mol/L}$, $R_B = 0.733$, $S_B = 0.790$ ; Complete segregation: $C_B = 1.734 \text{ mol/L}$, $R_B = 0.693$, $S_B = 0.798$ ; Maximum mixedness: $C_B = 1.475 \text{ mol/L}$, $R_B = 0.590$, $S_B = 0.728$
70. a) eg for t=6 min (θ =0.7276), E(t) = 0.2407 min$^{-1}$, F(t) = 0.1330, E(θ)= 1.9846, etc.; b) Complete segregation: ξ = 0.696 ; c) Maximum mixedness: ξ = 0.697 (~like b) ; d) eg PFR+CSTR in series (regardless of the order) with dead volume (of 17.5 L), with $\tau_{PFR} = 5$ min, $\tau_{CSTR} = 3.25$ min, ξ = 0.682

71. a) Complete segregation with E(t) laminar PFR: ξ = 0.542 ; b) Complete segregation with E(t) CSTR: ξ = 0.500, and with E(t) PFR: ξ = 0.632 ; c) at high t, F(t) for laminar PFR seems more like F(t) for CSTR

72. Bypass and dead volume model: ξ = 0.517, with $\alpha = 0.702$ and $\beta = 0.188$ (from the slope and intercept); ξ = 0.507, with $\alpha = 0.701$ and $\beta = 0.208$ (minimizing differences between experimental and calculated C)

73. a) Bypass and dead volume model: ξ = 0.580, with $\alpha = 0.795$ and $\beta = 0.117$ (from the slope and intercept); ξ = 0.577, with $\alpha = 0.798$ and $\beta = 0.123$ (minimizing differences between experimental and calculated C) ; b) $E(t) = \frac{(1-\beta)^2}{\alpha \tau} \exp\left(-\frac{1-\beta}{\alpha \tau} t\right)$ ; c) Segregation model: ξ = 0.585

74. Ideal CSTR: equivalent $V' = 2.25$ m$^3$

75. 2 CSTR with interchange: ξ = 0.517, with $\alpha = 0.845$ and $\beta = 0.083$ (from the slopes $m_1$ and $m_2$); ξ = 0.525, with $\alpha = 0.868$ and $\beta = 0.112$ (minimizing differences between experimental and calculated C)

76. a) 1-F(6) = 0.2028 ; b) Tanks in series: ξ = 0.749 ; c) Maximum mixedness: ξ = 0.746

77. a) Ideal CSTR: $C_A/C_{A0} = 0.132$ ; b) Ideal PFR: $C_A/C_{A0} = 0.020$ ; c) Segregation: $C_A/C_{A0} = 0.029$ ; d) Maximum mixedness: $C_A/C_{A0} = 0.057$ ; e) 3 CSTR in series: $C_A/C_{A0} = 0.049$ ; f) plots...

78. a) $F(4) = 0.689$ ; b) $V_m = 1.57$ L ; c) CSTR model with $V_m$: ξ = 0.584 ; d) Segregation model: ξ = 0.634 ; e) Maximum mixedness model: ξ = 0.584 ; f) In this case: $\xi_{seg} > \xi_{mix} = \xi_{CSTR}$