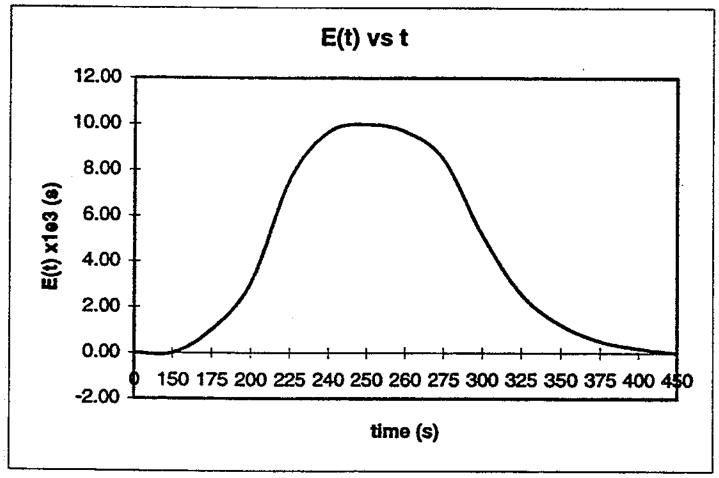
Problem P13-12$_B$(old manual solution)

t	C (x1000)	E(t) (x1000)	F(t)	t.E(t) (x1000)	(t-tm)^2 (x1000)	E(t) (t-tm)^2	1 - (e^-k.t)	(1-(e^-k.t))E(t)	t/(1+k.Co.t)	E(t).X(t)
sec	g/l	sec						(x1000)		
150	0	0	0	0	-	0	0	0	0	0
175	1	1.03		180.25	7.482	7.71	0.866	0.982	134	0.318
200	3	3.08	0.06	616	3.78	11.64	0.9	2.772	148	0.456
210	4.5	4.62		970.2	2.65	12.24	0.91	4.204	153	0.71
220	6.3	6.47		1423.4	1.72	11.13	0.92	5.952	159	1.03
230	8.5	8.74		2010.2	0.99	8.65	0.93	8.128	163	1.43
240	9.4	9.66		2318.4	0.462	4.46	0.94	9.080	169	1.63
250	9.7	9.97		2492.5	0.132	1.32	0.944	9.412	174	1.73
260	9.4	9.66	0.324	2511.6	0.002	0.02	0.95	9.177	178	1.72
270	8.6	8.44	0.422	2278.8	0.072	0.61	0.955	8.060	183	1.62
280	7.6	7.81		2186.8	0.342	2.67	0.96	7.498	188	1.47
290	6.3	6.47	0.768	1876.3	0.812	5.25	0.964	6.237	192	1.24
300	5	5.14	0.826	1542	1.482	7.62	0.968	4.976	196	1.01
325	2.5	2.57		835.25	4.03	10.36	0.976	2.508	207	0.532
350	1.2	1.23	0.976	430.5	7.83	9.63	0.982	1.208	217	0.266
400	0.2	0.21		84	19.18	4.03	0.99	0.208	235	0.049
450	0	0	1	0	-	0	-	0	-	0

Problem P13-12$_B$(old manual solution)

Part (a)

$$\int_0^\infty C(t)dt = 0.973 gm.s/dm^3$$



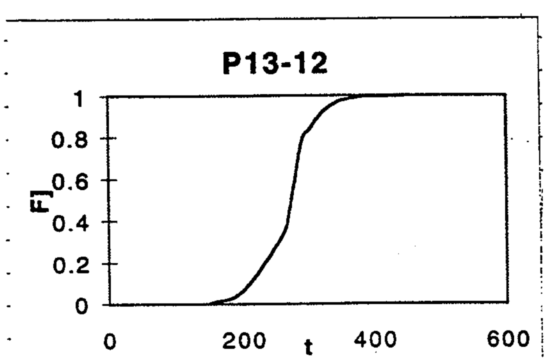
Part (b)

To find the fraction spending between 230 and 270 s, use Simpson's rule for points between 230 and 270 s :

$$\int_{230}^{270} E(t)dt = \frac{10}{3}[8.74 + 4(9.66 + 9.66) + 2(9.97) + 8.84]x10e-3$$

$$\int_{230}^{270} E(t)dt = 0.382$$

Part (c)



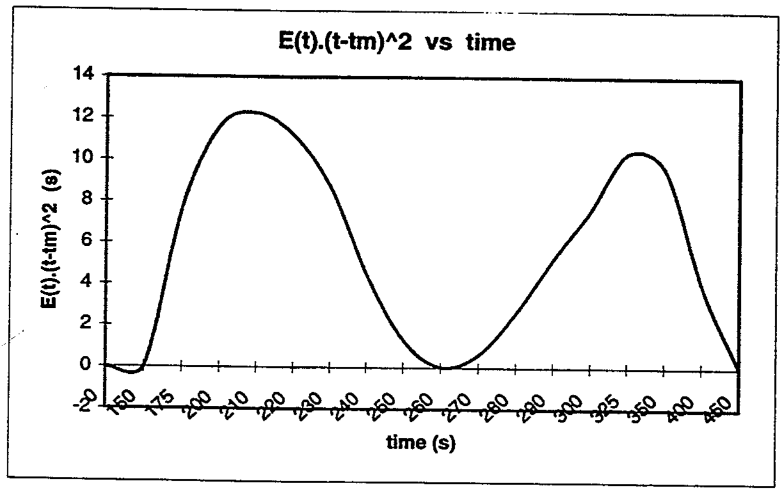
Part (d)

The fraction spending less than 250 s is o.422

Part (e)

Mean residence time $= t_m = \int_0^\infty t.E(t)dt = 273$ s from polynomial fitting

Part (f)



Part (g)

$\sigma^2 = \int_0^\infty (t - t_m)^2 E(t)dt = 1832$ by polynomial fitting

The standard deviation = 42.81 s

Part (h)

The E(t) graph demonstrates good symmetry about the mean time t_m = 260 s. The model suggested the reactor is a plug flow reactor with τ = 250 s.

Part (I)

For segregation model : $\overline{X} = \int_0^\infty X(t)E(t)dt$

P13-12 cont'd

For first order $X(t) = 1 - e^{-k.t}$ with k = 0.0115 /s

Gives xbar = 94.5 %

Part (j)

For second order reaction : $\frac{dC}{dt} = -k.C^2 \Rightarrow -\frac{1}{C} + \frac{1}{Co} = -k.t$

$$\frac{1}{C} = \frac{1}{Co} + k.t$$

$$C = \frac{Co}{1 + k.Co.t}$$

$$1 - X = \frac{1}{1 + k.Co.t}$$

$$X = \frac{k.Co.t}{1 + k.Co.t}$$

$$\overline{X} = k.Co \int_0^{\infty} \frac{t}{1 + k.Co.t} E(t)$$

where $Co = 0.01$ mol/dm^3 $k = 10.55/60 = 0.1758$ mol/dm^{3}s

gives xbar = 0.313

Problem P13-13$_B$

The elementary gas phase reaction : $A + B \rightarrow C$ in a CSTR

$F_C = 20$ kg/s ; $V_O = 1$ m^3 ; $C_{AO} = 0.4$ mol/dm^3 ; $\upsilon_O = 10$ dm^3/s ;

$k_d = 0.06$ /s ; $k = 0.03$ dm^6/mol.s.g ; $\tau_c = 200/20 = 10$ s

Second order decay : $\frac{da}{dt} = -k_d.a^2 \Rightarrow a = \frac{1}{1 + k_d.t}$