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17/ENG01/021

CHEMICAL ENGINEERING

(a) Mathematical Modelling can be defined as the mathematical representation of a system and simulation of a system involving the model and obtaining its mathematical solution.

(b) By the use of balance law
By differential equation
By use of newtons law of cooling.

(c) $\frac{dT}{dt} \propto (T - T_A)$

$\frac{dT}{dt} = k(T - T_A)$

$\frac{1}{T - T_A} dT = k\,dt$

$\ln(T - T_A) = kt + c$

$T - T_A = e^{kt + c}$

$T - T_A = e^{kt} \cdot e^{c}$

$T - T_A = T_0 e^{kt}$

@ $t = 0$ $T_A = 25$

$T - T_A = T_0$

$T - 25 = T_0$

$10 - 25 = T_0$

$\therefore T_0 = -15$

$T - 25 = -15e^{kt}$

$T = 25 - 15e^{kt}$

@ $t = 5\text{min}$, $T = 20$

$20 - 25 = -15e^{k(5)}$

$-5 = -15e^{5k}$

$e^{5k} = \frac{-5}{-15} = \frac{1}{3}$

$5K = \ln(1/3)$

$k = \ln(1/3)/5$

$k = -0.22$

$T = 25 - 15e^{-0.22t}$

① MATLAB

» Command window

clc

Clear

T = 25 - (15 * exp * (-0.22 * t))

t = 0:0.5:50

Tn = subs(T)

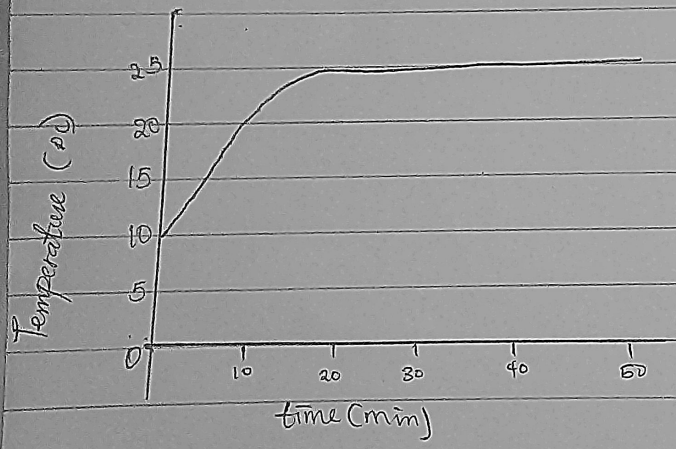
Plot (t, Tn)

grid on

grid minor

xlabel ('time(min)')

Ylabel ('Temperature(°C)')



② the steady-state of the system is 25°C.

③ The system was steady after 20min

④ at $T = 24.9°C$

$T = 25 - 15e^{-0.22t}$

~~25~~ $24.9 - 25 = -15e^{-0.22(t)}$

$\frac{-0.1}{-15} = e^{-0.22t}$

$e^{-0.22t} = 0.0067$

$-0.22t = \ln(0.0067)$

$t = \dfrac{\ln(0.0067)}{-0.22}$

$t = 22.76 \text{ mins}$

~~$t = 22.46 \text{ seconds}$~~

$t =$ 22 min, 46 seconds.