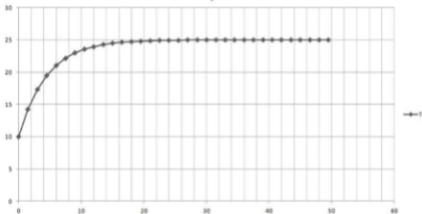


T



O200000 August 18

Engo lab 7

Chemical Eng

modelling is the mathematical representation and simulation of a system which involves solving the model and obtaining output variable for different value of input variables

Methods of obtaining models are

Differentiating
Balance law
analysis

iii) from Newton's law of cooling

$$\frac{dT}{dt} = k(T - T_0)$$

$$\frac{1}{T - T_0} dT = k dt$$

$$\ln(T - T_0) = kt + C$$

$$T - T_0 = e^{kt+C} = e^{kt} \cdot e^C = C_1 e^{kt}$$

$$T - T_0 = C_1 e^{kt}$$

$$T = T_0 + C_1 e^{kt} \text{ (model)}$$

$$\text{At } t=0, T=10, T_0=25$$

$$10 - 25 = C_1 \cdot e^{k \cdot 0}$$

$$-15 = C_1$$

$$\text{At } t=5, T=20, T_0=25$$

$$20 - 25 = -15 \cdot e^{k \cdot 5}$$

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

$$0.33 = e^{k \cdot 5}$$

$$\ln(0.33) = k \cdot 5$$

$$k = \frac{\ln(0.33)}{5} = -0.222$$

$$\text{Model } 2 \quad T - T_0 = 25 - 15 e^{-0.222t}$$

$$T = 25 - 15 e^{-0.222t}$$

i) Microsoft excel

$$t = 0 \rightarrow 50 \quad \Delta t = 10$$

$$T = 25 - 15 (\exp(-0.222 \cdot t))$$

ii) Matlab

Command window

clear

clc

close all

Syms t

$$t = 0:0.5:50$$

$$T = 25 - 15 (\exp(-0.222 \cdot t))$$

$$T_n = \text{subs } T$$

plot(t, T_n)

x label ('Time (min)')

y label ('Temperature')

axis tight

grid on

grid minor

iv) steady state temperature = 25°C

v) The system is not stable as the product changes with time

$$v) T = 24.9$$

$$24.9 - 25 = -15 e^{-0.222t}$$

$$24.9 - 25 = -15 e^{-0.222t}$$

$$\frac{-0.1}{-15} = e^{-0.222t}$$

$$-15$$

$$\ln\left(\frac{-0.1}{-15}\right) = -0.222t$$

$$t = \frac{-5.011}{-0.222}$$

$$t = 22.57 \approx 23 \text{ minutes}$$

