AGOAOIRU ROSEMARY ONYINYECHI
17/ENG01/003
CHEMICAL ENGINEERING
MATHS

It is discovered that 600ft³/min of fresh air flows into room 20000ft³ of air. The mixture which is mixs practically uniform by is exhausted at 0s rate of 6 [illegible]
If the room contains no fresh air initially

(a) develop a model for the amount of fresh air in the room at any time t

b) calculate time at which 90% of the air in the room will become fresh

c) with the aid of matlab plot the dynamic response of the amount of fresh air intake for t=0 to t=6hrs with step time of 5min

SOLUTION

let y(t) be the amount of air at any time t in ft³ within room

$$\frac{dy}{dt} = \text{fresh air inflow rate} - \text{fresh air outflow rate}$$

fresh air inflow = 600ft³/min

fresh air outflow NB: The amount flowing out of the room is a function of the amount in room

Hence $\frac{600}{20000} = 0.03\text{min}$

∴ 0.03 of y(t) is the outflow = 0.03ft³/min

now,

$$\frac{dy}{dt} = 600 - 0.03y$$

$$= -0.03y + 600$$

$$dy/dt = 0.03(y - 20000)$$

This can be simplified as

$$\frac{dy}{(y-2000)} = -0.03dt$$

$\ln(y-20000) = -0.03t + c$

$y - 20000 = e^{-0.03t + c}$

$y - 20000 = e^{-0.03t} + e^{c}$

let $e^{c} = y_0$

$y - 20000 = e^{-0.03t} \cdot y_0$

$y - 20000 = y_0 e^{-0.03t}$ ---- (1)

At $t = 0$, $y(t) = 0$ as the room contained no fresh air initially

Hence eqn (1) becomes

$y - 20000 = e^{-0.03t} \cdot y_0$

$0 - 20000 = e^{0} \cdot y_0$

$y_0 = 20000$

Hence the $y_0 = 20,000$ into eqn (i)

$y = 20,000(1 - e^{-0.03t})$

$\boxed{y = 20000(1 - e^{-0.03t})}$ - Model for the amount of fresh air

(b) ~~Calculate t~~

$90\% = 90/100 = 0.9$

$y = 0.9 \times 20,000$

$= 18,000 \, ft^3$

$y = 20000(1 - e^{-0.03t})$

$\therefore 18000 = 20000(1 - e^{-0.03t})$

$e^{-0.03t} = 1 - 0.9$

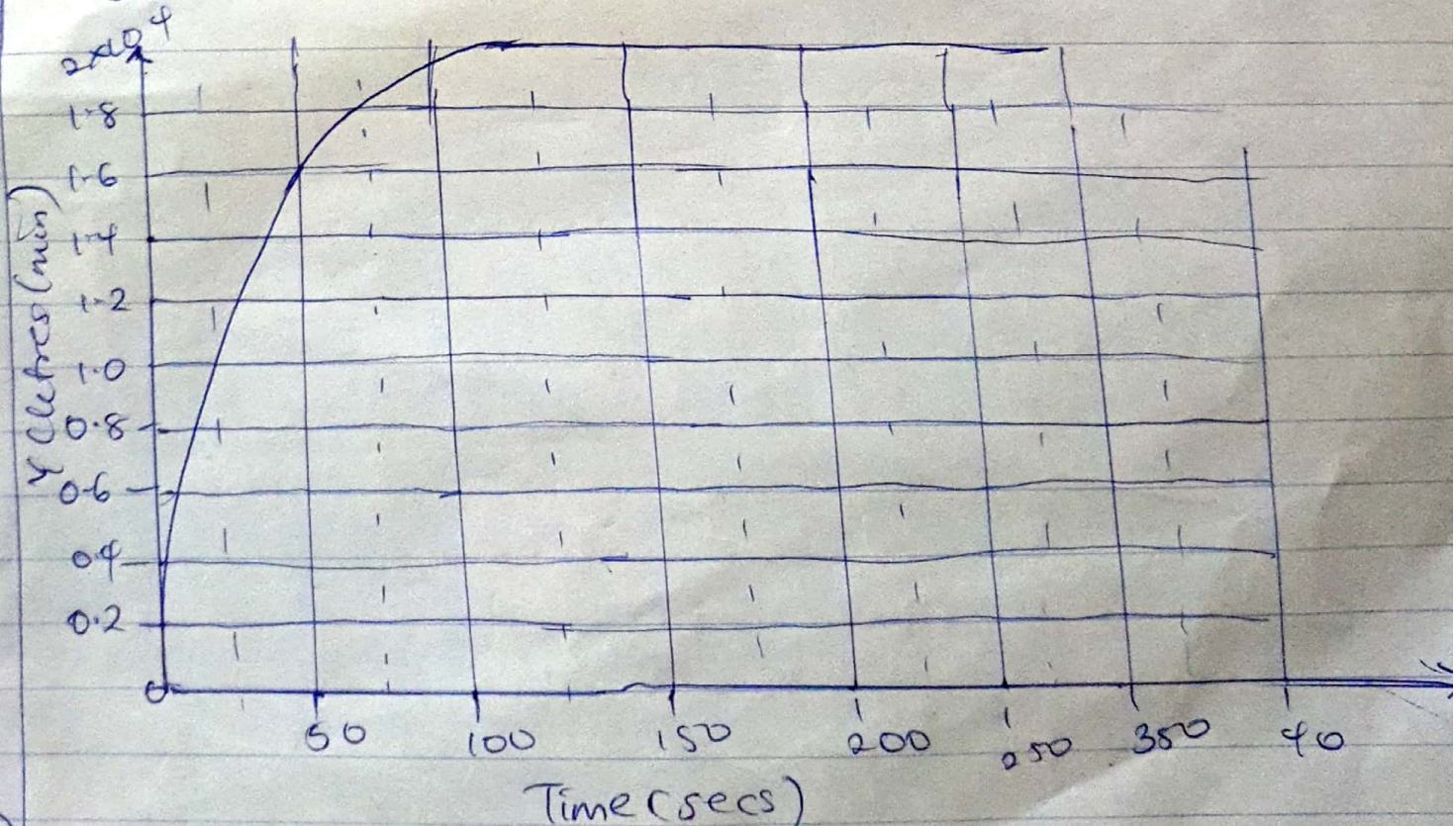
$e^{-0.03t} = 0.1$

$\frac{-0.03t}{-0.03} = \frac{\ln(0.1)}{-0.03}$

e-7[illegible]·77 min

(c) t = 6hrs
= 6x60s
= 360mins,,

MATLAB n-file
commandcoindow
clear
clc
close all
t=0:5:360
y=2000*(1-exp(-0.03*t))
yn=subs(y)
plot(t, yn)
grid on
grid minor
xlabel('Time(secs)')
ylabel('Clutres(min)')



(d) Steady value = 20000