ASSIGNMENT IV

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17/ENG03/037

SOLUTION

a) Let y(t) be the amount of air time t in the room

$\frac{dy}{dt}$ air inflow rate - fresh air over flow rate

fresh air flow = $600 ft^3/min$

fresh air outflow = $\frac{600}{20000}$ = 0.03min

i.e 0.03 of y(t) is the outflow = $0.03y ft^3$

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

$= 0.03y + 600$

factorize

$= -0.03(y - 20000)$

Solve by seperating variables

$\frac{dy}{y-20000} = 0.03dt$

Integrate both sides

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

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

$y - 20000 = e^{-0.03t} e^{C}$

Recall $C = e^{0}$

$y - 20000 = e^{-0.03t} C$

At t = 0, y(t) = 0

$y - 20000 = Ce^{-0.03t}$

$0 - 20000 = C$

$C = -20000$

Substitute ② into ①

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

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

$\therefore y = 2000(1 - e^{-0.03t})$

The equation above is the model for the amount of fresh air in the room

b) $90\% = \frac{90}{100} = 0.9$

$y = 0.9 \times 2000$

$= 18000 ft^3$

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

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

$e^{-0.03t} = 0.1$

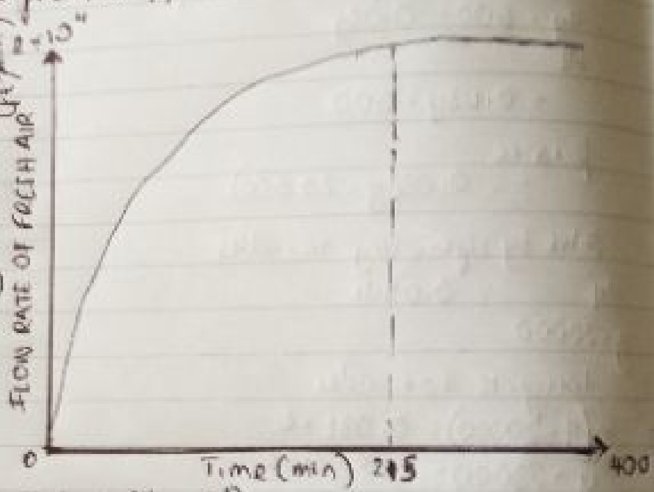
$-0.03t = \ln(0.1)$

$t = \frac{\ln(0.1)}{-0.03} = 76.75 \simeq 77 mins$

∴ The air in the room will be 90% fresh at 77mins

c) command window

```
clear all
clc
close all
syms Y, t, k
Y= 20000*(1- exp(0.03*t))
t = 0:5:360
Yn = subs(Y)
Plot (t, Yn)
x Label ('Time (mins)')
y Label ('FLOWRATE OF FRESH AIR (ft^3/min)')
grid on
grid minor
```



d) Steady state value is $20000 ft^3/min$ @ 215min of exponential approach

e) The function shows an exponential approach to the limit of $20000 ft^3$ of y increases with time. Also when the steady state value approaches $20000 ft^3$ at 215 mins and continues till 360 mins (1hr). The model discussed becomes more realistic in pneumatic tech, Although maybe difficult because mixing may be imperfect