CHINEDUM PRUDENCE ESE
CHEMICAL ENGINEERING
17/ENG01607

It is discovered that 600ft³/min of fresh air flows into a room containing 2000ft³ of air. The mixture, which is made practically uniform by circulating fans, is exhausted at a rate of 600 cubic feet per minute.

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) Calc. the 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 in the room for t = 0 to t = 6hr. using a step time of 5mn.

d) determine the steady state value of the amount of fresh air in the room and

e) Comment on the result obtained in (d)

Solutions.

a) let y be the amount of air at time t in (ft³) in the room $\frac{dy}{dt}$ = Inflow rate fresh air outflow rate.

fresh air ~~inflow~~ inflow → 100ft³/mn

fresh Air Outflow = 600

2000 = 0.03 min

∴ The amount flowing out of the room is a function of the amount in the room.

$= 0.03y\ ft^3/min.$

$\frac{dy}{dt} = 600 - 0.03y = -0.03y + 600 = -0.03(y - 20000)$

Equation can be resolved as

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

$\frac{dy}{y - 20000} = -0.03dt \quad \ln(y - 20000) = -0.03t + C$

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

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

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

$e^{C} = .$

At $t = 0, y(t) = 0$ Since no fresh air was contained in the room initially.

$y - 20000 = (e^{-0.03(0)}$

$0 - 20000 = C$

$C = -20000$

Substituting $C = -20000$

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

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

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

This is the model for the amount of fresh air in the room

1).) Calculate the time at when 90% of the air in the room will become fresh.

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

$y = 0.9$ of 20000

$0.9 \times 20000 = 18000 ft^3$

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

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

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

$e^{-0.03t} = 1 - 0.9 = 0.1$

$-0.03t = \ln(0.1)$

$t = \frac{-2.3026}{-0.03}$

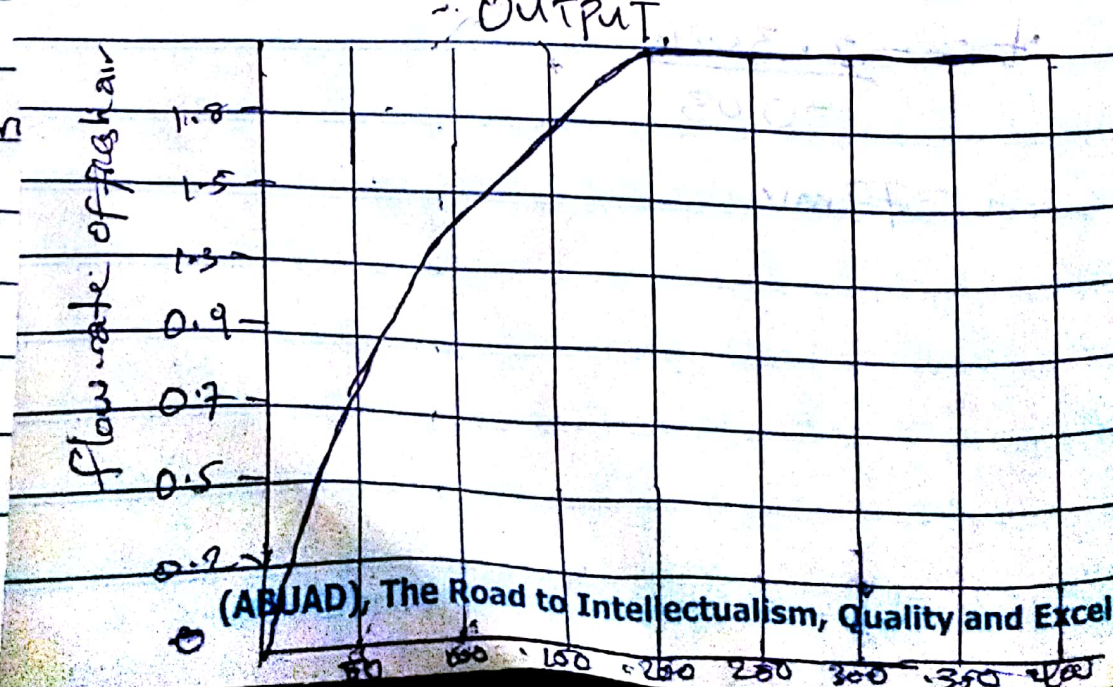
$t = 77 min.$

e) ~~Plotting the dynamic~~

CODE

```
*Command window
* Clear
* Cle
* Closeall
* Symst
* y=20000*(1-exp(-0.03*t))
* t=0:5:360
* yn=Subs(y)
* plot(t,yn)
* x label('Time(min)')
* y label('flowrate of freshair')
* grid on
* grid minor
* axis tight
```

OUTPUT



d.) The steady state value is 20000ft^3 of 215min of the exponential approach

e). The steady state value proves the function which shows the exponential growth of limit of 20000 ft^3 as y increases with time.