Tanarami Kelukworitsola Adriel
17/ENG05/038
Mechatronics Engineering

Let Y be the amount of air at time t in (ft^3) in the room:

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

Fresh Air Inflow → 100ft^3/min
Fresh Air Outflow → $\frac{600}{2000} = 0.03$min

The amount flowing out of the room is a function of the amount in the room = 0.03y ft^3/min

$$dy/dt = 600 - 0.03y$$
$$= -0.03y + 600$$
$$= -0.03(Y - 20000)$$

Equation can be resolved as

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

$$\ln(Y - 20000) = -0.03t + c$$
$$Y - 20000 = e^{-0.03t + c}$$
$$Y - 20000 = e^{-0.03t} \cdot e^{c}$$

$$Y - 20000 = e^{-0.03t} \cdot C$$

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

$$Y - 20000 = Ce^{-0.03(0)}$$

$$0 - 20000 = C$$

$$C = -20000$$

Subst. $C = -20000$

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

$$Y = (e^{-0.03t} \cdot -20000) + 20000$$

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

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

The equation above is the model for the amount of fresh air in the room at any time t.

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

$$Y = 0.9 \times 20000$$

$$= 18000 ft^3$$

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

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

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

$$-0.03t = \ln 0.1$$

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

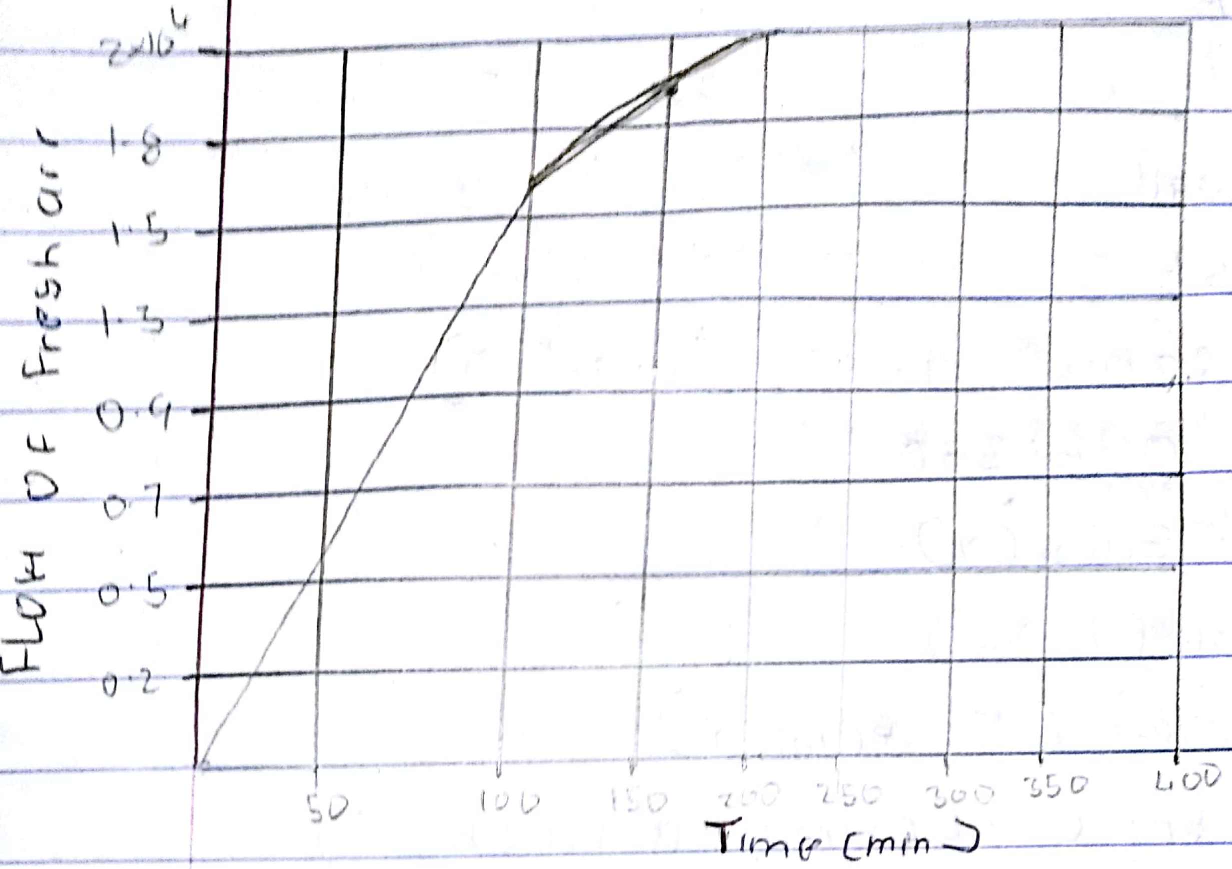
$= 77 mins$

with the aid of Matlab

C. Commandwindow

```
Clear
Clc
Closeall
Syms t
Y = 20000*(1-exp(-0.03*t))
t = 0:5:360
Yn = Subs(Y)
Plot(t, Yn)
xLabel('Time(mins)')
YLabel('Flowrate of Fresh air')
grid on
grid minor
axis tight
```

Output



d. The steady state value is 20 000Ft at 215 mm of the experimental approach.

e. The function shows an exponential growth approach to the limit of 20000Ft^3 as Y increase with time and the steady value was 20000Ft^3 at 215mm. It worked for 6hours.