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Solution

a) Let $y(t)$ be the amount of air fine of in (ft^3) in the room.

fresh air inflow → $600 ft^3/min$

fresh air outflow → Remember the amount flowing out of the room is a function of the

$$\frac{600}{20000} = 0.03 mm$$

∴ 0.03mm in the fresh air inflow

$$dy/dx = 600 - 0.03y$$

$$= -0.03y - 1600$$

$$= -0.03(y - 20000)$$

The equation can therefore be solved

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

integrating both sides.

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

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

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

Recall that $C = e^0$

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

$$0 - 20000 = C$$

$$C = -20000$$

$$y = 20000 - 20000e^{-0.05t}$$

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

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

b) $70\% = \frac{7y}{10y} = 0.7$

$$y = 0.7 \text{ of } 20000$$

$$= 0.7 \times 20000$$

$$= 18000 ft^3$$

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

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

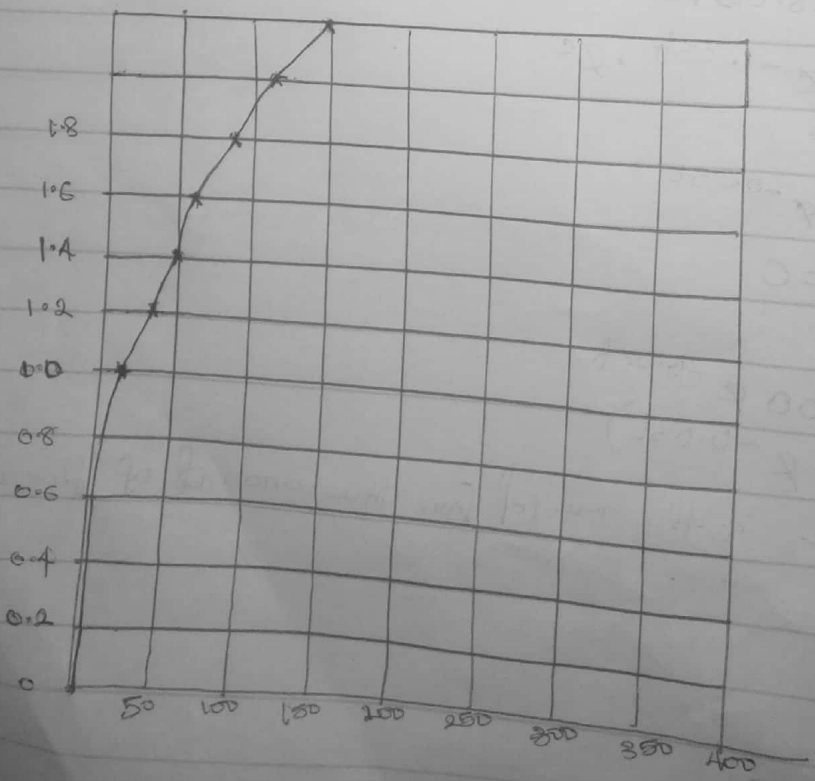
$= -0.03t = \ln(0.1)$

$= t = 77$ minutes

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

b) Command window.

```
clear
clc
close all
syms y, x, t
y = 20000 * (1 - exp(-0.03 * t))
t = 0.5:360
yn = subs(y)
plot(t, yn)
xlabel('Time (mins)')
ylabel('flow rate of fresh air (ft^3/min)')
grid on
grid minor
```



4) The steady value is 2000 ft³/min at 215 minutes of exponential approach

5) It shows that the limit of 2000 ft³ of y increase with time. Also when the steady state value approaches 2000 ft³ at 215 mins and continues till 360 minutes (1 hour). The mode discussed becomes more realistic in pneumatic technology although may be because mixing problem may be imperfect.