

16/ENG03/020

CIVIL ENGINEERING

ENG 282

VODINA EFEM  
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ENG 282.

Initial air = 20 000 ft<sup>3</sup>  
Input of air = 600 ft<sup>3</sup>/min  
In flow rate = 600 cfm

Rate of accumulation in the system = rate of  
inflow - rate of outflow.

Let  $y(t)$  = the amount of air at time  $t$ .

$\frac{dy}{dt}$  = amount of material of  $y$

rate of flow =  $y'$

$$\frac{dy}{dt} = y'_{in} - y'_{out}$$

The outflow rate =  $\frac{600}{20\ 000} = 0.03$ .

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

$$\frac{dy}{dt} = -0.03(y - 20\ 000)$$

$$\frac{dy}{(y - 20\ 000)} = -0.03 dt$$

$$\int \frac{dy}{(y - 20\ 000)} = \int -0.03 dt$$

$$\ln(y - 20\ 000) = -0.03t$$

Divide through by  $\ln$

$$y - 20\ 000 = e^{-0.03t + C}$$

$$y - 20\ 000 = e^{-0.03t} \cdot e^C$$

$$\text{Let } e^C = y_0 \cdot e^{-0.03t}$$

$$y - 20\ 000 = y_0 \cdot e^{-0.03t}$$

$$y = 20\ 000 + y_0 e^{-0.03t}$$

Sign: ~~Steady state~~

Calculating for  $y_0$  if  $t=0$   
 $0 = 20000 + y_0 e^{-0.03(0)}$   
 $0 = 20000 + y_0$

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

b) Time taken for which 90% of air in room will become fresh

Initial air =  $20000t^3$

90% of  $20000$

$\frac{90}{100} \times 20000 = 18000$

$18000 = 20000 - 20000e^{-0.03t}$

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

$\frac{-20000}{-20000} = e^{-0.03t}$

$0.1 = e^{-0.03t}$

$\ln(0.1) = -0.03t$

$-2.30 = -0.03t$

$t = 76.6 \text{ mins}$

c) See graph

d) The steady-state value is  $20000$

e) It was observed that the difference in the value of  $y$  was not much, on increase in time ( $t$ ),  $\ln$  to  $\ln$  increase in  $y$ . When the graph was plotted, at a certain point there was no progression which is a steady state.

