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ENG 282
Petroleum Engineering

2, $F_A(t)$ – amount of fresh air in the room at time t
Using Balance Law;

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

input of fresh air $= 600 ft^3/min$
initial fresh air rate $= 0 = F_1$
output mixture $= 600 ft^3/min$
Fresh Air and Normal Air mixture $= 20{,}000 ft^3/min$

$$= \frac{dF_A}{dt} = 600 - \frac{600}{20{,}000} F_A$$

$$= \frac{dF_A}{dt} = -0.03(F_A - 20{,}000)$$

ii, $\frac{dF_A}{dt} = -0.03(F_A - 20{,}000)$

$$\frac{dF_A}{F_A - 20000} = -0.03 dt$$

integrate both sides

$$F_A - 20{,}000 = c \cdot e^{-0.03t}$$

where $e^c = c$

$$F_A = 20000 + ce^{-0.03t}$$

F_A = general solution

Recall

$$F_A = 20{,}000 + ce^{-0.03t}$$

when $t = 0$, $F_A = 0$

$$0 = 20{,}000 + ce^{-(0.03)(0)}$$

$$c = -20{,}000$$

putting c into general solution

$$F_A = 20{,}000 - 20{,}000 e^{-0.03t}$$

$F_A(t)$ = particular solution

b. The time at which 90% of the air in the room will become fresh is

$90\% = \frac{90}{100} \times 20{,}000 = 20{,}000e^{-0.03t}$

$= 18000 = 20000 - 20{,}000e^{-0.03t}$

$18000 - 20{,}000 = -20{,}000e^{-0.03t}$

$-2000 = -20{,}000e^{-0.03t}$

$0.1 = 1 \cdot e^{-0.03t}$

take ln

$\ln 0.1 = -0.03t$

$-2.3026 = -0.03t$

$t = 76.75$ min   from $\cdot 60 \times 0.75 = 45$ secs

$t = 76$ mins, 45 secs

c. 6 hours = 360 minutes

d. The steady-state value of the fresh amount of air in the room gives = 20,000 ft^3 of air

e. Its a straight line graph and the amount of fresh air in the room does not change even with the exponent of increase in time. The fresh air is at steady state