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DEPT: CIVIL ENG

LVEL: 200

1a Let $y(t)$ denote the amount of fresh air at time t.

Input = Output + Accumulation

∴ Accumulation = Input - Output

Change in tank = Inflow - Outflow

Change in tank = Inflow rate - Outflow rate

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

Inflow rate = $600 ft^3/min$

Outflow rate = $\frac{600}{20000}$ of $y = 0.03y$

$$y' = 600 - 0.03y$$

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

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

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

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

$$\int \frac{1}{y - 20000} dy = \int -0.03dt$$

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

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

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

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

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

$y(t) = 0$ at $t = 0$ min

$\therefore \quad 0 = Ce^{-0.03 \times 0} + 20000$

$0 = Ce^{0} + 20000$

$0 = C + 20000$

$C = -20000$

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

1b at $y =$ 90% of room

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

$y = 18000$

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

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

$-2000 = -20000e^{-0.03t}$

$0.1 = e^{-0.03t}$

$e^{-0.03t} = 0.1$

$-0.03t = \ln(0.1)$

$-0.03t = -2.3026$

$t = 76.75$ mins

1 min = 60s

0.75 mins = 60×0.75

$= 45$s

$\therefore \quad t =$ 76 mins 45 seconds

1d The steady-state value for the amount of fresh air in the room is 20000 ft^3.

1e Steady-state value of fresh air in the room is 20 000 ft^3. This is because there was no change in the amount of fresh air with change in time. This was represented by a straight line on the graph.

2e .