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Course: ENG 282
Dept: Chemical Engineering
Matric No: 17/ENG01/035

1. Initial air = $20000 ft^3$

Input of air = $600 ft^3/min$

~~Rate =~~ out flow rate = 600 cfm

Balance law → rate of accumulation in the system = rate of inflow − rate of outflow.

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

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

rate of flow = y'

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

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

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

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

$dy/dt = -0.03(y - 20000)$

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

$\int \frac{1}{(y-20000)} = \int -0.03\,dt$

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

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

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

let $e^{c} = y_0$

$y - 20000 = y_0 e^{-0.03t}$

$y = 20000 + y_0 e^{-0.03t}$

calculating for y_0, If $t = 0$

$0 = 20\,000 + y_0 e^{-0.03(0)}$

$0 = 20\,000 + y_0$

$y_0 = -20\,000$

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

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

Initial air = 20,000

$\frac{90}{100} \times 20,000 = 18000$

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

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

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

$0.1 = e^{-0.03t}$

$\ln 0.1 = -0.03t$

$-2.30 = -0.03t$

$76.6 = t$

$t = 77$ min

d. The steady state value is 20000

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