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Dept: PETROLEUM ENGINEERING
Course: ENG 282

Assignment 2

It is discovered that 600ft³/min of fresh air flows into a room containing 20000ft³ of air. The mixture which is made practically uniform by circulating fans, is exhausted at a rate of 600 cubic feet per minute (cfm). If the room contains no fresh air initially

(a) Develop a model for the amount of fresh air at any time t in the room

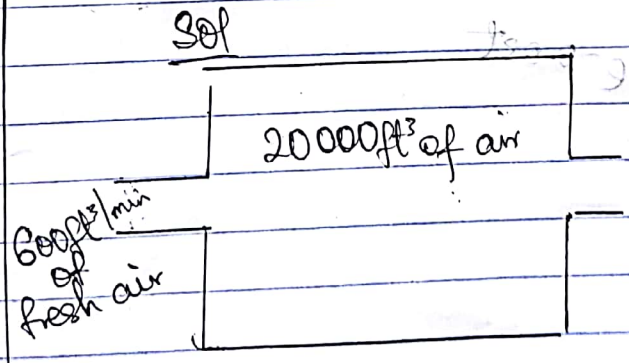
(b) Calculate the time at which 90% of the air at any ~~time~~ t in the room will have become fresh

(c) With the aid of Microsoft Excel, plot the dynamic response of the amount of fresh air in the room for t = 0 to t = 8hr using a step time of 5 min. The response (graph) should be made to occupy an entire sheet alone

(d) Using the dynamic response, plotted in (c) determine the steady state value of amount of fresh air in the room

(e) Comment on the result obtained in d

2a)



From Balance law

Rate of Accumulation = Rate of Inflow − Rate of Outflow
of any material of material of material

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

from: $600 \times \frac{1}{20000} = 0.03$

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

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

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

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

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

$$y - 20{,}000 = Y_0 e^{-0.03t}$$

$$y = 20000 + Y_0 e^{-0.03t}$$

At time $t = 0$ there was no fresh air $y = 0$

At $t = 0$, $y = 0$

$$0 = 20000 + Y_0 e^{-0.03(0)}$$

$$0 = 20000 + Y_0$$

$$Y_0 = -20000$$

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

b) 90% of $20000 ft^3$

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

$$y = 18000 ft^3$$

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

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

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

$$\ln\left(\frac{-2000}{-20,000}\right) = -0.03t$$

$$-2.3026 = -0.03t$$

$$t = \frac{-2.3026}{-0.03}$$

$$t = 76.7533 \text{ min}$$

(d) The steady state value is $20,000 ft^3$

(e) The result in (d) is stated that fresh air amount received an exponential growth until it was steady at $20000 ft^3$