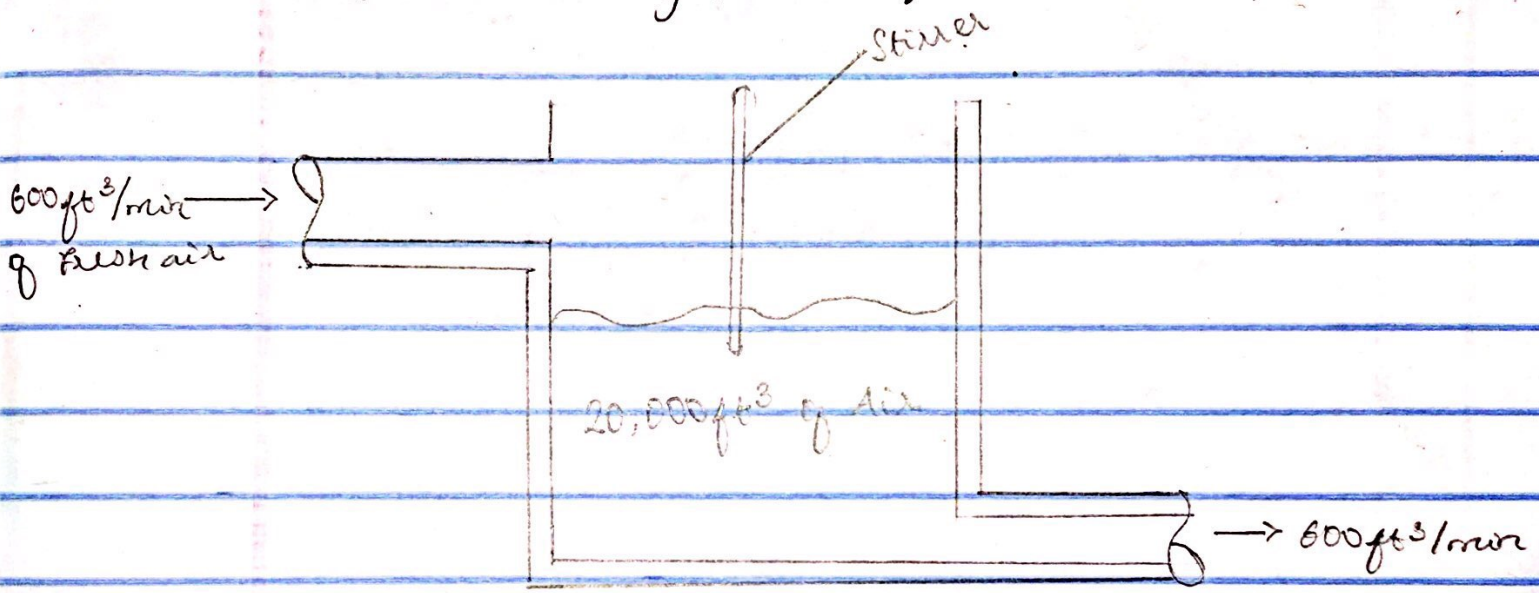
KAYODE MUINAT ADEBUKOLA

17/SCI14/016

Chemical Engineering

ENG 282 Assignment 4




Initially, no fresh air = 0ft³ of air

Let y(t) be the amount of fresh air present

or ft³

$\frac{dy}{dt}$ = Air in - Air out

Air in = 600ft³/min

Air out = $\frac{y}{20000} \times 600$ ft³/min

Air out = 0.03y ft³/min

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

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

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

$$\frac{1}{(y - 20{,}000)}\, dy = -0.03\, dt$$

Integrating

$$\int \frac{1}{(y - 20{,}000)}\, dy = \int -0.03\, dt$$

$$\ln(y - 20{,}000) = -0.03t + c$$

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

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

where $e^{c} = y_0$

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

@ critical point, $y = 0$ & $t = 0$

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

$$\therefore y_0 = -20{,}000$$

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

b) When will 90% of air will become fresh

$$\Rightarrow y = \frac{90}{100} \times 20000 = 18,000$$

$$\Rightarrow 18,000 - 20000 = -20000\, e^{-0.03t}$$

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

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

$$e^{-0.03t} = 0.1$$

$$-0.03t = \ln 0.1$$

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

$$t = 76.75 \approx 77 \text{ minutes.}$$

```
C Command window
clear
clc
close all
t = 0:50:360
y = 20,000 - 20,000 * exp(-0.03 * t)
plot(t, y)
xlabel('time (min)')
ylabel('amount (ft^3)')
grid on
grid minor
axis tight
```