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Petroleum Engineering
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1. Soln
let y represent fresh air

Rate of Accumulator = rate of inflow - rate of outflow

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

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

rate of inflow = $100 ft^3/min$

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

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

$$\ln(y-2000) = -0.03t + C$$

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

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

If the room contained no fresh air y = 0, t = 0

$$0 = 2000 + y_0$$

$$y_0 = -20,000$$

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

$$y = 20000(1 - e^{-0.03t})$$

This is the model for the amount air at any time t

b) Room contains $20000ft^3$ of air 90% of 20000

$= 18000 ft^3/min$

From the model

$$y = 20000(1 - e^{-0.03t})$$

$$18000 = 20000\left(1 - e^{-0.03t}\right)$$

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

$$-0.03t = \ln(0.1)$$

$$-0.03t = -2.303$$

$$t = \frac{2.303}{0.03}$$

$$= 76.77\text{min}.$$

d From the dynamic response plotted the Steady-State value of the amount of fresh air in the room is 20,000ft^3 of air

e It was noticed that the value of amount of fresh air Steadily increases until it got to 20,000ft^3 of air despite the increase in time the amount of fresh air remained 20,000ft^3 giving the steady-state value in Conclusion, 20,000ft^3 of air is the maximum air for the room