let y represent fresh air

rate of accumulator = rate of in flow − rate of outflow

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

rate of income = $600\ ft^3/min$

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

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

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

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

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

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

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

If the room contained no fresh air

$y = 0$, $t = 0$

$$0 = 20000 + y$$

$$y_0 = -20000$$

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

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

This is the model for the amount of oil at any time t.

b. room contains 20000 ft³ of oil

90% of 20000

= 18000 ft³/min

from the model:

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

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

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

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

$-0.03t = \ln 0.1$

$-0.03t = -2.303$

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

$t = 76.77$ min

c. Shows the equilibrium between

60 minutes = 1 hour

x = 6

6 × 60 = x × 1

x = 360 minute

d. The steady state value of the fresh amount of air in the room equals 20000 ft³ of air.

e The graph gave a straight line which entails that the steady rate value of the amount of fresh air in the room does not change even with the expense of increase in time