Method for finding Flow Rate for compressing gass into a fixed volume

$mass_{dot.in} = mass_{dot.out}$ Anything with .dot in the name is wrt time

$V_{dot} \cdot \rho = \frac{d}{dt}(V\rho)$ where V (volume) and ρ (density)

$V_{dot} \cdot \rho = V \cdot \left(\frac{d}{dt}\rho\right) + \rho \cdot \left(\frac{d}{dt}V\right)$

$V_{dot} \cdot \rho = V \cdot \left(\frac{d}{dt}\rho\right)$ since $\left(\frac{d}{dt}V\right) = 0$ Volume does not change

$V_{dot} \cdot \left(\frac{M \cdot P}{R \cdot T}\right) = V \cdot \left(\frac{M}{R \cdot T}\right)$ since $\left(\rho = \frac{M \cdot P}{R \cdot T}\right) \text{and} \cdot \left[\frac{d}{dt}(\rho) = \frac{M}{R \cdot T}\right], \text{and} \cdot \left(\frac{d}{dt}P\right) = V_{dot} \cdot \frac{P}{V}$

$\frac{V_{dot}}{V} \cdot \int_{t_o}^{t} 1 \, dt = \int_{P_o}^{P} \frac{1}{P} \, dP$ rearrange and integrate

$\frac{V_{dot} \cdot t}{V} = \ln\left(\frac{P}{P_o}\right)$ answer

$V_{dot} = \frac{V \cdot \ln\left(\frac{P}{P_o}\right)}{t}$ after rearranging terms, flow rate in terms of time