left tank

$$\frac{P_{Lf}}{P_2} = \left(\frac{\rho_{Lf}}{\rho_2}\right)^r$$

right tank

$$\frac{P_{Rf}}{P_a} = \left(\frac{\rho_{Rf}}{\rho_a}\right)^r$$

have equilibrium when $P_{Lf} = P_{Rf}$

$$P_2 \left(\frac{\rho_{Lf}}{\rho_2}\right)^r = P_a \left(\frac{\rho_{Rf}}{\rho_a}\right)^r$$

$$\Rightarrow \left(\frac{P_2}{P_a}\right)^{1/r} \frac{\rho_{Lf}}{\rho_2} = \frac{\rho_{Rf}}{\rho_a}$$

but

$$\rho_2 = \rho_a \frac{P_2}{P_a}$$

$$\Rightarrow \left(\frac{P_2}{P_a}\right)^{1/r} \frac{\rho_{Lf}}{\rho_a} \left(\frac{P_2}{P_a}\right)^{-1} = \frac{\rho_{Rf}}{\rho_a}$$

$$\rho_{Lf} \left(\frac{P_2}{P_a}\right)^{\frac{1}{r}-1} = \rho_{Rf}$$

Also have to satisfy mass conservation

initial state

$$m_{Li} = \rho_2 V \quad m_{Ri} = \rho_a V$$