$$\boldsymbol{v = \frac{l_A}{V}}$$

$$\frac{\mathrm{d}\boldsymbol{V}}{\mathrm{d}\boldsymbol{t}} = \frac{\boldsymbol{A}^2\,(-\,\boldsymbol{\Delta P})}{\boldsymbol{r}\,\boldsymbol{\mu}\,\boldsymbol{v}(\boldsymbol{V} + \boldsymbol{L}_a/\boldsymbol{v})}$$

$$\boldsymbol{\mu}_C = \boldsymbol{\mu}_\mathbf{0} \left(\mathbf{1} - \frac{\boldsymbol{C}}{\boldsymbol{C}_{\max}}\right)^{\boldsymbol{\alpha}} \qquad (1)$$

$$\boldsymbol{\frac{r\,\mu\,v}{2\,(-\,\Delta P)}\left(\frac{V_1+V_0}{A^2}+\frac{L}{A}\right)=\frac{t_1-t_0}{V_1-V_0}} \tag{2}$$

$$\begin{aligned}
&\frac{\mathrm{d}V}{\mathrm{d}t}=\frac{A^2\,(-\,\Delta P)}{r\,\mu\,v(V+L\,A/v)}\implies\\
&\implies\int_{V_0}^{V_1} r\,\mu\,v(V+L\,A/v)\ \mathrm{d}V=r\,\mu\,v\left(\int_{V_0}^{V_1} V\ \mathrm{d}V+L\,A/v\int_{V_0}^{V_1}\mathrm{d}V\right)=\\
&=r\,\mu\,v\left(\frac{V_1^2}{2}-\frac{V_0^2}{2}+\frac{L\,A}{v}(V_1-V_0)\right)=\\
&=\int_{t_0}^{t_1} A^2\,(-\,\Delta P)\ \mathrm{d}t=A^2\,(-\,\Delta P)\,(t_1-t_0)\implies\\
&\implies\frac{r\,\mu\,v}{2\,(-\,\Delta P)}\left(\frac{V_1+V_0}{A^2}+\frac{L}{A}\right)=\frac{t_1-t_0}{V_1-V_0}
\end{aligned}$$