$q = Ai$, $q = a_{tube} \cdot \frac{-dh}{dt}$, $i = \frac{\Delta h}{L}$, $A_{sample\ area}$

$$\therefore \quad a \int_{h_1}^{h_0} \frac{1}{h}\, dh = \frac{Ak}{L} \int_0^t dt$$

$$a \ln\left(\frac{h_0}{h_1}\right) = \frac{Ak}{L} t$$

$$k = \frac{a \ln\left(\frac{h_0}{h_1}\right) L}{A\, t}$$