$\frac{1}{6}\cdot Hz = 10\cdot\frac{1}{min}$ = rpm

$\omega := 2\cdot\pi\cdot\frac{1}{6}\cdot Hz$

$R_g := 1.98\cdot\frac{cal}{mole\cdot K}$

$D_{boule} := 30\cdot cm$

$nm := 10^{-9}\cdot m$

$\mu m := 10^{-6}\cdot m$

Properties of Silicon Melt

$\rho := 2.33\cdot\frac{gm}{cm^3}$

$\mu := 0.1\cdot poise$

$Mw := 28\cdot\frac{gm}{mole}$

$C_p := 0.71\cdot\frac{joule}{gm\cdot K}$

$\nu := \frac{\mu}{\rho}$

$\nu = 4.292\times 10^{-6}\,\frac{m^2}{s}$

$k := 1.48\cdot\frac{watt}{cm\cdot K}$

$D := 8\cdot 10^{-4}\cdot\frac{cm^2}{s}$

$\Delta H_f := 50550\cdot\frac{joule}{mole}$

$T_{eq} := 1685\cdot K$

$$S(T) := \exp\left(\frac{-\Delta H_f}{R_g\cdot T_{eq}}\cdot\frac{T - T_{eq}}{T}\right)$$

$C_{eq} := \frac{\rho}{Mw}$

$\alpha := \frac{k}{\rho\cdot C_p}$

$$Flux_C(S) := 0.62\cdot D^{\frac{2}{3}}\cdot C_{eq}\cdot\nu^{\frac{-1}{6}}\cdot\omega^{\frac{1}{2}}\cdot(S-1)$$

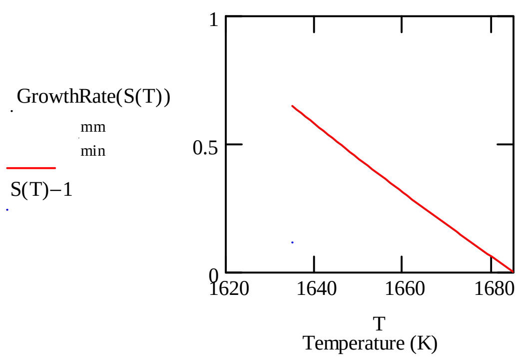
$Flux_C\left(S\left(T_{eq} - 30\cdot K\right)\right) = 0.521\,\frac{mol}{m^2 s}$

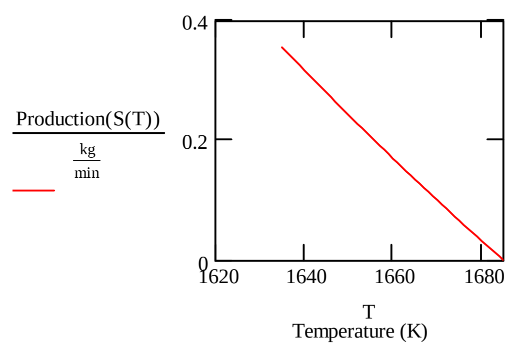
$$GrowthRate(S) := \frac{Flux_C(S)\cdot Mw}{\rho}$$

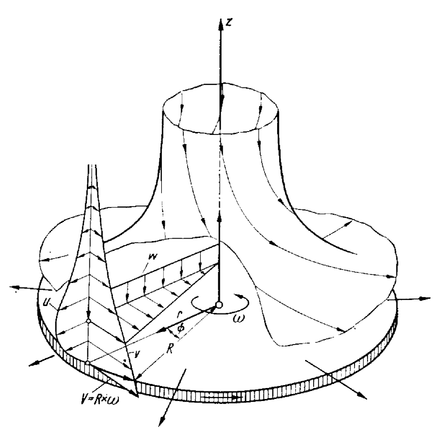
$T := T_{eq} - 50\cdot K .. T_{eq}$

$$Production(S) := GrowthRate(S)\cdot\frac{\pi}{4}\cdot D_{boule}\cdot\rho$$

Growth of Silicon Boule limited by BL-Mass Transfer







Mass Transfer Heat Transfer Analogy

$$Re(r) := \frac{(r\cdot\omega)\cdot r}{\nu} \qquad Re(10\cdot cm) = 2.44\times 10^{3}$$

$$Sh(r) := \left(0.62\cdot r\cdot D^{\frac{-1}{3}}\cdot\nu^{\frac{-1}{6}}\cdot\omega^{\frac{1}{2}}\right) \qquad Sc := \frac{\nu}{D} \qquad Sc = 53.648 \qquad h := Nu(r)\cdot\frac{k}{r} \qquad Pr := \frac{\nu}{\alpha}$$

$$Pr = 0.048$$

$$j_M(r) := \frac{Sh(r)}{Re(r)\cdot Sc}\cdot Sc^{\frac{2}{3}} \qquad f(r) := 2\cdot 0.62\cdot Re(r)^{\frac{-1}{2}} \qquad j_H(r) := \frac{Nu(r)}{Re(r)\cdot Pr}\cdot Pr^{\frac{2}{3}} \qquad j_H = j_M = \frac{f}{2}$$

$$Sh(r) := 0.62\cdot Re(r)^{\frac{1}{2}}\cdot Sc^{\frac{1}{3}} \qquad Nu(r) := 0.62\cdot Re(r)^{\frac{1}{2}}\cdot Pr^{\frac{1}{3}}$$

Nu was Derived from MT HT Analogy above

$$h := 0.62\cdot\left[\left(\frac{\omega}{\nu}\right)^{\left(\frac{1}{2}\right)}\cdot Pr^{\left(\frac{1}{3}\right)}\cdot k\right] \qquad Flux_H(T) := \frac{h\cdot\left(T_{eq}-T\right)}{\Delta H_f} \qquad Flux_H\left(T_{eq}-30\cdot K\right) = 9.774\cdot\frac{mol}{m^2 s}$$

$$GrowthRate_H(T) := \frac{Flux_H(T)\cdot Mw}{\rho}$$

$$Production_H(T) := GrowthRate_H(T)\cdot\frac{\pi}{4}\cdot D_{boule}\cdot\rho$$

Growth of Silicon Boule limited by BL-Heat Transfer