The engine geometry is:

The exposed area of the cylinder is

\[ A = \pi B H + \left( \frac{\pi B^2}{4} \right) \times 2 \]

where \( H = \frac{V}{(\pi B^2/4)} \)

The mean piston speed is:

\[ S_p = 2\pi N L = 2 \times \left( \frac{R_p n}{60} \right) L \]

The average charge density is \( \rho = \frac{M}{V} \) where \( M = (\rho v V_p / R_f) (1 + F_h) \)

The Reynolds no \( Re = \frac{PS_p}{\mu} \)

Then the heat transfer is given by \( Nu = 0.35 Re^{0.8} Pr^{0.4} \) and \( \delta = Nu \delta_k / \delta \).

The gas temperature \( T_g = \left( x_p T_k + (1 - x_p) T_u \right) / (x_p g_k u_k + (1 - x_p) g_u u_u) \)

(Note that strictly speaking, it should be \( \bar{U} \) in the above \( T_g \), but \( g \times C \) grows)

Finally, \( \dot{Q} = A_h \delta T \) and \( \delta T \) is obtained from \( \dot{Q} \) by integration.

\[ Q = \int_{\text{inc}}^{\text{dec}} \dot{Q} \, dt = \int_{\text{dec}}^{\text{inc}} \dot{Q} \, dt \]

where \( \dot{Q} = \frac{d\theta}{dt} \) in radians.

Numerical values: - thru 8:30 is TDC compression.
9.2) Instantaneous piston speed

\[
\frac{U(0)}{2nL} = \frac{\pi}{2} \sin \theta \left[ 1 + \frac{Cn^2}{R - \sin^2(\theta)} \right]
\]

The corresponding values of \( R = [U(0)/2nL] \) are plotted. Note that \( U(0)/2nL \), the resolution per second of the engine.

Note: The reason why Savitral is such a small value (10^{-5}) is because the real criterion is life where \( h \) is the film thickness and \( e \) the surface roughness height.

\[
\left( \frac{h}{a} \right) = \left( \frac{a}{h} \right) \cdot \left( \frac{h}{a} \right)
\]

\[
\left( \frac{h}{a} \right) \approx \sqrt{5} \approx 2.2\
\]

\[
\left( \frac{h}{a} \right) = \left( \frac{a}{h} \right) \sqrt{5}
\]

If the initial \( \left( \frac{h}{a} \right) = 1.5 \) and \( e \) is typically \( \approx 3 \mu m \), then \( \left( \frac{h}{a} \right) = 100 \) and \( \text{Savitral} = \left[ \left( \frac{h}{a} \right) \left( \frac{e}{h} \right) \right]^2 = \left( \frac{1}{100} \right)^2 \times 10^{-5} \)

\[ \]