Test Results
N=8 teeth
Working Fluid: AIR

Nomenclature:

Cc = Empirical coefficient
Cr = Empirical coefficient
Ct = Empirical coefficient
Af = Flow Area
T = Temperature (high P side)
t = Tooth thickness
N = number of teeth
P = Pressure
Pr = Pressure ratio
p = Tooth spacing
R = Gas Constant
Re = Reynolds Number
r = radius
δ = gap diameter
ρ = density (high P side)

Governing Equations:

$$m_{dot} = \pi \cdot 2 \cdot r_o \cdot \delta \cdot C_t \cdot C_c \cdot C_r \cdot \rho_o \cdot \sqrt{R \cdot T}$$

$$m_{dot} = \rho A V$$

$$C_t = 2.143 \cdot \frac{\ln(N) - 1.464}{n - 4.322} \cdot \left(1 - P_r\right)^{0.375 \cdot P_r}$$

$$R = C_p - C_v$$

$$C_r = 1 - \frac{1}{3 + \left(\frac{54.3}{1 + 100 \cdot \frac{\delta}{t}}\right)^{3.45}}$$

$$C_c = 1 + X_1 \cdot \frac{\frac{\delta}{p} - X_2 \cdot \ln\left(1 + \frac{\delta}{p}\right)}{1 - X_2}$$

$$A = \pi\left(r_o^{\ 2} - r_i^{\ 2}\right)$$

$$Re = \frac{\rho V D}{\mu} = \frac{V D}{\nu}$$

$X_1 = 15.1 - 0.05255 \cdot e^{0.507 \cdot (12 - N)}$ $\quad$ $X_2 = 1.058 + .0218 \cdot N$ $\quad$ *N < or = 12*

$X_1 = 13.15 + .1625N$ $\quad$ $X_2 = 1.32$ $\quad$ *N >12*

Seal Dimensions: Impeller Labyrinth Gap size .18mm

$r_o := \frac{68}{2}\text{mm}$ $\quad p := 1\text{mm}$ $\quad \delta := 0.18\text{mm}$ $\quad t := .5\text{mm}$ $\quad N_{teeth} := 8$

ro is the inner diameter of the seal but the outer diameter of the teeth

$r_i := r_o - \delta$

$A_{flow} := \pi \cdot \left(r_o^2 - r_i^2\right)$ $\quad A_{flow} = 38.351\,\text{mm}^2$

Air Properties at Testing Conditions

$kJ := 1000J$

$T_{hp} := (21 + 273.15)K$ $\quad P_L := .1048\text{MPa}$ $\quad P_H := .1772\text{MPa}$ $\quad P_r := \frac{P_L}{P_H}$

$\rho_o := 2.1484\,\frac{kg}{m^3}$ $\quad C_p := 1.0076\,\frac{kJ}{kg \cdot K}$ $\quad C_v := .71781\,\frac{kJ}{kg \cdot K}$ $\quad \nu := .083540\,\frac{cm^2}{s}$

$R := C_p - C_v$

Mass Flow Calculation:

$$C_r := 1 - \frac{1}{3 + \left(\dfrac{54.3}{1 + 100\cdot\dfrac{\delta}{t}}\right)^{3.45}}$$

$$C_r = 0.852$$

$$C_t := 2.143\cdot\frac{\ln\left(N_{teeth}\right) - 1.464}{N_{teeth} - 4.322}\cdot\left(1 - P_r\right)^{0.375\cdot P_r}$$

$$C_t = 0.294$$

$$X_1 := 15.1 - 0.05255\cdot e^{0.507\cdot\left(12 - N_{teeth}\right)}$$

$$X_1 = 14.701$$

$$X_2 := \left(1.058 + .0218\cdot N_{teeth}\right)$$

$$X_2 = 1.232$$

$$C_c := 1 + X_1\cdot\frac{\dfrac{\delta}{p} - X_2\cdot\ln\left(1 + \dfrac{\delta}{p}\right)}{1 - X_2}$$

$$C_c = 2.517$$

$$m_{dot} := \pi\cdot 2\cdot r_o\cdot\delta\cdot C_t\cdot C_c\cdot C_r\cdot\rho_o\cdot\sqrt{R\cdot T_{hp}}$$

$$m_{dot} = 0.015\ \frac{kg}{s}$$