A_2/A_1 vs L/h_1

$h_1 = r_c - r_n$

L = length of diffuser

Data Points

0.9,	1.33
1,	1.35
2,	1.48
3,	1.59
4,	1.68
5,	1.76
8,	2.0
10,	2.1
30,	3

$$\sigma = A\left(L/h_i\right)^B + C$$

$L/h_i = AR$

$AR = L/h_i$

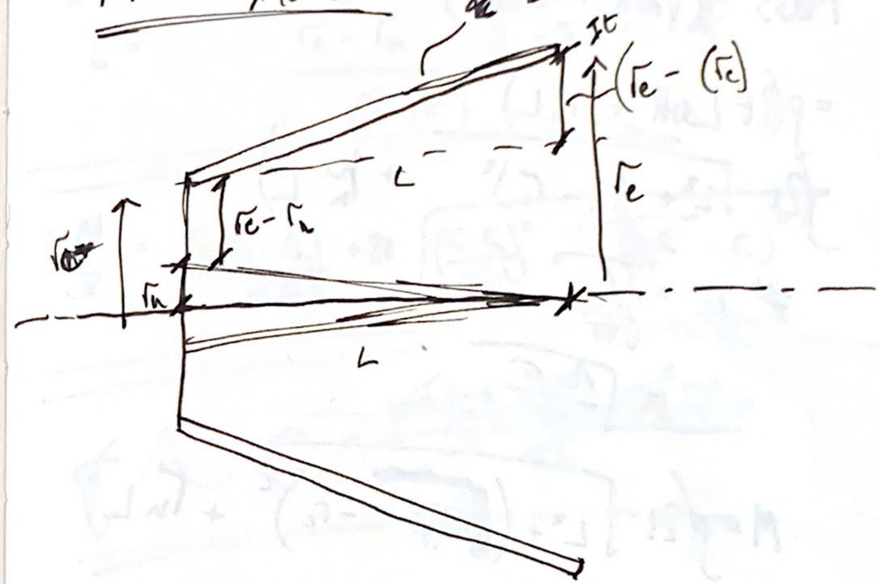
$\sigma = A_2/A_1 = A_e/\pi(r_c^2 - r_n^2)$

$$\left(\frac{\sigma - C}{A}\right)^{1/B} L = (r_c - r_n)$$

$h_i = r_c - r_n$

Mass Model

$L_{diff} = \sqrt{L^2 + (r_e - r_c)^2}$



$\therefore$ Volume of end cone $\sim \frac{1}{3} h \pi r^2$

$$V_{cone} = 2 \times \frac{r_n L}{2} = r_n L$$

$\therefore$ Volume of diffuser

$V_{diff} = 2 \times \ldots$

$A_e = \pi r_e^2$

$\therefore V_{diff} = 2 \times L_{diff} \times t$

$\therefore$ Diffuser weight

$$\text{Mass} = \rho(V_{diff} + V_{cone})$$

$$= \rho(2t\, L_{diff} + r_n L)$$

$$= \rho\left(2t\sqrt{L^2 + (r_e - r_c)^2} + r_n L\right)$$

$r_e = \sqrt{\frac{A_e}{\pi}}$

$$= \sqrt{\frac{A_x \sigma}{\pi}}$$

$$\therefore M = \rho\left(2t\sqrt{L^2 + \left(\sqrt{\frac{A_x\sigma}{\pi}} - r_c\right)^2} + r_n L\right)$$

$$\frac{M}{\rho} = 2t\sqrt{L^2 + \left(\sqrt{\frac{A_x\sigma}{\pi}} - r_c\right)^2} + r_n L$$

$\underbrace{\left(\frac{\sigma - c}{A}\right)^{-1/3}}_{\Rightarrow DF} \cdot L + r_n = r_c$

$$\therefore \frac{M}{\rho} = 2t\sqrt{L^2 + \left(\sqrt{\frac{A_x\sigma}{\pi}} - r_n - L\cdot DF\right)^2} + r_n L$$

$$\frac{M}{\rho} = r_n L + 2t\sqrt{L^2 + \left(\sqrt{\frac{A_x\sigma}{\pi}} - r_n - L\cdot DF(\sigma)\right)^2}$$

BUT

$$L = \frac{r_c - r_n}{DF(\sigma)} \quad \Big\|\; -r_n - (r_c - r_n) = \cancel{-r_n} - r_c + \cancel{r_n}$$

$$\therefore \frac{M}{\rho\rho} = \frac{r_n(r_c - r_n)}{DF(\sigma)} + 2t\sqrt{\left(\frac{r_c - r_n}{DF(\sigma)}\right)^2 + \left(\sqrt{\frac{A_x\sigma}{\pi}} - r_c\right)^2}$$

$$\sigma = \phi^2 \cancel{\frac{\rho\pi(r_c - r_n)(r_c + r_n)^2\Omega^2}{4r_1}}$$

$$\frac{\phi^2}{\varphi} = 2\sigma^2 \Rightarrow \sigma = \frac{\phi}{\sqrt{2\varphi}}$$

In the limit of seperation, diffuser mass can be written wrt ϕ, φ, r_c
where $DF = fn(\phi, \varphi)$

$$\left(\frac{M}{\rho\rho}\right) = \frac{r_n(r_c - r_n)}{DF()} + 2t\sqrt{\left(\frac{r_c - r_n}{DF}\right)^2 + \left(\sqrt{\frac{A_x\sigma}{\pi}} - r_c\right)^2}$$

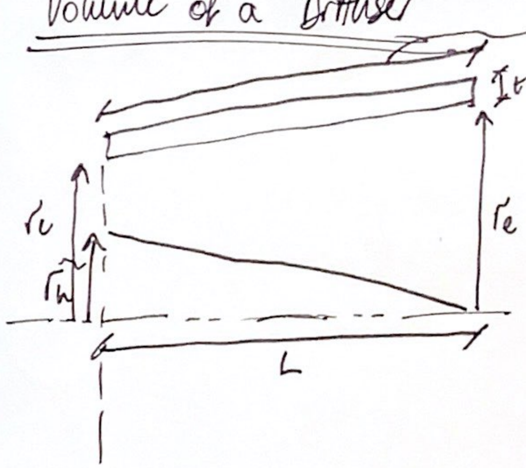
$$\frac{M}{\rho} = \frac{r_h(r_c - r_h)}{DF} + 2t\sqrt{\left(\frac{r_c - r_h}{DF}\right)^2 + \left(\frac{(r_c^2 - r_h^2)\phi}{\sqrt{2\varphi}} - r_c\right)^2}$$

$$A(r_c - r_h)^2 + (B r_c^2 - r_h^2 B - r_c)^2$$

$$= A(r_c - r_h)^2 + r_c^4$$

~~Area~~

Volume of a Diffuser



$$V_{cone} = \frac{1}{3} h \pi r^2$$

$$= \frac{1}{3} L \pi r_h^2$$

$$= \frac{\pi r_h^2 (r_c - r_h)}{3DF}$$

$$L_{diff}^2 = L^2 + (r_e - r_c)^2$$

$$L_{diff} = L^2 + (r$$

$$= \sqrt{L^2 + \left(\sqrt{\frac{A_x \sigma}{\pi}} - r_c\right)^2}$$

$$= \sqrt{L^2 + \left(\sqrt{\frac{\phi^2 (r_c^2 - r_h^2)}{\sqrt{2\varphi}}} - r_c\right)^2}$$

$$A_e = \pi r_e^2$$

$$A_x = \frac{\pi r_e^2}{\sigma}$$

$$\therefore r_e = \sqrt{\frac{A_x \sigma}{\pi}}$$

$$A_x = \pi (r_c^2 - r_h^2)$$

$$\sigma = \frac{\phi^2}{\sqrt{2\varphi}}$$

$$\therefore V_{diff} \approx L_{diff} \cdot t \cdot 2\pi r_e$$

$$\approx L_{diff} \cdot t \cdot \cancel{2\pi \sqrt{\frac{A_x \sigma}{\pi}}} \quad 2\pi \sqrt{\frac{\phi^2 (r_c^2 - r_h^2)}{\sqrt{2\varphi}}}$$

$$= L_{diff} \cdot t \cdot \cancel{\sqrt{4\pi A_x \sigma}}$$

$$= 2\pi t \sqrt{\frac{\phi^2 (r_c^2 - r_h^2)}{\sqrt{2\varphi}}} \cdot \sqrt{\left(\frac{r_c - r_h}{DF}\right)^2 + \left(\frac{\phi^2 (r_c^2 - r_h^2)}{\sqrt{2\varphi}} - r_c\right)^2}$$