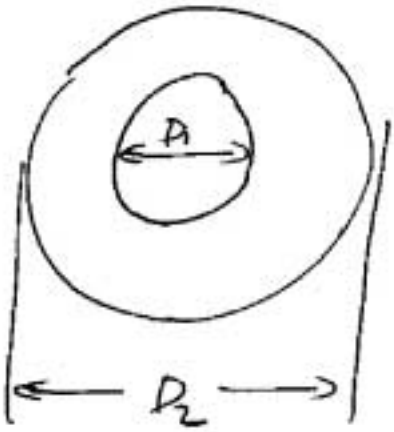
(noncircular)

CM3110
10-7-03

a) CALC D_H FOR ANNULUS



$D_1 = 2R_1$

$D_2 = 2R_2$

$$D_H = 4 \frac{\text{cross-sectional area}}{\text{wetted perimeter}}$$

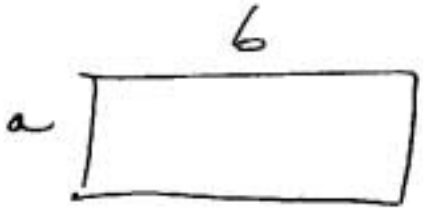
$$= 4\left(\frac{\pi R_2^2 - \pi R_1^2}{2\pi R_1 + 2\pi R_2}\right)$$

$$= 2\left(\frac{R_2^2 - R_1^2}{R_1 + R_2}\right) = 2\left(\frac{(R_2 - R_1)(R_2 + R_1)}{(R_2 + R_1)}\right)$$

$$= 2R_2 - 2R_1$$

$$\boxed{D_H = D_2 - D_1}$$

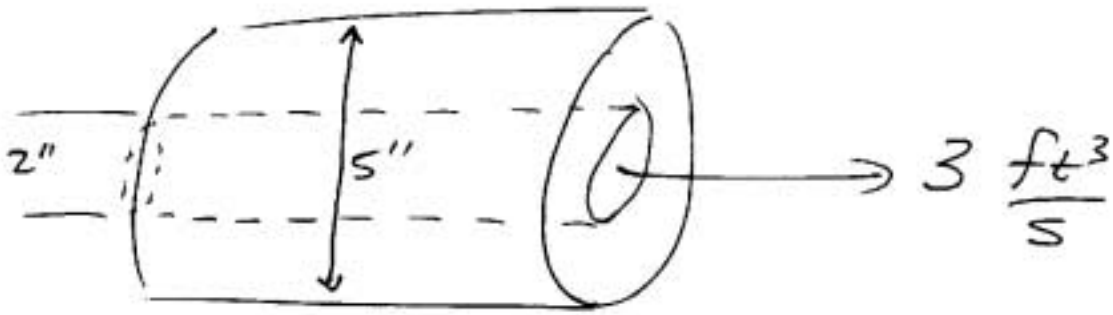
(b) CALC D_H FOR RECTANGULAR DUCT.



$$D_H = 4\left(\frac{ab}{2a+2b}\right)$$

$$\boxed{D_H = \frac{2ab}{a+b}}$$

(c) WHAT IS $\frac{\Delta P}{L}$ FOR FLOW IN ANNULUS?



$$\boxed{D_H = 5 - 2 = 3 \text{ in}}$$

(noncircular)

$$\langle V \rangle = \frac{Q}{A}$$

$$= \frac{3\ ft^3/s}{\frac{\pi}{4}\left(D_2^2 - D_1^2\right)}$$

$$= \left(3\ \frac{ft^3}{s}\right)\frac{4}{\pi}\left(\frac{1}{5^2 - 2^2}\right)\left(\frac{12\ in}{ft}\right)^2$$

$$\boxed{\langle V \rangle = 26.2\ ft/s}$$

$$Re = \frac{\rho V D_H}{\mu} = \frac{(62.4)(26.2)\left(\frac{3}{12}\right)}{6.72 \times 10^{-4}}$$

$$\boxed{Re = 6.08 \times 10^5}$$

definition of f in pipe w $D \to D_H$

$\frac{\Delta P}{L}$ comes from $f = \frac{\Delta P}{L}\frac{D_H}{2}\frac{1}{\rho V^2}$

f comes from correlation (for pipe)

$$\frac{1}{\sqrt{f}} = 4 \log_{10} Re\sqrt{f} - 0.4$$

(non circular)

D_H=	0.25	ft	
density=	62.4	lbm/ft3	
viscosity=	6.72E-04	lbm/fts	
v=	2.62E+01		
Re=	6.08E+05		
guess f=	0.00318		
1/sqrt(f)=	1.77E+01	from correlation	
f=	0.00318	calculated friction factor	
DeltaP/L=	1.09E+03	lbm/s2ft2	
DeltaP/L=	1.96E-02	lbf/in3	

$4\log_{10}(Re\sqrt{f_{guess}}) - 0.4$

$$\frac{\Delta P}{L} = \frac{2 f \rho V^2}{D_H}$$

$$\frac{\Delta P}{L} = 1.96 \times 10^{-2} \ \text{psi/in}$$