FRAZIER TEST FOR THIN MEDIA

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Operating Procedure:

1. Select the size of the disk opening. Place the sample between the disks and clamp the lever.
2. Plug in the controller for the flow meter.
3. Switch on the blower and slowly increase the flowrate such that the reading on the left manometer shows 0.5 inches of water.
4. Read the flowrate from the controller (m^3/hr)
5. Slowly reduce the flowrate and switch off the blower.
6. Remove the sample from the disks and place a piece of paper between disks.
7. Unplug the controller for the flow meter.
8. Calculate k from Darcy's Law.

Example 1:

A 2 mm thick media is tested. We have air as the fluid. The opening is 1". The dP on the left manometer is 0.5 inches of water. The flowrate from the controller is 5 m^3/hr. Calculate k.

$$\frac{Q}{A} = \frac{k\Delta P}{\mu l}$$

$$k = \frac{Q\mu L}{A\Delta P}$$

Q = 5 m^3/hr = .001 m^3/s

dP = 0.5 inches of water = 124.5 Pa

μ = 0.0181 cP = 1.81E-5 kg/m-s

Calculate A based off disk opening

D = 1" = 0.0254 m

$$A = \frac{\pi D^2}{4} = .0005m^2$$

$$k = \frac{\left\{\left(.001\, {m^3}/{s}\right)\left(1.81 * 10^{-5}\, {kg}/{ms}\right)(.002m)\right\}}{\{(.0005m^2)(124.5Pa)\}} = 5.81 * 10^{-11}m^2$$

FRAZIER TEST for THICK MEDIA

Effect of Geometry :

To include the effect of geometry for converging disk flow we will rewrite the Darcy's Law by introducing a Shape factor G_{Disk}.

$$\frac{Q}{A_0} = G_{Disk} \frac{k}{\mu} \frac{\Delta P}{L}$$

Consider the converging flow in a disk geometry as shown figure (1). Inlet and outlet surfaces A_I and A_o are at pressures P_I and P_o. The cylindrical coordinate origin is at the center of the inlet surface and the z-direction points towards the outlet.

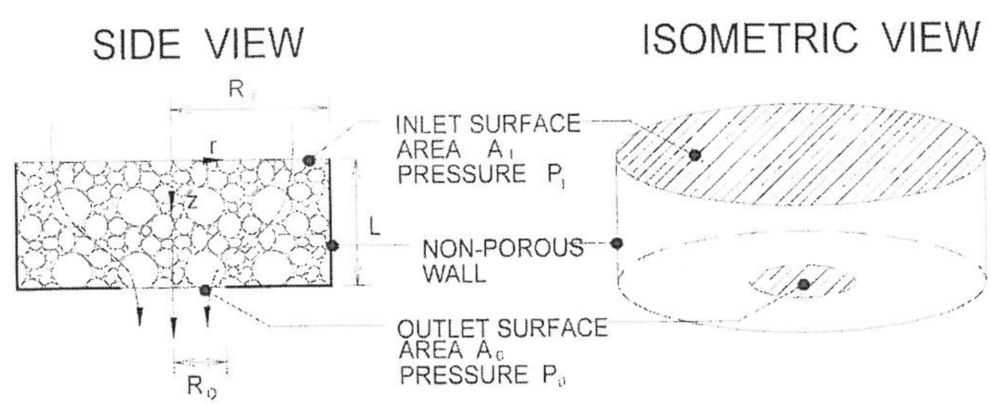

Figure 1: converging flow in a disk geometry

The values for G_{Disk} calculated by for varying geometric ratios of L/R_o and R_I/R_o are plotted in Figure 2. This figure indicates a dependence on L and R_I for a fixed value of R_o. For the ratio L/R_o of 2.0 or less G_{Disk} approaches a constant asymptotic value. For values of L/R_o greater than 2.0, G_{Disk} appears to vary linearly with R_I/R_o. This shows that for thin disks and large values of R_I/R_o the outer part of the disk far from the exit surface does not contribute to the total flow. For very thick disks the flow field depends more on the depth, L.

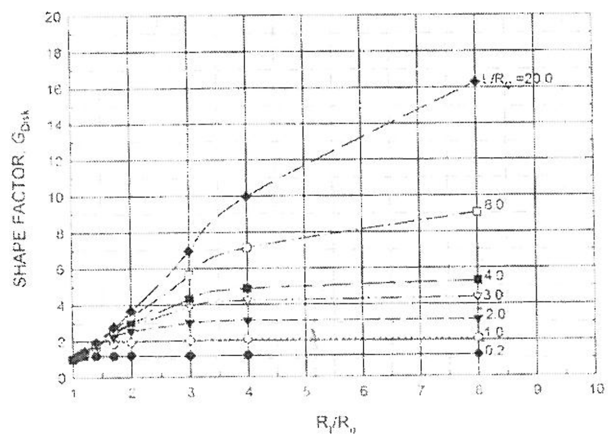

Figure 2 : Calculated geometric factor, G_{Disk}, for length and depth of the disk geometry in figure (1)

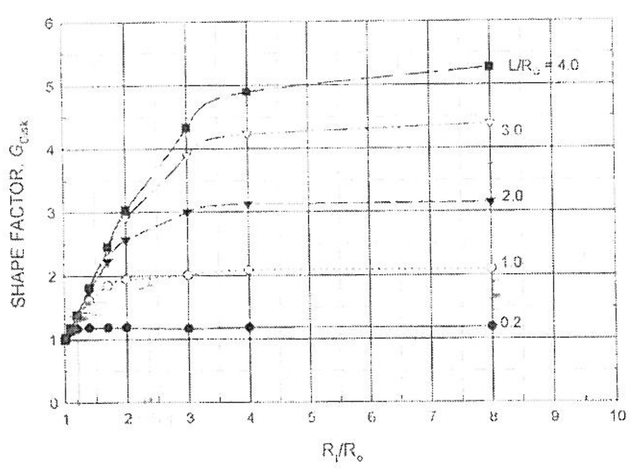

Figure 3: Expanded view of Figure 2 in the small range of L/R_o.

Operating Procedure:

Operating procedure remains the same as thin media with the exception of putting the media sample in a holder with some vacuum oil between sample and holder.

Example 2:

Rewriting example 1 for the converging disk flow with sample dimensions as follows:

Inlet radius = 15 cm

Outlet radius = 5 cm

Disk thickness = 40 cm

For this geometry shape factor G_{Disk} = 5.7

Now, Darcy's Law with geometric disk factor is

$$\frac{Q}{A_o} = \frac{Gk\Delta P}{\mu L}$$

$$k = \frac{Q\mu L}{AG\Delta P}$$

$$A_o = \frac{\pi D^2}{4} = \frac{\pi (0.05m)^2}{4} = 0.002\ m^2$$

Q = 0.001 m^3/s

ΔP=0.5 inches of water = 124.5 Pa= 124.5 N/m^2=124. 5 kg/m-s^2

µ = 0.0181 cp = 1.81* 10^{-5} kg/m-s

k = {(.001 m^3/s)*(1.81*10^{5} kg/m-s)*(.4m)}/{(.005m^2)*(124.5 kg/m-s^2)*(5.7)} = 2.04*10^{-9} m^2