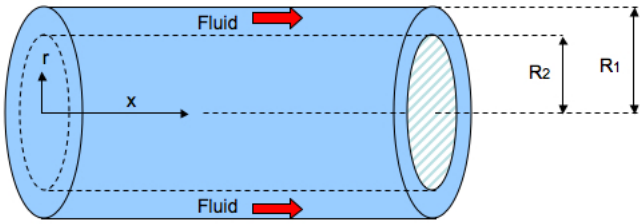
MIT Department of Mechanical Engineering
2.25 Advanced Fluid Mechanics

Problem 6.04
This problem is from "Advanced Fluid Mechanics Problems" by A.H. Shapiro and A.A. Sonin



Consider a steady, fully developed laminar flow in an annulus with inside radius R_2 and outside radius R_1.

- (a) Find a relation between the pressure gradient $\frac{dp}{dx}$, the volume flow rate Q, the fluid viscosity μ, R_1, and $\frac{R_2}{R_1}$.
- (b) Find the limiting form of the relation for a very thin annulus by expressing it in terms of R_1 and $\frac{h}{R_1}$, where $h = R_1 - R_2$, and taking the limit $\frac{h}{R_1} \to 0$. Compare with the formula for fully developed laminar flow between parallel flat plates separated by a distance h.
- (c) In the opposite limit $\frac{R_2}{R_1} \to 0$, does the relation of (a) reduce to the formula for Hagen-Poiseuille flow in a circular pipe of radius R_1? Discuss your answer.

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