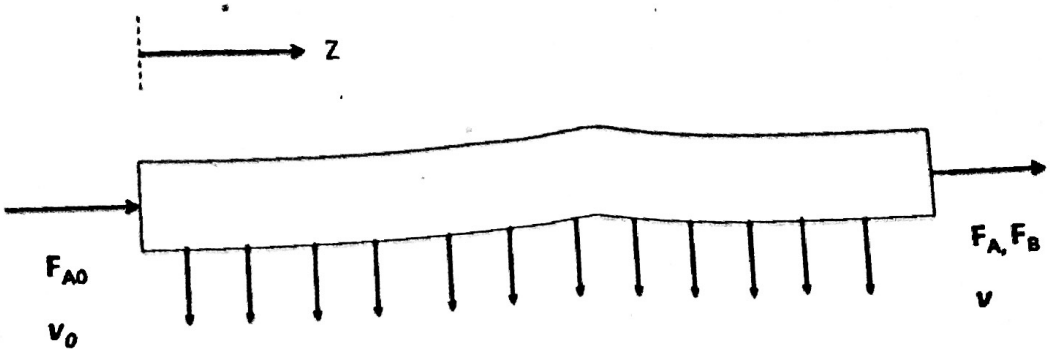
Name: ADA SHAW

Problem 4 (25 points)

The liquid-phase reaction of A--->B occurs isothermally in a leaky steady-state PFR of length L and constant cross-sectional area A_C, through which both A and B can flow radially out of tube along the entire axial length of the reactor (see schematic below).



Both species A and B have the same liquid density. The reaction is first order in A with a rate constant k. Furthermore, the axial volumetric flow rate (v) at any given point in the reactor obeys the following equation where v_0 is the inlet volumetric flow rate:

$$v = v_0\left(1 - \frac{Z}{2L}\right)$$

a. Using a differential mass balance obtain an expression for the radial volumetric flow rate out per unit length of reactor. acc = in-out+gen
$0 = v|_{v+\Delta v} - v|_{v+\Delta v}$

b. Derive a differential mole balance that describes how F_A (molar flow rate of A) varies along the length of the reactor, as a differential equation.

c. Obtain an analytical expression for the molar flow rate of A, F_A, down the length of the reactor. Do this by first re-writing your differential equation from (b) in terms of flow rates. You will have the constants provided in the problem statement k, L, A_C, and v_0 appear in your final solution.