ch1-1

國立臺北科技大學

九十四學年度化學工程研究所入學考試

單元操作與輸送現象試題

填准考證號碼　　　　　　　　　　　　第一頁　共一頁

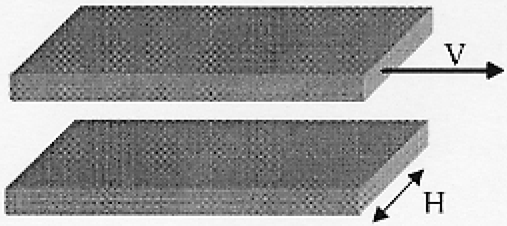
注意事項：

1. 本試題共 5 題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. A particular non-Newtonina fluid is a Bingham Plastic where, in one-dimensional transport, the momentum flux is related to the velocity gradient by

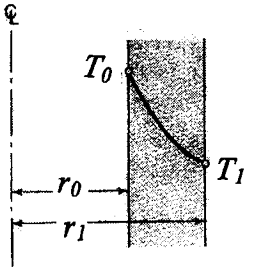
$$\tau_{ij} = \tau_0 - \mu \frac{dv_j}{dx_i}$$

Where τ_0 is the yield stress. Obtain an expression for the velocity distribution for a Bingham Plastic in Couette Flow between horizontal parallel plates (width, H) where the top plate has a velocity V and the bottom plate is stationary. (20%)



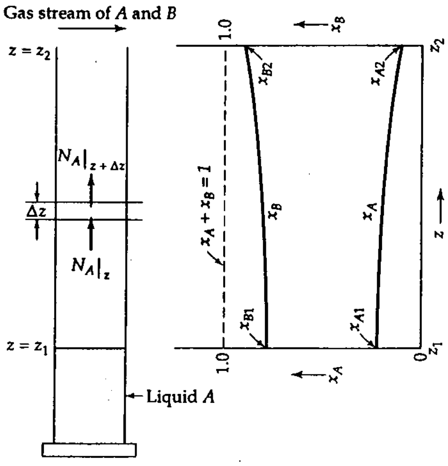
2. We are developing a microfluidics device which has small channels in a piece of polymer material. By controlling the velocity profile of the fluid inside the channel, we are able to design the mixing, separation, or reactor "unit operation" device on the chip.
   (a) Please discuss how you can change the material properties to control the velocity profile inside the channel. Which material properties are important? How can you measure these properties. (10%)
   (b) Assume the diameter of these channel are smaller than 1mm. Please discuss the type of fluid flow in the tube (Hint: Reynolds number). (10%)

3. Heat is flowing through an annular wall of inside radius r_0 and outside radius r_1. The thermal conductivity varies linearly with temperature from k_0 at T_0 to k_1 at T_1. Develop an expression for the heat flow through the wall. (20%)



Temperature profile in an annular wall.

4. The diffusion system shown in the following figure in which liquid A is evaporating into gas B. We imagine there is some device that maintains the liquid level at $z=z_1$. Right at the liquid-gas interface, the gas-phase concentration of A, expressed as mole fraction, is x_{A1}. This is taken to be the gas-phase concentration of A corresponding to equilibrium with the liquid at the interface. That is, x_{A1} is the vapor pressure of A divided by the total pressure, p_A^{VAP}/p, provided that A and B form an ideal gas mixture and that the solubility of gas B in liquid A is negligible. A stream of gas mixture A-B of concentration x_{A2} flows slowly past the top of the tube, to maintain the mole fraction of A at x_{A2} for $z=z_2$. The entire system is kept at constant temperature and pressure. Gases A and B are assumed to be ideal. Determine the relations between x_A (mole fraction of A) and height z. (20%)



5. The barrel of an extruder can be modeled as if a solid rod is moving with a velocity V, through a fluid inside a horizontal cylindrical tube as shown in the figure. There is also a pressure gradient ΔP imposed on the Newtonian fluid in the annulus. We wish to derive an expression for the velocity distribution of the fluid in the annulus under steady-state, fully developed laminar flow conditions. (20%)