中原大學 100 學年度 碩士班 入學考試

3 月 19 日 13:30~15:00　　化學工程學系

誠實是我們珍視的美德，
我們喜愛「拒絕作弊，堅守正直」的你！

科目：輸送現象及單元操作

■可使用計算機(僅限不具可程式及多重記憶者)，但不可帶單位換算表入試場。　　□不可使用計算機

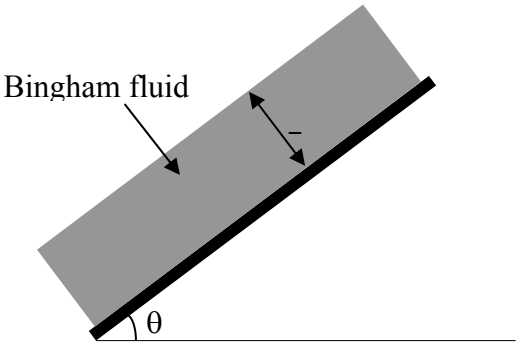
Problem-1 (20%)

(1) Membrane filtration processes are generally classified as microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RO). Please compare the four different processes based on the size (or molecular weight) of the rejected species. (5%)

(2) Give simple explanation of the following terms: (a) Fully developed flow, (b) Rotameter, (c) Hindered settling, (d) Biot number, (e) Nucleate boiling. (15%)

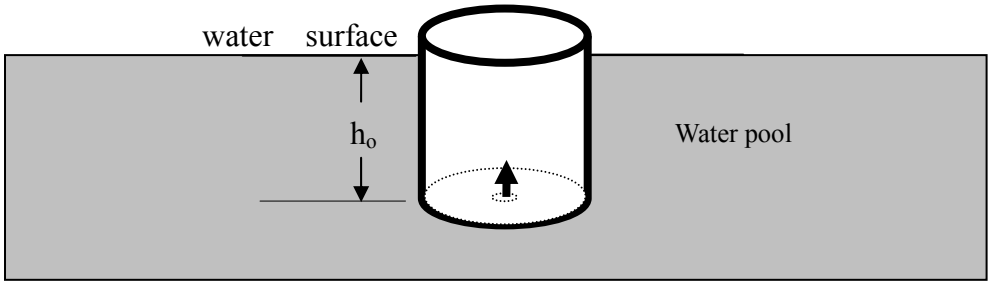
Problem-2 (10%)

Consider a Bingham fluid layer spread uniformly on a flat plate inclined at an angle, θ, to the horizontal. Rheological property of the Bingham fluid is described by $\tau=\tau_o+\eta\dot{\gamma}$, where τ_o is yield stress and $\dot{\gamma}$ is shear rate. Density of the fluid is ρ. Derive an expression for the maximum layer thickness, δ, for which the fluid layer will not flow under the action of gravity.



Problem-3 (15 %)

An uncovered tank of cross-sectional area A_t has a small hole of cross-sectional area A_o in its bottom. The tank is empty and is suddenly immersed into a large water pool to a depth of h_o. Assuming that the water flow through the hole is frictionless, how long does it take to fill up (填滿) the tank to same level as the water pool ?



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Problem-4 (15 %)

Double-pipe heat exchanger has been widely used in laboratory for measuring the heat transfer coefficient. An experiment is carried out using a double-pipe heat exchanger with a thin-walled inner pipe of diameter 0.02 m and length 1.5 m. A hot stream of oil at 80 ^{o}C and a rate of 200 kg/hr enters the inner pipe and a cold stream of 25 ^{o}C water at a rate of 100 kg/hr enters in countercurrent flow into the annular space between the outside and the inside pipes. Heat capacities,C_p ,of the oil and water are 2.2 and 4.2 kJ/kg·K, respectively, assuming to be independent of temperature. If the outside pipe is not perfectly insulated and the exiting temperatures (出口溫度) of the oil and water streams measured are 60 and 45 ^{o}C , respectively, calculate

(a) the rate of heat loss from the outside pipe surface of the exchanger,

(b) the overall heat transfer coefficient, U, of the exchanger under given operating conditions.

Problem-5 (20%)

Calculate the time needed for a water spill to evaporate into still air at 534°R and 1 atm, with an absolute humidity of 0.0019 lb of water per lb of dry air. The water is 0.039 inch above the ground surface and is at a constant temperature of 534°R. Evaporation occurs by the process of molecular diffusion through a gas film of thickness 0.19 inch. The saturated humidity is 0.0188 lb of water per lb of dry air at 534°R and the diffusivity of water vapor in air is 0.274 cm^2/s at 560°R and 1 atm. The density of water is 62.38 lb/ft^3 at 534°R and the gas constant, R, is 0.73 ft^3atm/lbmol°R.

Problem-6 (20%)

A highly soluble solid (sucrose) is to be dissolved in an agitated tank. Spherical particles of initial radius R_o = 10 mm are available. Assume that convection of the dissolved sucrose from the solid/liquid interface is the rate-determining step in dissolution, and the dissolved sucrose is quickly dispersed throughout the agitated tank and the tank volume is so large that the sucrose concentration in the bulk of the liquid is very small compared to the equilibrium solubility. Find the time to dissolve 30% of the initial mass. For sucrose at 25℃, the density is 1600 kg/m^3, and the concentration, C_s, is 3000 kg/m^3. The convective mass transfer coefficient, k_c, is $6.3x10^{-6}$ m/s.