中原大學 102 學年度碩士班入學考試

月　日　　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　　（共 2 頁第 1 頁）

☑可使用計算機，惟僅限不具可程式及多重記憶者　☐不可使用計算機

Problem 1 (10%)

Please show the SI units of the following terms:

(a) diffusion coefficient (b) NPSH (c) specific surface area

(d) Prandtl number (e) log-mean temperature difference

Problem 2 (10%)

Please explain the following terms

(a) Purge of a chemical process (b) Bubble point

Problem 3 (15%)

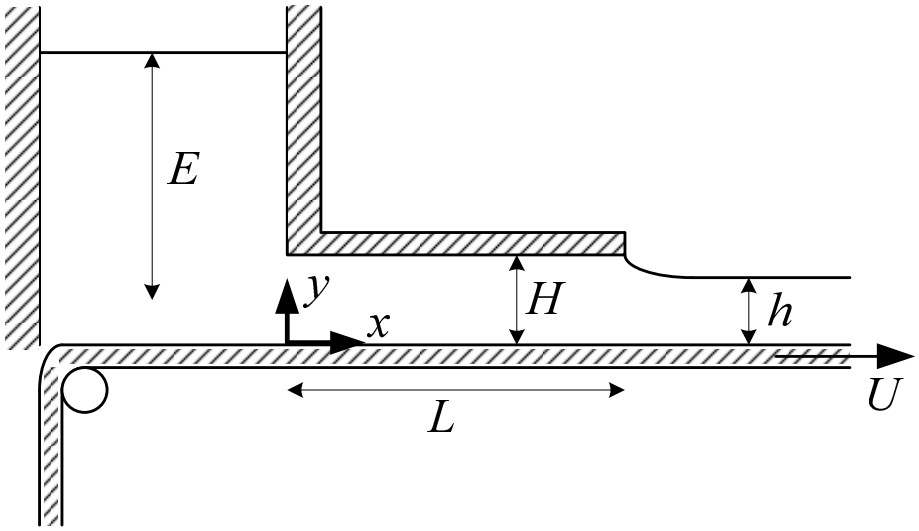
Stripping of oxygen from water is carried out in a bubble column by using a nitrogen stream. The concentrations of oxygen in the bulk gas and liquid phases are y_{AG} and x_{AL}. At the gas-liquid interface, the gas-side and liquid-side concentrations are y_{Ai} and x_{Ai}.

(a) Based on the two-film theory, please plot the possible concentration profiles in the two phases.

(b) The local mass transfer coefficient in gas phase (k_G) is 0.2 m/s and the local mass transfer coefficient in liquid phase (k_L) is 0.05 m/s. Assume that the concentration of oxygen is very dilute in both phases and the Henry's law constant ($m = y_A / x_A$) is 35. Please find the overall mass transfer coefficient in the liquid phase (K_L).

Problem 4 (25%)

A liquid with a viscosity of μ and a density of ρ is flowing in a narrow planar slot: the lower plate is a belt moving at a constant velocity U and the upper is fixed. The liquid level in the reservoir, E, is constant and the height and length of the slot are H and L, respectively. When a steady flow is achieved, what is the film thickness h?



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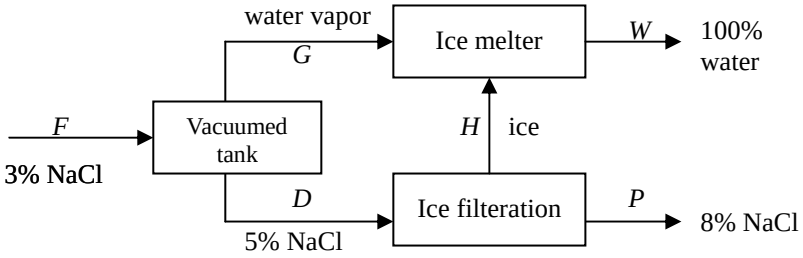
Problem 5 (15%)

Sea water is fed at 40°F into the desalination process (海水淡化程序) shown below. The process first vaporizes the feed to water vapor and then condenses the vapor to the final fresh water for drink. In the vacuuming process, sea water is released the need for the latent heat of vaporization and becomes ice. At the other exit of the vacuumed tank, concentrated sea water enters the next unit to filter out ice. The ice stream then recovers the latent heat from the vapor and two streams are merged to become fresh water.



(a) How many *lb/hr* of streams *W* and *D* can be obtained from 100 *lb/hr* of feed?

(b) If the filtration is operated at 30°F, what is the temperature of the fresh water? Assume the whole process has no heat loss and the diluted brine can be dealt as water for heat transfer.

Problem 6 (25%)

People have paid much more attention than ever to energy-saving materials to respond the era of expensive and insecure energy. A real example in our life is the replacement of tungsten bulbs(鎢絲燈泡) with LED bulbs. However, we are aware that LED material is more expensive than tungsten bulbs. The end users therefore need more thoughts about which option is more economical: saving the energy cost or material cost?

Your boss now asks you to save the energy cost for your company by improving the heat insulation of a hot 5-m long tube, which contains a 200°F flowing fluid. Outside that 10-cm (OD) tube, material *A* poorly keeps the heat from dissipating to 77°F atmosphere. You are considering to cover an additional layer on material *A* to achieve your task. There are two good insulated materials, *B* and *C* that you have found out:

	Thickness mm	Thermal conductivity, *k* w/(m·K)	Heat-transfer coefficient, *h* w/(m^2·K)	Cost $/m
Material *A*	3.0	0.80	20.00	
Material *B*	1.0	0.05	11.67	2600
Material *C*	0.5	0.01	2.05	5000

(a) Calculate the energy saving percentage from these two materials. (15%)

(b) Considering the material cost, which material will save the better net cost, if your boss demand to see the cost saving in 5 years? (10%)

You may ignore the heat resistances from the fluid and tube. The Taiwan Power Company (台電) lists the energy cost as $250/(kw·month).