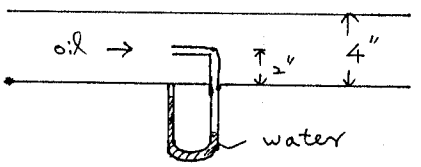
1. A pitot tube with a U-tube water manometer is attached to a horizontal oil pipe of 4" inside diameter, as shown in the figure. If the manometer reading is 15", determine the volumetric flow rate of oil in the pipe. The oil has a specific gravity of 0.84 and a viscosity of 0.0336 lbm/ft·sec. ($\rho_{H_2O} = 1$ g/cc). (12%)

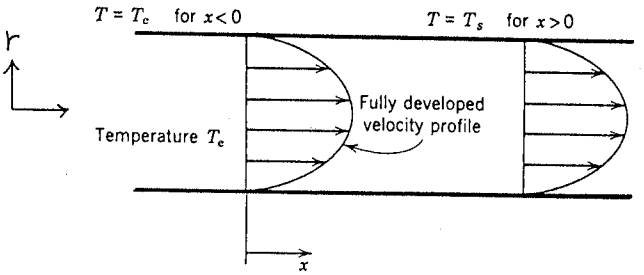


2. Fluid flows between two parallel plates, a distance h apart. The upper plates moves at velocity v_0; the lower plate is stationary. For what value of pressure gradient will the shear stress at the lower wall be zero?

($\rho \frac{D\hat{v}}{Dt} = \rho \hat{g} - \nabla P + \mu \nabla^2 \hat{v}$) (11%)

3. 何謂 Cross flow filtration ? 其優點為何? (10%)

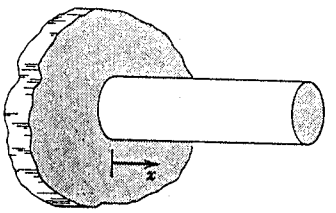
4. Energy transfer associated with forced convection inside tubes will be considered for laminar flow. Please apply the energy conservation principle to the system as depicted in the following figure to derive the differential equation governing the temperature profile T(x,r). The assumptions are as follows: (1) The velocity profile is parabolic and fully developed before any energy exchange between the tube wall and the fluid occurs. (2) All properties of the fluid are constant. (3) The surface temperature of the tube is constant at a value of T_s during the energy transfer. (7%)



5. Different boiling regimes can be observed in the boiling curve, which is a plot of the boiling heat flux versus the temperature difference between the heated surface and the saturated liquid. Please describe each boiling regime briefly. (5%)

(背面仍有題目,請繼續作答)

6. (a) Please derive the differential equation for the steady-state heat-conduction analysis of extended surfaces by considering the pin fin depicted in the following figure. The cross-sectional area is A and the perimeter is P, which do not vary along the fin in the x direction. Since the cross section is thin, the temperature is a function of x only. The ambient fluid temperature is T_∞. (4%)
(b) For a sufficient long fin, please solve the differential equation to obtain the temperature profile T(x). Both thermal conductivity k and convective heat transfer coefficient h are taken to be constant. (6%)



7. 工廠排放廢氣中含有氨氣，今欲以填充塔吸收廢氣中氨氣以合乎排放標準。(1)試就可操作之氣、液流量範圍、可處理之入口氨氣濃度範圍、單位塔高度壓降等三方面，比較逆流式操作或順流式操作何者爲優(6%)。(2)試就單位塔高度壓降、質量傳送係數、可操作之氣、液流量範圍等三方面，比較以大尺寸或小尺寸填充物設計時何者爲優(6%)。(3)值班工程師發現現場出口氨氣濃度高於排放標準，其合理之應變措施爲何(3%)。

8. 考慮以(1)去吸收(desorption)(2)蒸餾(3)吸附(4)結晶或(5)萃取去除水溶液中溶解之微量酚，簡述以上各種單元操作所利用之分離原理。(10%)

9. 操作或設計吸附床時常會應用到突破曲線(breakthrough curve)之概念。(1)簡述理想突破點時間(ideal break-point time)與突破點時間(break-point time)之意義(4%)；(2)若以 LUB(length of unused bed)法進行設計，則三者間有何關係(3%)；(3)若長度爲 40 公分吸附床之 LUB 爲 10 公分，則長度改爲 50 公分時，其突破點時間變爲原來的幾倍(4%)。

10. 將藥丸製成不同顆粒大小球體再混合服用可達到增加藥效時間而簡少服藥次數目的。今欲以下面流動流體與單一球體表面間之無因次群質傳模式來估計藥丸之質量傳送係數 $k_C = 2D_{AB}/D_P$，其中 D_P 爲球體直徑，D_{AB} 爲藥丸在胃液中之普通擴散係數。若藥丸在胃液之飽和溶解度爲 C_S (g mole/cm^3)，胃液中藥丸濃度可忽略，藥丸之密度與平均分子量分別爲 ρ_S (g/cm^3)與 M_S，(1)寫出描述藥丸直徑隨時間變化之質量守恆式(5%)；(2)若時間爲零時藥丸之初始直徑爲 D_{PO}，請解出藥丸完全溶解所需時間(4%)。