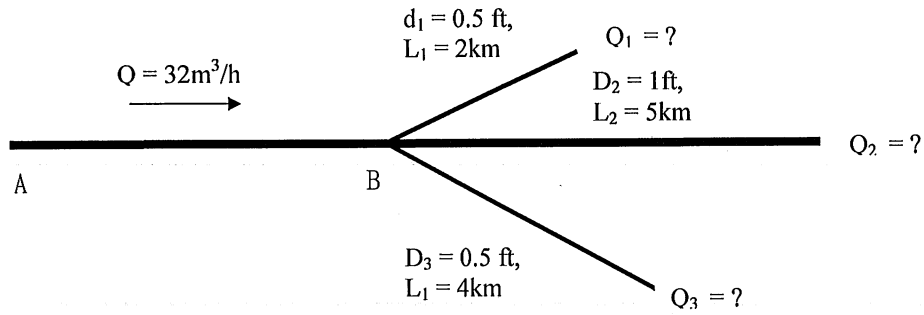
大同大學102 學年度研究所碩士班入學考試試題

考試科目:單操與輸送　　所別:化學工程研究所　　

註:本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 可以使用計算器。

1. Calculate the flow rate of each branch pipeline, Q_1, Q_2, and Q_3, in a petroleum distribution network with delivery flowrate of 32 m^3/h. The delivery pressure at location A is 1.82 MPa and the end pressures are 1 atm. (25%)



2. A hot stream of kerosene at 150^0F is to be cooled to 100^0F by a counter-flow water stream at 70^0F. If the mass flow rate of the kerosene stream is 5 lb_m/s and the exit temperature of the water stream is 100^0F. Calculate the required mass flow rate of the water stream and the required heat-transfer area if the overall heat-transfer coefficient is 20 Btu/h-ft^2-^{0}F. Cp for kerosene $=0.5225 Btu/lb_m \cdot^0 F$, Cp for water = $0.999 Btu/lb_m \cdot^0 F$. (15%)

3. A flat membrane with size dimension of 50cmx50cmx100μm separates two gas mixtures containing a species of concern. If the species concentrations in the membrane surfaces are 50 and 2 mg/cm^3, respectively and the species diffusion coefficient in the membrane is $3x10^{-5}$ cm^2/s, calculate the species mass transfer rate through the membrane in mg/s. (10%)

4. (a) A small capillary with an inside diameter of $2.22x10^{-3}$ m and a length 0.317 m is being used to continuously measure the flow rate of a liquid having a density of 875 kg/m^3 and a viscosity of $\mu = 1.13x10^{-3}$ (Pa)(s). The pressure-drop reading across the capillary during flow is 0.0655 m water (density 996 kg/m^3). (i)What is the flow rate in m^3/s if end-effect corrections are neglected? (7%) (ii) What is Reynolds number of the flow? (3%)
   (b) Consider steady-state laminar flow inside the annulus between two concentric horizontal pipes with a length z = L, the velocity in the annulus will reach a maximum at some radius, $r = r_{max}$ which is between r_1 (outside radius of the insider pipe) and r_2 (inside radius of the outside pipe). Please find r_{max} (The flow is far from the pipe inlet, the fluid is incompressible and viscosity, μ is a constant, and the flow is driven in one direction by constant-pressure gradient). (10%)

5. In a single-pass shell and tube heat exchanger, cooling water is used to condense an organic vapor. Under present operating conditions, the heat transfer coefficients are $h_i = 2300$ W/m^2K (turbulent flow of cooling water), $h_o = 950$ W/m^2K. Fouling is negligible and the tubes are 1 in. 16 BWG carbon steel (k (thermal conductivity) = 45 W/(m)(K), D_o(outside diameter) =25.40mm, D_i(inside diameter)= 22.10mm). Water flows in the tubes. If the cooling water rate was to rise suddenly by 10%, estimate the change in overall heat transfer coefficient based on outside diameter. (15%)

6. An absorber is to be designed to remove a VOC pollutant from an exhaust gas stream. Fifteen cubic meters per minute of gas at 289K and 101.3 kPa containing 5.0 mol% VOC is fed to the bottom of the absorption tower. By feeding a VOC-free solvent stream to the top of the tower, the VOC concentration is reduced to 0.3 mol%. The solvent stream leaves the tower containing 3.65 mol% VOC. With the specified stream flow rates, the overall mass transfer coefficient, $K_Y a$, equals 52.0 $mol/((m^2)(s)(\triangle Y_{VOC}))$. The cross-sectional area of the tower is 0.2 m^2. The equilibrium data at 289K may be represented by
   Y (mole VOC / mole VOC-free gas) = 0.8 X (mole VOC / mole VOC-free solvent)
   Evaluate the height of tower required. (15%)