

元智大學 102 學年度研究所 碩士班 招生試題卷

系(所)別： 化學工程與材料 組別： 不分組-選考 A 科目： 輸送現象與單元操作 用紙第 / 頁共 2 頁  
科學學系碩士班

●可使用現行「國家考試電子計算器規格標準」規定第二類之計算機

1. Please define the heat transfer. Describe the ways of heat transfer, formation conditions of each way, the corresponding equations of each way, and thermal resistance of each way (include the Cartesian coordinate, cylindrical coordinate, spherical coordinate system) (10 %).
2. A copper ingot was well connected with a nickel ingot at room temperature, as shown in Fig. 1A(a). Before high temperature treatment, the schematic representations of Cu and Ni atom locations and concentrations of both atoms within the diffusion couple were shown in Figs. 1A(b) and 1A(c), respectively. We found an alloyed diffusion zone, shown in Fig. 1B(a), as the couple was annealed at high temperature. The atom locations and concentrations of both atoms within the diffusion couple were also transfer to Figs. 1B(b) and 1B(c), respectively. Please briefly describe the mechanisms of diffusion in this Cu-Ni couple during annealing. (10 %)
3. The hot saturated steam with 247 kPa flows through a metal pipe (assuming that  $k \gg 1$ ) of an outside diameter of 30 mm. The pipe is covered with an insulation having a thickness of 20 mm and  $k$  of 0.88 W/m-K. The pipe is exposed to Air at 300 K and a convection coefficient of 30 W/m<sup>2</sup>-K. Please calculate (a) the critical radius (5 %) and the heat loss per m of length for the bare pipe (5 %), as well as (b) the maximum heat loss for covering the insulation on the pipe assuming that the surface temperature of the pipe remains constant (請寫到小數點後第四位). (10 %)
4. A fluidized coal reactor has been proposed for a new power plant. If operated at 1145 K, the process will be limited by the diffusion of oxygen countercurrent to the carbon dioxide, CO<sub>2</sub>, formed at the particle surface. Assume that the coal is pure solid carbon with a density of  $1.28 \times 10^3$  kg/m<sup>3</sup> and that the particle is spherical with an initial diameter of 150 μm. Air exists several diameters away from the sphere. Under the condition of the combination process, the diffusivity of oxygen in the gas mixture at 1145 K is  $1.3 \times 10^{-4}$  m<sup>2</sup>/s. If a steady-state process is assumed, please calculate the time necessary to burn out the coal. (10 %)
5. Please write down the (1) Fick's Law, (2) Fick's 1<sup>st</sup> Law, (3) Fick's 2<sup>nd</sup> Law, and (4) the general equation of continuity. The physical meaning of each term in the equations is necessary to be clarified. (10 %)
6. Water on the horizontal apron of the 100-ft-wide spillway in Fig. 2 has a depth of 0.6 ft and a velocity of 18 ft/s. Determine the depth,  $y_2$ , after the jump, the Froude numbers before and after the jump,  $Fr_1$  and  $Fr_2$ , and dissipated,  $\mathcal{P}$ , within the jump. (20 %)
7. Please see the Fig. 3(a). The water is pumped from a large open tank (1) to another large open tank (2). The diameter of pipe is 6 in. and the total length of the pipe between the entrance and exit is 200 ft. Minor loss coefficients for the entrance, exit, and the elbow are shown on the figure, and the friction factor for the pipe can be assumed constant and equal to 0.02. A certain centrifugal pump having the performance characteristics shown in Fig. 3(b) is suggested as a good pump for this flow system. With this pump, what would be the flow rate between the tanks? Do you think this pump would be a good choice? (20 %)

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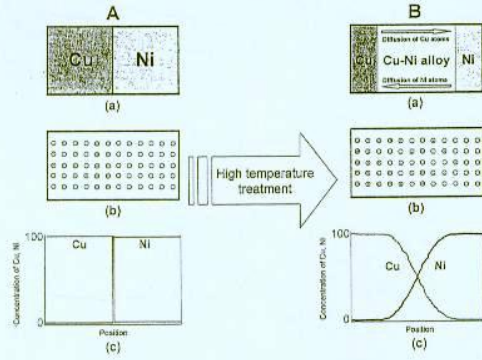


Fig. 1.

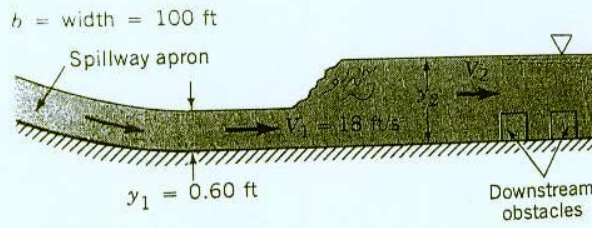


Fig. 2.

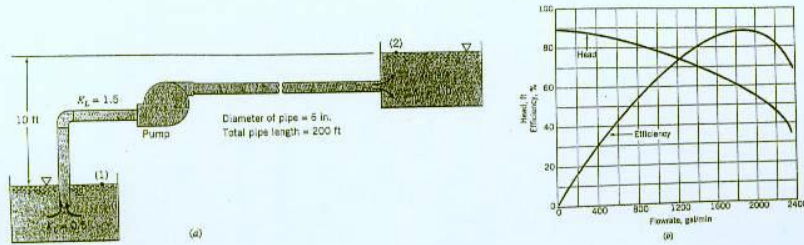


Fig. 3.

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