

國立中央大學八十五學年度碩士班研究生入學試題卷

所別: 化學工程研究所 不分組 科目: 單元操作

共 1 頁 第 1 頁

1. (15%)

For the axial flow of an incompressible Newtonian fluid through a slit of width W , thickness $2B$, and length L under a pressure drop $P_0 - P_L$ ($B \ll W \ll L$), find the expression for volume rate of flow Q .

2. (20%)

A pump draws water from a storage tank through a 75-mm steel pipe. The efficiency of the pump is 60 percent. The velocity in the suction line is 0.9 m/s. The pump discharges through a 50-mm pipe to an overhead tank. The end of the discharge pipe is 15 m above the level of water in the feed tank. Friction losses in the entire piping system are 30 J/Kg. What is the power of the pump? What pressure must the pump develop (i.e., the difference of outlet pressure and inlet pressure of the pump)?

3. (20%)

A thermopane window consists of two pieces of glass 7 mm thick that enclose an air space 7 mm thick. The window separates room air at 20 C from outside ambient air at -10 C. The convection effect on the air enclosed between the panes can be neglected. The convection coefficient associated with the inner (room-side) surface is 10 W/m² K, while that associated with the outer (ambient air) side is 80 W/m² K. What is the heat loss through a window which is 0.8 m long by 0.5 m wide? Thermal conductivity of glass is 1.4 W/m K, while that of air is about 0.025 W/m K.

4. (15%)

Air at a temperature of 27 C flows with a velocity of 2 m/s over a flat plate 0.5 m long. Estimate the heating rate per unit width of the plate needed to maintain it at a surface temperature of 200 C. The average Nusselt number for laminar flow over a plate is known as $Nu = 0.664 Pr^{1/3} Re^{1/2}$. For air at film temperature of 350 K, the thermal conductivity is 0.03 W/m K, the kinematic viscosity is 20.92×10^{-6} m²/s, and the thermal diffusivity is 29.9×10^{-6} m²/s.

5. (30%)

Membrane reactors have the advantage that the reaction and separation can all take place within the membrane.

In the membrane reactor of the following figure catalyst gel is contained between two membranes.

The following reaction takes place between the membranes:

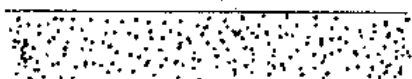


The bottom membrane is permeable to both A and B, while the top is permeable only to A.

- If the reaction is first order in A and zero order in C, derive equations for the concentration profiles of A, and B in the membrane and the flux of B out of the membrane.
- Derive an equation for the effectiveness factor.
- What is the effect of varying the flow rates on the product and reaction sides?
- What is the role of the mass transfer resistance of the membrane external on the overall effectiveness factor.

A, C (inert) ---->

A, C (inert) --->



<---- B, Sweep Fluid

<---- Sweep Fluid

