國立中正大學九十學年度碩士班招生考試試題

系所別：化學工程學系　　科　目：輸送現象與單元操作

1. (15 points)
   Answer the following questions.
   (a) Physical meaning of ∇p, where p is a scalar field.
   (b) Under what conditions, the Bernoulli equation can be used?
   (c) Why one needs two subscripts to describe a shear stress τ_{xy}?
   (d) Give an example where radiation is far more important than conduction and convection.
   (e) Why viscosity of liquid decreases as temperature increases?

2. (20 points)
   Consider a steady-state flow of a Newtonian fluid flowing down an inclined plane surface.
   (a) Write down the governing equation and boundary conditions.
   (b) Solve the velocity profile.
   (c) What is the driving force of this flow?

3. (15 points)
   A steady-state two-dimensional conduction problem is given as

$$\frac{\partial^2 T}{\partial x^2} + (1 + aT)\frac{\partial^2 T}{\partial y^2} = 0$$

   with the boundary conditions,

   $T = 0$, at $x = 0$ for all values of y
   $T = 0$, at $x = L$ for all values of y
   $T = T_1$, at $y = 0$ for $0 \le x \le L$
   $T = T_1$, as $y \to \infty$ for $0 \le x \le L$,

   (a) Solve the temperature profile for $a = 0$.
   (b) Show how to solve the temperature profile if $a \ge 0$ and $a << 1$.

4. In a mass transfer system the Sherwood number can be evaluated by the following equation:

$$N_{Sh} = 2 + 0.6 N_{Re}^{1/2} N_{Sc}^{2/3}$$

(a) What is the exact meaning of the value of "2" in this equation? Briefly describe how you can obtain $N_{Sh} = 2$.

(b) Define the Reynolds number N_{Re} and Schmidt number N_{Sc} in this equation.

(10 points)

5. Briefly define the following terms and when there is more than one, compare and contrast their general characteristic with those of others in the same groups:

(a) crushers, grinders

(b) minimum number of plates, minimum reflux ratio

(c) humidity, relative humidity

(15 points)

6. Acetinomycin is an antibiotic produced by fermentation. A countercurrent extraction equipment is used to extract acetinomycin from its mixture with water by means of butyl acetate. The feed consists of 260 mg/*l* of acetinomycin. Pure solvent (butyl acetate) is used as the extracting liquid. Assume that the acetinomycin concentrations in the extract flow (V) and raffinate flow (L) are in equilibrium in each of the stages, from one end of the extractor to the other. The equilibrium relation is $x_n = Ky_n$ with $K = 50$. Here x and y are respectively the acetinomycin concentrations in the extract and raffinate flows. Assume that flow-rates for the extract and raffinate flows are constant at L = 450 *l*/h and V = 37 *l*/h, respectively. You hope to remove 98 % of the antibiotic in the feed.

(a) Find the equation of the operating line.

(b) Find the concentration of acetinomycin in the extract flow leaving the extraction unit.

(c) Calculate the number of ideal stages required (N), based on both the graphic method and the equation for N.

(d) Suggest an extractor for this antibiotic extraction.

(25 points)