练 习 九

1. Understanding processes for transporting mass, momentum, energy, and species is one of the paradigms of modern chemical engineering. Most chemical processes are controlled by the interplay between transport processes and chemical reaction. Examples include the design of artificial organs for the body, reactors for reactive ion etching and chemical vapor deposition used in the processing of optoelectronic materials, the coupling between fluid mechanics and molecular structure in polymer processing, and the understanding of transport and chemical reaction in packed beds used in industrial-scale chemical reactors.

2. Modern research in transport processes addresses these issues through a combination of theory, computation, and experiment. Chemical engineers have been at the forefront of these applications in analysis of fluid mechanics and heat and mass transport, where progress in the last quarter century has greatly influenced engineering science and technology. Many of these developments have been based on traditional systems and on flow, mass and energy transport in homogeneous Newtonian fluids. The style of this research has been classical; the mathematical description of the processes has been well established and analysis and computation have aimed at understanding the effects of changes in thermophysical properties and operating conditions on transport rates. Experiments have verified theories and established new operating regimes.

3. Today the frontiers of transport processes have shifted toward more complex physicochemical systems and toward new applications. Many of the fundamental studies involve understanding transport processes in materials with microstructure, such as polymer melts and solutions and colloids, flow of suspensions, and transport through porous media. The issues in current research are quite broad, because it is necessary to model the constitutive equation underlying the continuum description of each transport process, as well as to account for the dynamics of systems obeying these descriptions.

4. Many processing operations depend for their success on the effective agitation and mixing of fluids. Though often confused, agitation and mixing are not synonymous. Agitation refers to the induced motion of a material in a specified way, usually in a circulatory pattern inside some sort of container. Mixing is the random distribution, into and through one another, of two or more initially separate phases. A single homogeneous material, such as a tankful of cold water, can be agitated, but it cannot be mixed until some other material (such as a quantity of hot water or some powdered solid) is added to it.

5. The term mixing is applied to a variety of operations, differing widely in the degree of homogeneity of the "mixed" material. Consider, in one case, two gases which are brought together and thoroughly blended, in a second case, sand, gravel, cement, and water which are tumbled in a rotating drum for a long time. In both cases the final product is said to be mixed. Yet the products are obviously not equally homogeneous. Samples of the mixed gases--- even very small samples ---all have the same composition. Small samples of the mixed concrete, on the other hand, obviously differ widely in composition.

6. Steady-flow process in a steady-flow process, the flow rates and the properties of the flowing materials, such as temperature, pressure, composition, density, and velocity, at each point in the apparatus, including all entrance and exit ports, are constant with in it. These quantities can, and usually do, vary from point to point in the system, but at any one location they do no change. Because of this constancy of local conditions, there is no accumulation or depletion of either mass or energy within the apparatus, and all material and energy balances are of the simple type: Input = output

7. The behavior of fluids is important to process engineering generally and constitutes one of the foundations for the study of the unit operations. An understanding of fluids is essential, not only for accurately treating problems on the movement of fluids through pipes, pumps, and all kinds of process equipment but also for the study of heat flow and the many separation operations that depend on diffusion and mass transfer. The branch of engineering science that has to do with the behavior of fluids—and fluids are understood to include liquids, gases, and vapors—is called fluid mechanics. Fluid mechanics in turn is a part of a larger discipline called continuum mechanics, which also includes the study of stressed solids.