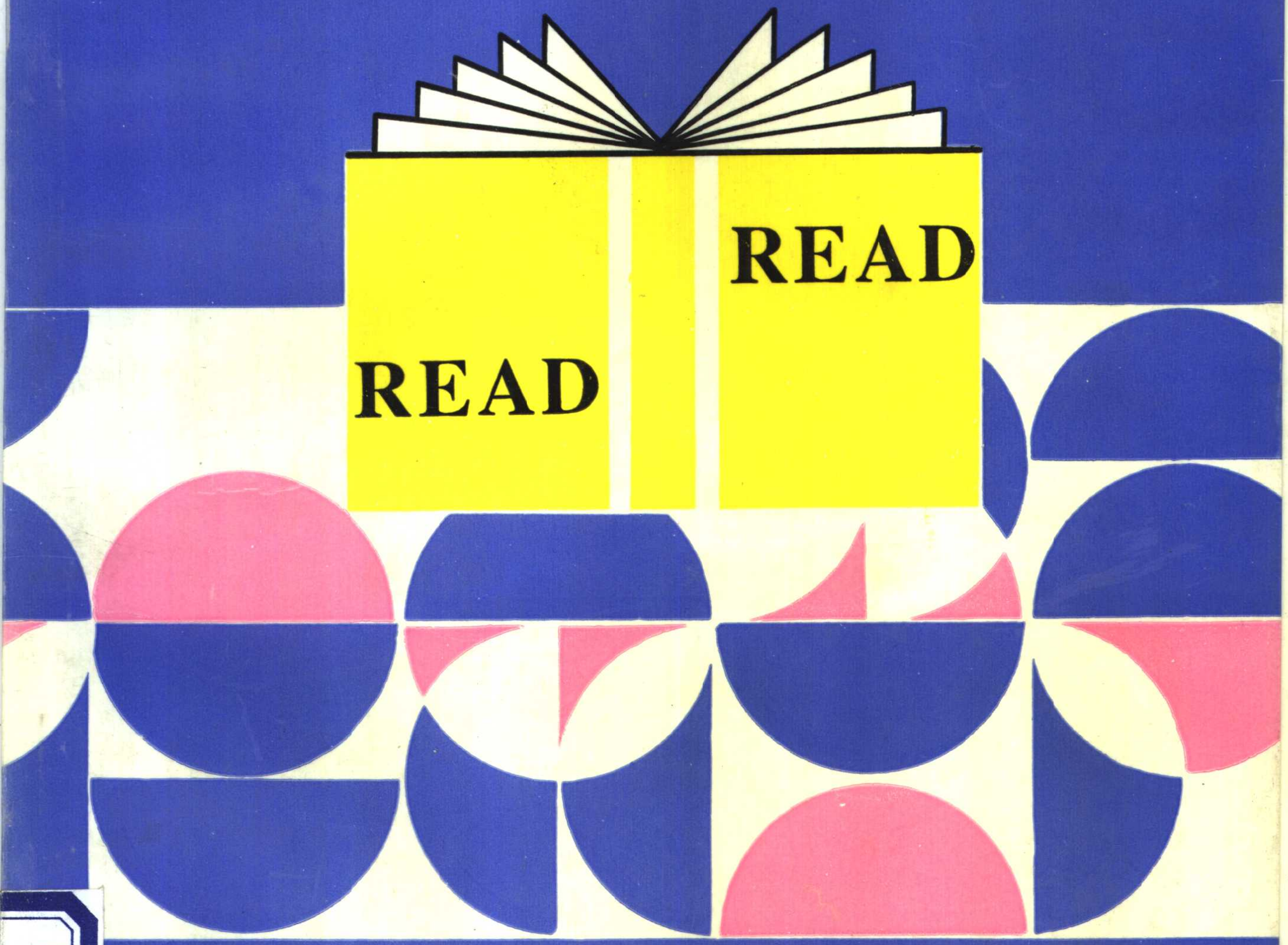
化学工程(石油加工)
专业英语阅读教程

主　编　罗雄麟



石油大学出版社

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前　　言

本书是根据《高等学校理工科大学英语教学大纲》和《石油高校大学英语专业阅读阶段教学大纲》编写的。它是高等学校化学工程(石油加工)专业的专业英语阅读教材，也可供其它相近专业选用，还作为有关工程技术人员的参考书。

本书旨在培养学完基础英语的大学化学工程(石油加工)专业学生顺利阅读专业英语的能力。阅读材料是从英语版专业书籍中精选的。全书共16单元，前8个单元为化学工程部分，包括流体流动、传热、传质、精馏、吸收和化学反应工程等；后8个单元为石油加工部分，包括原油性质、常减压精馏、延迟焦化、催化裂化、催化重整、催化加氢和润滑油生产等。每单元含两篇课文，其中Passage A为主课，Passage B为副课。每课之后均设有词汇与短语、注释，主课之后还设有阅读理解、词汇和英译汉等练习。主课用于课堂教学，副课用于课后阅读。本教程安排64学时，教师可根据具体情况，有选择地安排教学。

本书由石油大学(华东)罗雄麟主编，化学工程专业和英语专业教师联合编写，参加编写的有(按姓氏笔画为序)：山红红、王清亭、刘宇慧、吕春胜、张艳梅、张桂萍和罗雄麟等。在本书编写过程中，石油大学(华东)吴铭方教授自始至终给予了极大的关心和帮助，石油大学出版社给予了大力支持，在此一并表示感谢。

专业英语教材的编写毕竟是一种尝试，对于书中不足之处，诚恳欢迎广大师生和读者批评指正。

编　者

1997年12月

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UNIT 1

Passage A

CHEMICAL ENGINEERING

1. Definition of Chemical Engineering

* Chemical engineering is defined as "…the application of the principles of the physical sciences, together with the principles of economics and human relations, to fields that pertain directly to processes and process equipment in which matter is treated to effect a change in state, energy content, or composition…". [1] This very vague definition is intentionally broad and indefinite as to the extent of the field. It is probably as satisfactory a definition as any practicing chemical engineer would give. It should be noted that considerable emphasis is placed on the process and process equipment. The work of many chemical engineers would better be called process engineering.

The process may be any collection of steps involving changes in chemical composition or involving certain physical changes in material being prepared, processed, separated, or purified. The work of many chemical engineers involves choosing the appropriate steps in the appropriate order to formulate a process for accomplishing a chemical manufacturing operation, a separation, or a purification. Since each of the steps constituting a process is subject to variations, the process engineer must also specify the exact conditions under which each step is to be carried out.

As the process evolves and equipment must be designed, the work of the chemical engineer merges with that of the mechanical and civil engineer. * The transfer of primary responsibility from the process engineer to the mechanical engineer can take place satisfactorily at various stages of the design, so it is impossible to define a fixed extent to which the responsibility should be called that of a chemical engineer or a stage at which the mechanical engineer should take over responsibility for equipment. [2]

At the time the definition quoted above was presented, the physical sciences referred to were primarily chemistry and some classical physics. As the understanding of mathematical models of chemical processes advances, the treatment of the chemistry and physics of the process is expressed in considerably more mathematical form. Increasing use of thermodynamics, fluid dynamics, and mathematical techniques such as probability and statistics, matrix manipuiation, and complex variables is characteristic of modern chemical engineering practice. * In most processes being carried out on a large scale, however, the chemistry has been previously worked out, and the physical changes incident to preparation and purification of the reaction mixtures demand considerably more study than does the chemical reaction. [3] Frequent application of the principles of physics and of physical chemistry is required in the processing steps that produce physical changes, such as vaporization, condensation, or crystallization. As a process evolves into a plant and the work merges with that of mechanical designers, the science of mechanics becomes increasingly important. The chemical engineers who specialize in equipment must have thorough and extensive grounding in mechanics of materials.

All of an engineer's work must be quantitative, and mathematics is therefore a fundamental tool of the engineer. Unfortunately, our understanding of mathematics is largely restricted to the domain of linear mathematics, and, equally unfortunately, chemical molecules seldom behave in accordance with linear mathematical rules. Energy and material balance calculations, which are fundamental to any process study, can usually be expressed with confidence and precision in terms of linear mathematics, as long as we omit atomic and nuclear processes from our considerations. * In the economic study to determine the most profitable operating conditions——and in accounting for the sales receipts and distribution of income to profits and costs, including replacement of the plant——mathematical calculations are universal. [4]

The existence or contemplation of a process implies that a material is to be produced for which customers will pay. It must be delivered in a quantity, of a quality, and at a price which are acceptable to the customer. Simultaneously, it must pay for materials, labor, and equipment used in the manufacture and return a profit over and above all costs. Many materials produced by the chemical industry are planned and plants built before the real market potential has been developed. For a completely new product, some estimate of the size of the market must be made, and the plant should be scaled in proportion.

The human-relations aspect of engineering practice is not usually emphasized in undergraduate training because of the great quantity of technical information and techniques the student must learn. * That this may be a fallacious course is implied by the fact that failures of young engineers because of personnel problems are at least five times as frequent as failures because of inadequate technical training. [5] All engineers must realize that the industry in which they are working requires team effort of all personnel. Valuable information can be obtained from operators of limited educational background who have observed similar processes. The person who has "lived" with an operation has probably observed * actions and effects[6] and has learned methods of detailed control that cannot be approached by formal theory alone. The best engineering job can be done only with proper regard for all available facts regardless of their source. A new process or the technical improvement of an existing one designed without due regard for the operators is usually destined to failure. * The start-up of a new plant or the installation of a technical change is likely to be much smoother and the cost of it much less if the operating personnel understand the objectives and are convinced of their soundness. [7]

Before attempting to describe the operations that comprise a chemical process, it is necessary to introduce several basic concepts that must be understood before a description of the operations is meaningful.

2. Equilibrium

There exists for all combinations of phases a condition of zero net interchange of properties (usually mass or energy in chemical processing) called equilibrium. For all such combinations not at equilibrium, the difference in concentration of some property between one in the existing condition and one that would exist at the equilibrium condition is a driving force, or a potential difference, tending to alter the system toward the equilibrium condition. The tendency of thermal energy to flow from a region of high concentration——hot body——to a region of low concentration——cold body——is universally familiar. Similarly, the tendency of electrical energy to flow from a region of high potential to one of low potential in accordance with Ohm's law ($I=E/R$) is well known. The tendency of acetic acid to flow from an acetic acid-water solution into an ether phase in contact with it is less widely known. The description of this equilibrium is considerably more complicated than the statement of equality of temperatures, which describes the equilibrium of energy of molecules. Material will flow from a region of high concentration (activity) to one of low concentration (activity), just as heat and electricity flow from high- to low-concentration regions in the situations mentioned above.

The expression of the equilibrium condition is familiar to all in connection with electrical and thermal energy. The concentration of such energy is expressed directly as a voltage potemial or a temperature. Accordingly, two bodies at the same electrical potential, or at the same temperature, will be in equilibrium with regard to that particular kind of energy. For the equilibrium between a liquid and its vapor, the vapor-pressure curve is reasonably familiar. The curve expresses in pressure units the concentration of vapor that is in equilibrium with the pure liquid when both are at a specified temperature. In case of a liquid mixture, equilibrium must exist between the liquid phase and the vapor phase in regard to each and every constituent present. For a binary mixture, the relation is a relatively simple one describing the concentration or partial pressure of each constituent in the vapor phase that is in equilibrium with a liquid of one particular composition at the specified temperature. Obviously, the vapor will be of different composition when it is in equilibrium with different liquid mixtures. The expressions for equilibrium in multicomponent mixtures between the liquid phase and its vapor or bexween two liguid phases having partial solubilities become more involved. In every case, the condition must be satisfied that the potential for each constituent is identical in all equilibrium phases of a particular system.

3. Driving Force

When two substances or phases not at equilibrium are brought into contact, there is a tendency for a change to take place that will result in an approach toward the equilibrium condition. The difference between the existing condition and the equilibrium condition is the driving force causing this change. The difference can be expressed in terms of concentrations of the various properties of substances. For example, if liquid water of low energy concentration——that is, low temperature——is brought in contact with water vapor of high energy concentration——that is, high temperature——energy will be transferred from the vapor phase to the liquid phase until the energy concentration is the same in both phases. In this particular case, if the amount of liquid is large in comparison with the vapor, both phases become one by the condensation of the vapor as its energy is transferred to the cold water. The final mixture will be an increased amount of liquid water at a higher temperature than initially and a decreased amount of water vapor. This combination reaches equilibrium very quickly, at a temperature such that the vapor pressure of the water equals the pressure of the vapor phase. * A similar line of reasoning can be followed in the case of two electrical condensers charged to different concentrations (i. e. voltage). [8] If they are brought into electrical contact, the electrical energy will flow from the region of higher concentration to that of lower. Both condensers will be charged to the same voltage when equilibrium is reached.

A less familiar type of driving force exists when a solution of acetic acid and water is brought in contact with isopropyl ether. The three materials will usually separate into two liquid phases, each containing some quantity of all three components. The concentration of each of the three substances in each of the two phases must be known to describe the equilibrium condition. If two phases that are not in equilibrium are brought together, a transfer analogous to that for electrical and thermal energy will occur. The result will be a transfer of isopropyl ether into the water-acid phase and the transfer of both water and acid into the ether phase until the potential of each constituent is identical in the two phases. There is no convenient and simple expression for the chemical potential; hence, the amount per unit volume, or concentration, of mass in such a phase is commonly so designated. Mass concentration is not a rigorous definition, but the more accurate and more complex functions of activity, fugacity, and Gibbs free energy demand more knowledge of physical chemistry than is expected at this time. In the preceding example the mass concentration of a component is different in each phase at equilibrium.

In all cases discussed above, the potential (concentration) of an existing substance or mixture when compared with the potential at the equilibrium condition yields a difference in potential that is a driving force, tending to change the conditions of the system toward the equilibrium. The driving forces, or differences in the potential of energy or matter, will tend to produce a change at a rate directly proportional to the difference from the equilibrium potential.

4. Separations

Obviously, the separation of a solution, or other physically homogeneous mixture, requires preferential transfer of a constituent to a second phase that may be physically separated from the residual mixture. Illustrations are the dehumidification of air by condensing or by freezing a part of the moisture, or the use of a liquid solvent that is insoluble in the unextracted material. Any two phases that exhibit preferential distribution of constituents and that can be easily separated may be involved in a separation operation. Two solid phases may be very difficult to separate; a liquid and a gas or solid usually may be easily separated; * two liquids of approximately equal density and no interfacial tension may resist all practicable separation means short of altering one of the phases. [9]

5. Flow Patterns

In many of the operations for transferring energy or material from one phase to another, it is necessary to bring two streams into contact to permit a change toward equilibrium of energy or of material, or both. The transfer may be accomplished with both streams flowing in the same direction (i.e., cocurrent flow). If cocurrent flow is used, the limit in amount of transfer that can occur is firmly set by the equilibrium conditions that will be reached between the two streams being contacted. If, however, the two streams being contacted are made to flow in opposite directions, transfer of material or energy in considerably greater am unts is possible. Such a flow pattern is known as countercurrent flow.

As an illustration, if a stream of hot mercury and a stream of cold water are allowed to reach thermal equilibrium, the temperature attained can be predicted by a heat balance that recognizes the relative quantities of the streams, their initial temperatures, and their heat capacities. If the streams flow simultaneously from the same inlet point to the same outlet point, the equilibrium temperature is definite, and the path is as indicated in Fig. 1 a. * If the streams are made to flow in opposite directions, as by letting the mercury flow downward through an upflowing stream of water, it is possible for the entering hot-mercury stream to raise the temperature of the leaving cool-water stream to a temperature above that to which the mecury stream is lowered as it leaves the contacting equipment, as indicated in Fig. b.[10] The counterflow principle is used in many chemical engineering operations in order to permit greater transfer of a property than would be indicated merely by the attainment of a single equilibrium between the leaving streams.

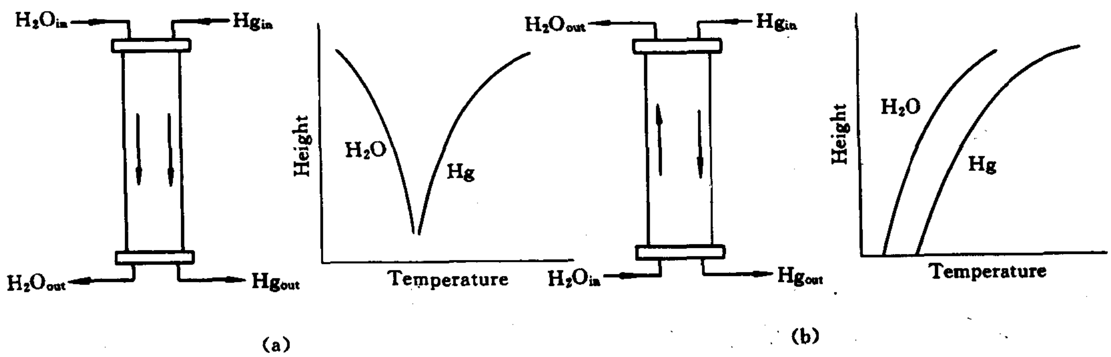

Fig. 1 Flow and temperature in a contactor
(a) Concurrent, (b) Counter

6. Continuous and Batch Operation

In the majority of chemical processing operations, it is more economical to maintain continuous and steady operation of equipment, with a minimum of disturbances and shutdowns. This is not always practical in some small-scale operations, in operations where extremely corrosive conditions force frequent repairs, and in others for various specific reasons. Because of the greater productivity of continuously operating equipment and the resultant lower unit cost, it is usually advantageous to operate equipment continuously. This means that time is not a variable in the analysis of such a process, except during the rather brief start-up and shutdown periods. The time rate of transfer or of reaction is important in fixing the necessary size and capacity of equipment, but the performance is expected to be the same today, tomorrow, or next year if the operating conditions remain the same. Conditions are not constant throughout a system at any time, but those at a particular point are constant with time.

When small quantities of material are to be processed, it is often more convenient to charge the entire quantity of material to the equipment, process it in place, and remove the products. This is called a batch operation.

An operation that is variant with time is spoken of as a transient or unsteady state, in contrast with that spoken of as steady state, in which conditions are invariant with time. Quenching a steel part for heat treating and freezing ice cubes in a domestic refrigerator are illustrations of unsteady-state operations. In batch operations, almost the entire cycle is a start-up transient and a shutdown transient. In a continuous operation, the time during which the start-up transient exists may be extremely small in comparison with the steady state operation. Analysis of transient or batch operations is usually more complex than of steady state operation. * Because of the greater simplicity and the wide occurrence throughout chemical processing of steady-state operations, the introductory treatment is in terms of conditions that do not vary with time.[11] Analysis of a transient operation is different from the steady state only in the introduction of the additional variable of time. This variable complicates the analysis but does not fundamentally change it.

New Words and Expressions

pertain [pə'tein] ***vi.***	从属，有关，适合(后可接 to)
intentionally [in'tenʃənəli] ***ad.***	有意地，故意地
formulate ['fɔːmjuleit] ***vt.***	构想出(计划、方法等)
merge [məːdʒ] ***v.***	合并，结合(后可接 with)
vague [veig] ***a.***	含糊的，模糊的，不明确的
matrix ['meitriks] ***n.***	基质，基体；模型；矩阵
manipulation [məˌnipju'leiʃən] ***n.***	应付，处理
incident ['insidənt] ***a.***	伴随而来的(后可接 to)
domain [də'mein] ***n.***	(活动、思想等)领域，范围
linear ['liniə] ***a.***	线性的；构线的；利用线的
linear mathematics	线性数学
contemplation [ˌkəntem'pleiʃən] ***n.***	沉思；打算，期望
simultaneously [ˌsiməl'teiniəsli] ***ad.***	同时发生[存在]地，同时
fallacious [fə'leiʃəs] ***a.***	谬误的，靠不住的
equilibrium [ˌikwi'libriəm] (*pl.* equilibria [ˌikwi'libriə], equilibriums) ***n.***	平衡，均衡
acetic [ə'siːtik] ***a.***	酸的；醋酸的
acetic acid	醋(乙)酸)
ether ['iːθə] ***n.***	醚，乙醚
involved [in'vɔlvd] ***a.***	不易懂的，复杂的
constituent [kən'stitiuənt] ***n.***	成份，组份
binary ['bainəri] ***a.***	二；双；二成份的；二进制的
solubility [ˌsɔlju'biliti] ***n.***	溶(解)度，溶(解)性，可溶性
condenser [kən'densə] ***n.***	冷凝器；电容器
isopropyl [ˌaisəu'prɔpil] ***n.***	异丙基
analogous [ə'næləgəs] ***a.***	类[相]似的，模[比]拟的
rigorous ['rigərəs] ***a.***	严密的；严格的
fugacity [fju'gæsiti] n.	逸度

homogeneous [ˌhɔmə'dʒiːniəs] ***a.***	同种类的；同性质的，均一的
residual [ri'zidjuəl] ***a.***	剩(余)的；残(余、留)的
dehumidification ['dihjuˌmidifi'keiʃən] ***n.***	除湿(作用)
solvent ['sɔlvənt] ***n.***	溶剂
insoluble [in'sɔljubl] ***a.***	不可溶的
unextracted [ˌʌniks'træktid] ***a.***	未被萃取[抽提]的
preferential [ˌprefə'renʃəl] ***a.***	优先的，特[优]惠的，择优的
batch [bætʃ] ***a.***	间歇(式)的，分批的
disturbance [dis'təːbəns] ***n.***	混乱，骚乱
shutdown ***n.***	停工(车、堆、炉)
productivity [ˌprɔdʌk'tiviti] ***n.***	处理量，生产量
resultant [ri'zʌltənt] ***a.***	作为结果的，因而发生的
variant ['væriənt] ***a.***	不同的，差异的(后可接 with)
transient ['trænziənt] ***a.***	瞬态的，短暂的
start-up ***n.***	开工
steady-state ***n.***	稳态，定常态
cocurrent ***n.***	并流
countercurrent ***n.***	逆流
quench [kwentʃ] ***vt.***	急冷，骤冷；把……淬火
physical science	自然科学
civil engineer	土木工程师
interfacial tension	表面张力
cocurrent flow	并(同，平行)流

Notes

1. *Chemical engineering is defined as"…the application of the principles of the physical sciences, together with the principles of economics and human relations, to fields that pertain directly to processes and process equipment in which matter is treated to effect a change in state, energy content, or composition…"*. 注意"the application of the principles …, to fields…"(把……原理应用于……领域)这一结构。"in which"引导的定语从句修饰"processes and process equipment"。参考译文：化学工程定义为"……把自然科学的基本原理与经济学和人际关系学的基本原理结合一起，应用于与会引起状态变化、能量变化或组成变化的过程和过程设备直接有关的领域……。

2. *"The transfer of primary responsibility from the process engineer to the mechanical engieer can take place satisfactorily at various stages of the design, so it is impossible to define a fixed extent to which the responsibility should be called that of a chemical engineer or a stage at which the mechanical engineer should take over responsibility for equip-*

ment. 此句为并列复合句，由连词"so"连接两个并列分句。在第二分句中，"a fixed extent"与"a stage"为不定式"to define"的并列宾语，由连词"or"连接；前者被"to which"引导的定语从句所修饰，后者被"at which"引导的定语从句所修饰。"that of a chemical engineer"中 that 指代 responsibility。参考译文：在设计的各个阶段，主要任务都有可能从过程工程师合理地转到机械工程师；所以，就不可能规定该任务在多大程度上该是化学工程师的，或者规定在哪一阶段应由机械工程师接受设备设计的任务。

3. *In most processes being carried out on a large sacle, however, the chemistry has been previously worked out, and physical changes incident to preparation and purification of the reaction mixtures demand considerably more study than does the chemical reaction.* 此处比较状语从句"…than does the chemical reaction."为倒装句，助动词"does"提到主语前。本句为并列复合句，由"and"连接，但内含让步之意，因此译成"虽然…但是…"。句中 incident 为形容词，后接 to，意为"易发生的，随之而来的"，在句中作后置定语，修饰前面的 physical changes。参考译文：然而，大多数大规模生产过程前，化学研究工作虽已完成，但反应混合物的预处理和提纯中的物理变化比起化学反应本身还需要做更多的研究工作。

4. *In the economic study to determine the most profitable operating conditions —and in accounting for the sales receipts and distribution of income to profits and costs, including replacement of the plant —mathematical calculations are universal.* 参考译文：在确定使效益最佳的操作条件的经济研究中，以及在考虑销售与投资分配(包括装置的更换)时，广泛需要数学计算。

5. *That this may be a fallacious course is implied by the fact that failures of young engineers because of personnel problems are at least five times as frequent as failures because of inadequate technical training.* "that"引导主语从句，而"this"指代上一句，参考译文：这种做法有失偏颇，因为实际上年轻工程师由于人际关系相处不好而失败的比例比起由于技术训练不够而失败的比例至少高出 4 倍。

6. *actions and effects*：操作过程中的因果关系

7. *The start-up of a new plant or the installation of a technical change is likely to be much smoother and the cost of it much less if the operating personnel understand the objectives and are convinced of their soundness.* 句中"are convinced of their soundness"意为"确信其合理性"。参考译文：对一个新装置的开工或一项技术改造的施工，如果操作人员能理解其目的和认识其合理性，那么实现起来可能就顺利得多、费用也少得多。

8. *A similar line of reasoning can be followed in the case of two electrical condensers charged to different concentrations(i. e. , voltage).* 句中"charged to different concentrations"是过去分词短语，做后置定语。参考译文：对于两个电容器，充电到不同电位(电压)时会出现类似的情形。

9. *Two liquids of approximately equal density and no interfacial tension may resist all practicable separation means short of altering one of the phases.* 句中"short of altering one of the phases"意为"unless one of the phases is altered"。参考译文：密度接近并且没

有界面张力的两个液相实际上是不可分离的，除非改变其中一相。

10. *If the streams are made to flow opposite in derections,*① *as by letting the mercury flow downward through an upflowing stream of water, it is possible for the entering hot-mercury stream to raise the temperature of the leaving cool-water stream to a temperature above that to which the mecury stream is lowered*② *as it leaves the contacting equipment,*③ *as indicated in Fig. 1b.* 此句为带"if"引导的条件状语从句的主从复合句。注意句中三个"as"引导的状语从句，①和③句为省略了主谓语成份的方式状语从句；②句为时间状语从句。"what"为代词，代替名词"temperature"。参考译文：如果两流体逆流流动，如水银下流而水上流，则热水银其入口处将冷水出口处的温度提高到高于水银在接触设备出口处的温度，如图1b所示。

11. *Because of the greater simplicity and the wide occurrence throughout chemical processing of steady-state operations, the introductory treatment is in terms of conditions that do not vary with time.* 句中"in terms of"是短语介词，意为"根据"，"按照"，在此可译成动词"认为"。参考译文：由于稳态操作化学处理比较简单且作用广泛。初步分析时认为条件不随时间变化。

Exercises

Ⅰ. A: Choose the best answer according to the text.

1. In chemical engineering __________.
   a. chemistry should be applied only
   b. physics should mainly be applied
   c. mathematics is less applied
   d. chemistry, physics and mathematics should all be applied
2. Mathematics is applied to all the following except ________.
   a. the treatment of the chemistry and physics of the process
   b. energy and material calculation
   c. the process evolving into a plant
   d. the economic study to determine the most profitable operating conditions
3. Which of the following is NOT true?
   a. The human-relations aspect of engineering practice is important in undergraduate training.
   b. Students should learn more about human relations than technical information and techniques at university.
   c. Failures of young engineers because of human relations are, to some extent, due to the lack of undergraduate training in this aspect.
   d. Chemical engineering requires team effort of all the engineers.
4. When a solution of acetic acid and water is brought into contact with isopropyl ether?