实用化工英语阅读

陈　健　陆九芳　李总成　编

中国石化出版社

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内容提要

本书精选化工专业的英文文献，每篇文献附注了词汇、注释和参考译文。所选内容包括化工基本原理、单元操作、主要化工产品和相关的最新发展等方面，尽量包括了化工专业的各个领域。适用于具有一般大学英语水平的读者学习化工专业英语。

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前　言

本书精选化工专业的英文文献，每篇文献附注了词汇、注释和参考译文。所选内容包括化工基本原理、单元操作、主要化工产品和相关的最新发展等方面，尽量包括了化工专业的各个领域。适用于具有一般大学英语水平的读者学习化工专业英语。

各篇附注的词汇是当篇的化工词汇及较难的通用词汇，为了便于分别阅读，各篇的词汇彼此独立，因此可能有重复。注释主要针对较难的句子结构。最后附作者翻译的参考译文，供读者参考。译文中注意了行业中的习惯用语。

除作者之间进行相互审阅外，下列人员也参加了审阅工作：清华大学紫光集团的孙林林高级工程师、清华大学化工系的胡山鹰副教授和梅东海博士后。作者在此一并表示感谢。

在编写过程中，由于编者水平有限，难免出现一些错误和非行业用语，作者希望广大读者给予指正。

编　　者

一九九六年十二月于清华园

目　　录

1. CHEMICAL ENGINEERING

Chemical engineering is concerned with transforming raw materials to final products by substantial chemical, biochemical or physical change of state[1]. It has traditionally been closely linked to the development and fortunes on the chemical and petroleum industries. These industries provide an enormous variety of products; such as synthetic rubber, gasoline and kerosene, fertilizers tailored for wheat, rice or any kind of vegetables, oxygen for firing blast furnaces or for medical uses. The discipline of chemical engineering has also always played a major part in the work of a much wider range of industries, the process industries[2]. These include processing of food and drink, manufacture of textiles and paper, pharmaceuticals, glass and ceramics, the extraction of metals and the production of synthetic fibbers and other polymers. The chemical engineering is thus involved in the manufacturing of many goods that are bought directly by the consumer for everyday use but perhaps to a greater extent, with products that form the raw materials for manufacturing processes in a much wider range of industries[3].

Chemical engineering grew out of chemistry as it becomes recognized that the manufacture of chemicals required more than just a simple "scalingup" of the chemical processes that were carried out on the laboratory bench[4]. One of the cornerstones in its development was the concept of unit operations. Although chemical processes differ from one another, the plants in which chemicals are produced are all made up by linking together different combinations of similar processing steps or "unit operations". The underlying principles of distillation are the same whether we are distilling crude oil as a primary separation step in an oil refinery, distilling air to separate oxygen and nitrogen, or distilling the product of fermentation to produce wine; filtration of salt crystals from a brine solution or microbial cells from a fermentation broth are all governed by the same physical processes and can all be described in a similar way[5]. Chemical engineering thus concentrated on the general description and understanding of individual unit operations—distillation, gas absorption, crystallization, drying, filtration, extraction, leach and so on—rather than on a specific description of each individual chemical manufacturing process[6]. So was evolved a methodology for the development of design procedures for different unit operations and for an understanding of how individual unit operations worked as a part of a complete chemical processing plant[7]. Unit operations continue to form a central part of the discipline of chemical engineering.

One interesting outcome was the realization that the majority of operations that are involved in chemical plants are not in fact chemical at all, but are rather physical processes, the separation processes mentioned above, for example, but also heating and cooling of process streams, pumping fluids from one piece of equipment to another or transferring solid through hoppers or cyclones[8]. Although the chemical reactor is usually at the heart of a process, other processing steps are crucial to the successful operation of the plant. The synthesis of a specific chemical product usually produces a processing stream that contains unconverted reactant and perhaps by-products. These chemical species have to be separated from one another so that unreacted material can be recycled and the required product produced at the specified purity.

A major development in understanding of chemical engineering came in the 1960s with the evolution of a "chemical engineering science" approach to the subject. By highlighting and developing a quantitative and mathematical description of the inner details of unit operations, emphasizing the links between heat transfer, mass transfer and momentum transfer (or fluid mechanics), it put the subject on a secure and rigorous basis[9]. The design of chemical reactors also attracted increasing attention. Chemical engineers need to understand more than just the chemical kinetics of a reaction. They need to define the extent to which the diffusion rates of reactants and products may limit the overall reaction rate, to understand the role of heat transfer in removing or adding the heat of reaction, to design the geometry of the reactor so that the fluid flow patterns result on effective contact between the reactants and with any catalyst that may be involved[10].

More recently greater emphasis has been placed on a systems approach to the study of chemical engineering where the process as a whole is studied, the interactions between different units are explored and the control scheme for, and controllability of, the process is given increasing emphasis[11].

As a result of these developments, chemical engineering now stands alongside civil, mechanical and electrical engineering as one of the four fundamental engineering disciplines. It is characterized by a particular approach to the solution of a wide range of problems; it deals with phenomena that are taking place at the molecular scale and so chemical engineers must be familiar with the concepts of chemistry; it also emphasizes a system approach, looking at the overall picture as well as the innermost details of the molecular processes that are taking place[12]. Chemical engineering is concerned with the mechanism by which reactions and separations occur and with the synthesis of the whole process. It is inherently interdisciplinary in nature, drawing on concepts from chemistry and physics, the biological sciences and other engineering disciplines, materials science and mathematics, and welding these together with its own specific areas of knowledge[13]. And because the chemical processing industries are science-based, chemical engineering is deeply involved in basic and applied research.

Although very successful, it is probably true to say that the traditional chemical industry does not have a good image. It is often associated with dirt, smells and the discharge of polluting substances to the air, to rivers and to the sea. The industry is now spending vast sums of money to redress some of these problems and is coming to terms with the new challenges that it faces. It must work for a cleaner, safer environment; it must develop more efficient ways of converting raw materials to products of high value; it must minimize the generation of waste and maximize the role of recycling; and it must develop more efficient supply and use of clean energy sources[14]. Chemical engineers will be at the center of such developments, contributing their unique skills to these challenging problems. Perhaps their most challenging task is in relation to the impact of chemicals on the environment where they have the responsibility to act as 'cradle-to-grave' guardians for chemicals[15]. Although it is the youngest of the four major engineering disciplines, chemical engineering is now in many ways a mature discipline. But it is entering a period of rapid change and great excitement where the specific skills, knowledge and approach of chemical engineers are contributing to the solution of an ever expanding range of problems. We are sure that chemical engineering has a unlimited future.

[词汇]

biochemical	生物化学的	petroleum	石油
synthetic	合成的	rubber	橡胶
gasoline	汽油	kerosene	煤油
fertilizer	肥料	tailor for	适合于
oxygen	氧,氧气	blast	鼓风

discipline	学科
pharmaceutical	药物的
extraction	萃取，提取，抽提
polymer	聚合物
scaling-up	放大
concept	概念
crude oil	原油
nitrogen	氮，氮气
crystal	晶体，结晶，水晶
microbial	细菌的，微生物的
gas absorption	气体吸收
filtration	过滤
unit operation	单元操作
majority	大多数
cyclone	旋风分离器
crucial	决定性的
unconverted	未转换的
by-product	副产物
highlight	强调
approach	方法
momentum	动量
kinetics	动力学
diffusion	扩散
catalyst	催化剂
civil engineering	建筑工程
electrical engineering	电子工程
inherently	固有地
interdisciplinary	学科间的
polluting substance	污染物质
textile	纺织的
ceramics	陶瓷
fibber	纤维
manufacture	制造
cornerstone	基石
distillation	蒸馏，精馏，馏份
refinery	精制，精炼厂
fermentation	发酵
brine	盐水
broth	肉汁
crystallization	结晶
leach	浸取，浸出
methodology	研究方法
hopper	漏斗，给料器
reactor	反应器，反应堆
synthesis	合成，综合
reactant	反应剂
recycle	再循环
quantitative	定量的
subject	题目，科目，主题
fluid mechanics	流体力学
extent	程度，范围
geometry	几何(学)
controllability	可控性
mechanical	机械的
solution	溶液，解答
weld	焊接，熔合
discharge	卸料，排放，放出
minimize	减至最小

redress	调整,纠正	generation	产生,制造,一代
waste	废物,废弃的	maximize	增至最大
impact	碰撞,影响	environment	环境
cradle	摇篮,支架	mature	成熟的
excitement	兴奋,刺激		

[注释]

1. 这句话的直译为:"化学工程涉及到由物质的化学、生物化学和物理状态的变化而从原料转变为最终产品"。这样句子的中文显然不够通顺。因此,只能按照英语句子的意思而从新组织中文句子,为此,就有可能要增加或减少一些词,或改变句子的结构。本译文中的"任务"就是加上去的。这种情况在以后很常见。因此,我们认为对译文的要求最少应有两条:1.忠实于原意(不然就不是译文了);2.中文通顺。
2. process 一般应译为"过程",但是 process industry 译为"过程工程"就不大通顺了,此处译为"制造(加工)工业"。
3. 在英语科技文章中,常用动词的被动语态,而且句子往往相当长。这个句子就是一个例子。句子中主语为 chemical engineer,谓语为 is involved,是被动语态,后面的 in 和 with 均为 involve 所要求,而构成 involve in 和 involve with 两个短语,用 but 连接,而这两个短语语又各有一个以 that 引起的定语副句,分别说明 goods 和 products。
4. as 后面引起的是时间状语副句,此副句又以为 it 引语,becomes recognized 是谓语,that 后面是副句中的真正主语,它本身又是一个句子。其中主语是 manufacture,谓语是 required,第二个 that 后面的是定语副句。这种副句套副句的情况在科技文章中很常见。读者如不能一下读懂,就要用所掌握的语法知识对句子结构进行分析。
5. 这也是一个长句子,是个并列句,用分号";"连接。第一分句中又有一个用 whether…or…引起的并列句,句子中的 distillation 在此句中译为"精馏"。
6. extraction 可译为萃取、提取或抽提,在此处应译为"萃取",即液液萃取。但是在第一段中应译为"提取",这是根据原句的内容而选择的。本句中两个破折号之间是同位语。
7. 这是一个倒装句,主语是 methodology,谓语是 was evolved,倒装的作用是为了强调 so 的意义,这种句子一般只在书面语言中出现。
8. 这又是一个长句子,主语是 outcome,was 是系动词,realization 是表语,后面是 realization 的定语副句,而 are involved in chemical plant 又是 majority of operation 的定语副句。
9. 本句的主语是 it,谓语是 put,而前面三行是由 by 引起的状语短语。
10. 本句中的谓语是 need,宾语是三个不定式,即 to define, to understand 和 to design。
11. 这是由三个短句组成的并列句,主语分别是 emphasis, interaction 和 control scheme。
12. 这是一个由三个短句组成的并列句,由分号连接,主语都是 it(即 chemical; engineering),第二个句子又是一个并列句,由 and 连接,第三个句子中 looking at 后面的短语为状语,因此本句是一个并列复合句。
13. weld 可译为"焊接",但是在此处应译为"融合"。

14. 这也是一个并列句，由分号和 and 连接。

15. cradle-to-grave 的直译为从“摇篮到坟墓”，此处译作“终身”。

[参考译文]

化学工程

化学工程的任务是通过物质的化学、生物化学和物理状态的变化而从原料制取产品。它过去一直与化学工业和石油工业的发展和命运紧密相关。这些工业提供了大量产品，如合成橡胶、汽油、煤油以及用于小麦、水稻和各种蔬菜种植的肥料，用于鼓风炉燃烧和医疗的氧气等等。化学工程学科还在广泛得多的工业部门的工作中也起着主要作用。这些工业部门包括食品和饮料的生产加工，纺织品、纸张、药品、玻璃和水泥的制造，金属的提取，以及合成纤维和塑料的生产等。因此化学工业涉及到人们直接购买的日常用品的制造过程，而且可能是在更大程度上，它生产的产品是许多其它工业所需要的原材料。

化学工程是从化学学科成长出来的。这是由于人们认识到化学品的制造并不仅是在实验室范围内的化学过程的简单放大。化学工程发展过程中的一个基石是单元操作的概念。虽然化学过程彼此之间是互不相同的，但是生产化学物质的工厂都是相似的操作步骤或“单元操作”的不同组合的连接而构成的。不论我们在石油精炼过程的初始分离步骤中精馏原油，还是精馏空气以分离氧气和氮气，或是精馏发酵液以制取葡萄酒，精馏所遵循的原理是相同的；而从盐水中过滤出盐的晶体和从发酵液中过滤出细菌体，都是由同样的物理过程所控制，并可以由同样的方式进行描述。这样化学工程就集中于在对这些单元操作的全面描述和理解，而不是对每一个单独化工过程的专门描述。这些单元操作包括精馏，气体吸收，结晶，干燥，过滤，萃取，浸出等等。所以，关于如何进行不同单元操作的设计过程，和关于这些单元操作如何作为一个完整的化工厂中的一个部分而工作的方法在逐步发展。而单元操作也一直成为化学工程学科中的一个核心部分。

一个有意义的结果是人们认识到：在化工厂中的大多数操作实际上并不完全是化学操作，而是物理过程，例如上述的分离过程，流体的加热和冷却，流体从一个设备泵入到另一个设备，或者通过漏斗或旋风分离器输送固体等等都是物理过程。虽然化学反应器常处在过程的核心部分，但其它的过程步骤对工厂的成功操作也是关系重大的。在一个特定化学产物的合成过程中通常会产生一股物流，其中包含有未转化的反应剂，也可能包含有副产品。这些化学物质必须进行分离以使未反应的物质能够循环到流程中，并使所要求的产物达到指定的纯度。

对化学工程认识的主要进展发生在60年代。此时“化学工程科学”发展成了学科。由于注意了并发展了单元操作内部细节的定量和数学的描述，强调了热量、质量和动量传递（或流体力学）之间的联系，就把这个学科建立在牢固可靠的基础上。对化学反应器的设计也引起了越来越多的注意。化学工程师需要了解的知识比反应的化学动力学要多得多。他们必须确定包括反应物和产物的扩散速度可能以何种程度限制总的反应速度，必须了解将热量移出和加入反应器时传热的作用，也必须设计反应器形状和尺寸以产生合理的流动型式，使得在反应物之间及反应物和可能包括的催化剂之间产生有效接触等等。

最近化学工程系统方法的研究很受重视，在系统方法中过程是作为一个整体被研究的，并同时探讨不同单元的相互作用。而过程的控制方案以及可控制性，也越来越受到重视。这样，

上述这些发展的结果就导致化学工程和建筑工程、机械工程和电力工程一同成为四个基本的工程学科。它解决广范围问题的特殊方法是其特色。它涉及的是以分子规模发生的现象，因此化学工程师必需熟悉化学，他们也必须重视系统方法，即他们在仔细研究所发生的分子过程的同时，也要仔细研究整个过程。化学工程师涉及到发生的反应和分离的机理，也涉及到一个完整过程的综合。化学工程在本质上是一个交叉学科，依赖诸如化学、物理、生物、其它的工程学科、材料科学和数学的原理，并将它们和自己的特殊知识领域融合在一起。同时由于化学工程是以科学为基础的，因此它和基础研究以及应用研究有密切的关系。

尽管传统的化学工业是很成功的，但我们大概也应当承认，它并没有一个好的形象。人们经常把它和脏物及臭味联系在一起，把它和向大气、河流和海洋排放污物等问题联系在一起。这个工业现在已经花费了大量的金钱以解决这些问题。它现在正走向一个面对新挑战的时期。化学工业必须为一个较清洁的和较安全的环境而工作，必须发展把原料转变为有价值产品的更有效的方法，它必须致力于减少废物的产生并增加再循环的作用，它必须发展更有效的能源和使用清洁的能源。化学工程师将处于这些发展的核心位置，应把自己的专长贡献给这些挑战性的问题。可能他们的最富挑战性的问题是与化学物质对环境的作用有关，他们有化学物质的终身保护者的责任。虽然在上述四个主要的工程学科中，化学工程是最年轻的，但在很多方面它也是一个成熟的学科。它正进入一个迅速变化和令人振奋的年代。化学工程师的特殊的技能、知识和方法，正在贡献给一个不断扩大的领域。我们确信：化学工程具有不可限量的前途。

2. THERMODYNAMICS

We live in a world of mixture—the air we breathe, the food we eat, the gasoline in our automobiles[1]. Wherever we turn, we find that our lives are linked with materials which consist of a variety of chemical substances. Many of the things we do are concerned with the transfer of substances from one mixture to another; for example, in our lungs, we take oxygen from the air and dissolve it in our blood, while carbon dioxide leaves the blood and enters the air; in our tea pot, water soluble ingredients are leached from the tea-leaves into the water; and when someone stains his clothes with gravy he relies on some cleaning fluid to dissolve and thereby remove the greasy spot[2]. In each of these common daily experiences, as well as on many others in home life and industry, there is a transfer of a substance from one phase to another. This occurs because when two phases are brought into contact, they tend to exchange their constituents until the composition of each phase attains a constant value; when that state is reached we say that the phases are in equilibrium. The equilibrium compositions of two phases are often very much different from one another and it is precisely this difference which enables us to separate mixtures by distillation, extraction, and other phase-contacting operations.

The final, or equilibrium, phase compositions depend on many variables, such as the temperature and pressure, and on the chemical nature and concentration of the various substances involved. Phase equilibrium thermodynamics seeks to establish the relations between the various properties (in particular, temperature, pressure, and composition) which ultimately prevail when two or, more phases reach a state of equilibrium wherein all tendency for further change has ceased[3].

Since so much of life is concerned with the interaction between different phases, it is evident that phase-equilibrium thermodynamics is a subject of fundamental importance in many sciences, physical as well as biological. It is of special interest in chemistry and chemical engineering since so many operations in the manufacture of chemical products consist of phase-contacting; extraction, distillation, leaching, and absorption are essential unit operations in chemical industry and an understanding of any one of them is based, at least in part, on the science of phase equilibrium.

One of the characteristics of modern science is abstraction. By describing a difficult, real problem in abstract, mathematical terms, it is sometimes possible to obtain a simple solution to the problem not in terms of immediate physical reality, but in terms of mathematical quantities which are suggested by an abstract description of the real problem[4]. Thermodynamics provides the mathematical language in which an abstract solution of the phase-equilibrium problem is readily obtained.

Thermodynamics as we know it today originated during the middle of the nineteenth century, and while the original thermodynamic formulas were applied to only a limited class of phenomena (such as heat engines), they have, as a result of suitable extensions, become applicable to a large number of problems in both physical and biological sciences[5]. From its Greek root (*therme*, heat; *dynamis*, force), one might well wonder what thermodynamics has to do with the distribution of various components between various phases. Indeed the early workers in thermodynamics were concerned only with systems of one component, and it was not until the monumental work of J. Willard Gibbs that thermodynamic methods were shown to be useful in the study of multicomponent systems[6]. It was Gibbs who first saw the generality of thermodynamics. He was able to show that a thermodynamic treatment is possible for a wide variety of applications, including the behavior of chemical systems.

The solution of a phase-equilibrium problem using thermodynamics involves three steps. In Step 1, the real problem is translated into an abstract, mathematical problem; in Step 2 a solution is found to the mathematical problem, and in Step 3 the mathematical solution is translated back into physically meaningful terms.

The essential feature of Step 1 is to define appropriate and useful mathematical functions in order to facilitate Step 2. Gibbs, who in 1875 defined such a function-the chemical potential, made it possible to achieve the goal of Step 2; the mathematical solution to the phase-equilibrium problem is given by the remarkably simple result that at equilibrium, the chemical potential of each component must be the same in every phase.

The really difficult step is the last one, Step 3. Thanks to Gibbs, Step 1 and 2 present no further problems and essentially all work in this field, after Gibbs, has been concerned with Step 3. From the viewpoint of a formal theoretical physicist, the phase-equilibrium problem has been solved completely by Gibbs' relation for the chemical potentials. A pure theoretician may require nothing further, but someone who is concerned with obtaining useful numerical answers to real problems must face the task of translating the abstract results of Step 2 into the language of physical reality[7].

To solve problems of the type illustrated above, we must make the transition from what we have, viz., the abstract thermodynamic equation of equilibrium, toward what we want, viz., quantitative information about temperature, pressure and phase compositions. Thanks to Gibbs, the thermodynamic equation of equilibrium is now well known. In any problem concerning the equilibrium distribution of some component i between two phases α and β, we must always begin with the relation

$$\mu_i^{\alpha} = \mu_i^{\beta}$$

where μ is the chemical potential. It is then that our problem begins; we must now ask how μ_i^{α} is related to T, P, and $x_1^{\alpha}, x_2^{\alpha} \cdots$, and similarly how μ_i^{β} is related to T, P, and $x_1^{\beta}, x_2^{\beta} \cdots$. To establish these relations it is conveniently to introduce certain auxiliary functions such as fugacity and activity. These function do not solve the problem for us, but they facilitate our efforts to find a solution since they make the problem somewhat easier to visualize; fugacity and activity are quantities which are much closer to our physical senses than the abstract concept of a chemical potential. Suppose, for example, that phase α is a vapor and phase β is a liquid. Then the above equation can be rewritten

$$\varphi_i y_i p = \gamma_i x_i f_i^0$$

where, in the vapor phase, y_i is the mole fraction and φ_i is the fugacity coefficient, and, in the liquid phase, x_i is the mole fraction, γ_i is the activity coefficient, and f_i^0 is the fugacity of component i at some fixed condition known as the standard state.

The science of thermodynamics is concerned with macroscopic variables, such as volume, pressure, temperature and concentration, and with the relationships between them. It therefore employs a method of description of material systems which differs fundamentally from that used in mechanics where these parameters employed refer to the position and momentum of the individual particles in the system[8]. This difference is necessary in order to define the state of thermodynamic equilibrium.

[词汇]

breathe	呼吸	gasoline	汽油
lung	肺	ingredient	成分,要素
tea-leaves	茶叶	stain	弄脏,污染
gravy	肉汁	rely	依赖
cleaning fluid	清洁剂	greasy	油脂的
spot	斑点,污点	tend	趋向,护理
exchange	交换	constituent	构成,组成
equilibrium	平衡	precisely	恰恰,精确地
variable	变量	ultimately	最终地
prevail	占优势,压倒	subject	主题,学科,主语
manufacture	制造	abstraction	抽象,提取
abstract	提取物;抽象的	term	术语,项,关系
in terms of	依据,按照	immediate	直接的
reality	真实,实际	extension	扩展,范围,广延性
distribution	分布	monumental	不朽的
multicomponent	多组分	generality	普遍性,一般性
treatment	处理	solution	解答,解法,溶液
meaningful	有意义的	facilitate	使容易,便于
profound	深刻的	insight	洞察力
chemical potential	化学位	illustrate	证明
viz.	即,就是	relate to	与…有关
auxiliary	辅助的,补充的	fugacity	逸度
activity	活度,活动,放射性	visualize	设想,目测
mole fraction	摩尔分数	standard state	标准态
employ	应用	momentum	动量

[注释]

1. 句中的 the air, the food, 和 the gasoline 都是 mixture 的同位语。