普通高等教育“十三五”规划教材

化工专业英语

第二版

丁丽　王志萍　编

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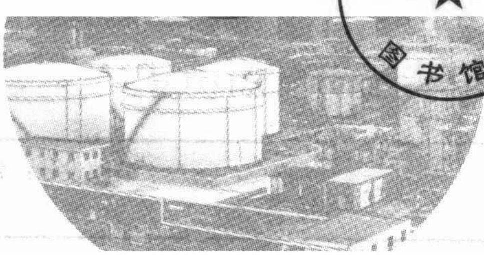

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·北京·

《化工专业英语》(第二版)是为化工及相关专业编写的专业英语教材，旨在提高学生阅读英语科技文献水平。主要内容包括科技英语的特点以及化学反应、化学工程、单元操作、最新技术等共26个单元。每个单元由课文、词汇表、难点注释、课后练习和阅读材料组成。文章内容丰富，语言难度适中，编排深入浅出，循序渐进。书后还附有总词汇表、化学化工常用构词、常用有机基团名称，便于读者查阅和自学。

《化工专业英语》(第二版)可作为化工及相关专业本科、高职高专学生和在职硕士生的专业英语教材，也可作为从事化工生产和产品经销的人员学习英语的参考书。

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前 言

随着社会对化工专业技术人才素质要求的提高，具备化工专业知识技能并掌握化工专业英语的技术人才越来越受到社会各界的欢迎。《化工专业英语》（Specialized English for Chemical Engineering）是化工专业学生一门非常重要的课程，着重培养学生对英文资料的阅读及写作的能力。为适应新时期对化工专业学生的能力培养目标和综合素质的要求，我们针对化工专业的学生，分析并比较众多的同类教材，博采众长，结合青岛科技大学化工专业的教学实践，编写了本书。

《化工专业英语》（第二版）保留了第一版的特色，修改了上一版中的错漏，在选编内容时紧扣化工专业知识，从适用及专业方面考虑，突出实用、够用和好用的特点。首先介绍了科技英语的特点，课文内容涵盖了化学工程的基础内容和前沿领域，主要内容包括化学反应、化学工程、单元操作及最新技术等共 26 个单元。每个单元由课文、词汇表、难点注释、课后练习和阅读材料组成。选材范围广、词汇全面，所选内容适应性强，覆盖面宽，图文并茂，内容丰富，适宜化工类及相关专业本科、高职高专学生及在职研究生作为教材选用或自学。本书还配有课件（www.cipedu.com.cn）。

由于编者水平有限，书中不妥之处在所难免，敬请使用本书的读者指正，不胜感激。

编　者

2019 年 9 月

目 录

Summarization

Features of English for Science and Technology

科技文体崇尚严谨周密，概念准确，逻辑性强，行文简练，重点突出，句式严整，少有变化。科技文章文体的特点是：清晰、准确、精练、严密。那么，科技文章的语言结构特色在翻译过程中如何处理，这是进行英汉科技翻译时需要探讨的问题。

一、科技英语的特点

1. 大量使用名词化结构

大量使用名词化结构（Nominalization）是科技英语的特点之一。因科技文体要求行文简洁、表达客观、内容确切、信息量大、强调存在的事实, 而非某一行为。

Archimedes first discovered the principle of displacement of water by solid bodies. 阿基米德最先发现固体排水的原理。句中 the principle of displacement of water by solid bodies 系名词化结构，一方面简化了同位语从句，另一方强调 displacement 这一事实。

The rotation of the earth on its own axis causes the change from day to night. 地球绕轴自转，引起昼夜的变化。名词化结构 the rotation of the earth on its own axis 使复合句简化成简单句，而且使表达的概念更加确切严密。

Television is the transmission and reception of images of moving objects by radio waves. 电视通过无线电波发射和接受活动物体的图像。名词化结构 the transmission and reception of images of moving objects by radio waves 强调客观事实，而谓语动词则着重其发射和接受的能力。

2. 广泛使用被动语句

根据英国利兹大学 John Swales 的统计，科技英语中的谓语至少三分之一是被动态。这是因为科技文章侧重叙事推理，强调客观准确。第一、二人称使用过多，会造成主观臆断的印象。因此尽量使用第三人称叙述，采用被动语态，例如：

Attention must be paid to the working temperature of the machine. 应当注意机器的工作温度。而很少说：You must pay attention to the working temperature of the machine. 你们必须注意机器的工作温度。

此外，科技文章将主要信息前置，放在主语部分。这也是广泛使用被动态的主要原因。试观察并比较下列两段短文的主语。

Electrical energy can be stored in two metal plates separated by an insulating medium. Such a device is called a capacitor, and **its** ability to store electrical energy is called capacitance. **It** is measured in farads. 电能可储存在由一绝缘介质隔开的两块金属极板内。这样的装置称为电容器，其储存电能的能力称为电容。电容的单位是法拉。

这一段短文中各句的主语分别为：Electrical energy, Such a device, Its ability to store electrical energy, It (Capacitance)。 它们都处于句首的位置，非常醒目。足见被动结构可收简洁客观之效。试比较：

We can store electrical energy in two metal plates separated by an insulating medium. We call such a device a capacitor, or a condenser, and call its ability to store electrical energy capacitance. We measure it in farads.

3. 经常运用非限定动词

如前所述，科技文章要求行文简练，结构紧凑，为此，往往使用分词短语代替定语从句或状语从句；使用分词独立结构代替状语从句或并列分句；使用不定式短语代替各种从句；介词+动名词短语代替定语从句或状语从句。这样可缩短句子，又比较醒目。试比较下列各组句子。

A direct current is a current flowing always in the same direction. 直流电是一种总是沿同一方向流动的电流。

Radiating from the earth, heat causes air currents to rise. 热量由地球辐射出来时，使得气流上升。

A body can move uniformly and in a straight line, there being no cause to change that motion. 如果没有改变物体运动的原因，那么物体将做匀速直线运动。

Vibrating objects produce sound waves, each vibration producing one sound wave. 振动着的物体产生声波，每一次振动产生一个声波。

In communications, the problem of electronics is how to convey information from one place to another. 在通信系统中，电子学要解决的问题是如何把信息从一个地方传递到另一个地方。

Materials to be used for structural purposes are chosen so as to behave elastically in the environmental conditions. 结构材料的选择应使其在外界条件中保持其弹性。

There are different ways of changing energy from one form into another. 将能量从一种形式转变成另一种形式有各种不同的方法。

In making the radio waves correspond to each sound in turn, messages are carried from a broadcasting station to a receiving set. 当无线电波依次对每一个声音作出相应变化时，信息就由广播电台传递到接收机。

4. 频繁使用后置定语

大量使用后置定语也是科技文章的特点之一。常见的结构有以下五种：

（1）介词短语。The forces due to friction are called frictional forces. 由于摩擦而产生的力称之为摩擦力。The data in table 1 show….

（2）形容词及形容词短语。In this factory the only fuel available is coal. 该厂唯一可用的燃料是煤。In radiation, thermal energy is transformed into radiant energy, similar in nature to light. 热能在辐射时，转换成性质与光相似的辐射能。

（3）副词。The temperature of air outside is…. 外面的空气的温度是…。 The force upward equals the force downward so that the balloon stays at the level. 向上的力与向下的力相等，所以气球就保持在这一高度。

（4）单个分词。The results obtained must be checked. 获得的结果必须加以校核。The heat produced is equal to the electrical energy wasted. 产生的热量等于浪费了的电能。

（5）定语从句。During construction, problems often arise which require design changes. 在施工过程中，常会出现需要改变设计的问题。The molecules exert forces upon each other, which depend upon the distance between them. 分子相互间都存在着力的作用，该力的大小取决于它们之间的距离。Very wonderful changes in matter take place before our eyes every day to which we pay little attention. （定语从句 to which we pay little attention 修饰的是 changes，这是一种分隔定语从句。）我们几乎没有注意的很奇异的物质变化每天都在眼前发生。To make an atomic bomb we have to use uranium 235, in which all the atoms are available for fission. 制造原子弹，我们必须用铀 235，因为铀 235 的所有原子都会裂变。

5. 常用特定的句型

科技文章中经常使用若干特定的句型，从而形成科技文体区别于其他文体的标志。

例如：**It…that…**结构句型；被动态结构句型；比较结构句型；分词短语结构句型；省略句结构句型等。举例如下：

It is evident that a well lubricated bearing turns more easily than a dry one. 显然，润滑好的轴承，比不润滑的轴承容易转动。

It seems that these two branches of science are mutually dependent and interacting. 看来这两个科学分支是相互依存，相互作用的。

It has been proved that induced voltage causes a **current** to flow in opposition to the force producing **it**. 已经证明，感应电压使电流的方向与产生电流的磁场力方向相反。

It was not until the 19th century that heat was considered as a form of energy. 直到 19 世纪人们才认识到热是能量的一种形式。 Computers may be classified as analog and digital. 计算机可分为模拟计算机和数字计算机两种。

6. 长句使用较多

为了表述一个复杂概念，使之逻辑严密，结构紧凑，科技文章中往往出现许多长句。例如：Major disadvantages of fermentation **compared with petrochemical processes**(过去分词短语作状语)are, firstly, the **time scale**(时间规模), **which usually**(省略了 is) of the **order**(数量级)of days **compared to literally**(简直，几乎)seconds for some catalytic petrochemical reactions, and secondly, the **fact that** the product is usually obtained as a **dilute aqueous solution** (<10% concentration)(稀的水溶液)。

7. 有大量的复合词与缩略词

大量使用复合词与缩略词是科技文章的特点之一，复合词从过去的双词组合发展到多词组合；缩略词趋向于任意构词，这给翻译工作带来一定的困难。例如：full-enclosed 全封闭的（双词合成形容词）；feed-back 反馈（双词合成名词）；work-harden 加工硬化（双词合成动词）；on-and-off-the-road 路面越野两用的（多词合成形容词）；anti-armoured-fighting-vehicle-missile 反装甲车导弹（多词合成名词）；radiophotography 无线电传真（无连字符复合词）；colorimeter 色度计（无连字符复合词）；maths (mathematics)数学（裁减式缩略词）；lab (laboratory)实验室；ft (foot/feet)英尺；cpd (compound)化合物；FM (frequency modulation)调频（用首字母组成的缩略词）；P.S.I. (pounds per square inch) 磅/英寸；SCR (silicon controlled rectifier)可控硅整流器；PVC、PP、PS、MTBE 等等。

二、科技英语汉译时需注意的问题

1. 科技术语的汉译

术语是表示某一专门概念的词语，科技术语就是在科技方面表示某一专门概念的词语。因此翻译时要十分注意，不能疏忽。英语科技术语的特点是词义繁多，专业性强，翻译时必须根据专业内容谨慎处理，稍不注意就会造成很大的错误。如有人把“the newly developed picture tub”（最新研制成功的显像管）错译为“新近被发展的画面管”。如 couple，热电偶，夫妇；column，塔、柱，栏；有多个意思，究竟应译为哪个意思，要从上下文的具体语境去分析判断。

2. 科技英语中倍数增减（包括比较）的汉译

科技英语中倍数增减句型究竟应当如何汉译，在我国翻译界中一直存在着争论，国内出版的一些语法书和工具书所持看法也不尽一致，这就影响了对这种句型的正确翻译。这个问题比较重要，数据上的一倍之差往往会造成不可估量的损失。同时，倍数增减这个问题，在科技英语中又是经常会遇到的。因此，其译法很有必要加以统一。

（1）倍数增加的译法

英语中说“增加了多少倍”，都是连基数也包括在内的，是表示增加后的结果；而在汉语里所谓“增加了多少倍”，则只表示纯粹增加的数量。所以英语里凡表示倍数增加的句型，汉译时都可译成“是……的几倍”，或“比……增加（n-1）倍”。现将英语中表示倍数增加的一些表达法及其译法举例如下：

① The production of various stereo recorders has been increased four times as against 1977. 各种立体声录音机的产量比 1977 年增加了三倍。

② The output of colour television receivers increased by a factor of 3 last year. 去年彩色电视接收机的产量增加了二倍。

（2）倍数比较的译法

①“*n* times + larger than + 被比较对象”，表示其大小“为……的 *n* 倍”，或“的比……大 *n*-1 倍”。例如：This thermal power plant is four times larger than that one. 这个热电站比那个热电站大三倍。这是因为英语在倍数比较的表达上，其传统习惯是 larger than 等于 as large as，因此汉译时不能只从字面上理解，将其译为“比……大 *n* 倍”，而应将其译为“是……的 *n* 倍”，或“比……大 *n*-1 倍”。

②“*n* times + as + 原级 + as + 被比较对象”，表示“是……的 *n* 倍”。例如：Iron is almost three times as heavy as aluminium. 铁的重量几乎是铝的三倍。

（3）倍数减少的译法

英语中一切表示倍数减少的句型，汉译时都要把它换成分数，而不能按照字面意义将其译成减少了多少倍。因为汉语是不用这种表达方式的，所以应当把它译成减少了几分之几，或减少到几分之几。我们所说的增减多少，指的都是差额，差额应当是以原来的数量为标准，而不能以减少后的数量作标准。英语表示倍数减少时第一种表达方式为：“……+ 减少意义的谓语 + by a factor of *n* 或 by *n* times”。这种表达法的意思是“成 *n* 倍地减少”，即减少前的数量比减少后的数量。

The automatic assembly line can shorten the assembling period (by) ten times. 自动装配线能够缩短装配期十分之九。 This metal is three times as light as that one. 这种金属比那种金属轻三分之二。第二种表达方式为“*n* times + 减少意义的比较级”。

3. 科技英语中部分否定句的汉译

在英语的否定结构中，由于习惯用法问题，其中部分否定句所表示的意思是不能按字面顺序译成汉语的，因此，翻译时要特别注意。英语中含有全体意义的代词和副词如 all，every，both，always，altogether，entirety 等统称为总括词。它们用于否定结构时不是表示全部否定，而只表示其中的一部分被否定。因此，汉译时不能译作“一切……都不”，而应译为“并非一切……都是的 ”，或“一切……不都是”。例如：

（1）All of the heat supplied to the engine is not converted into useful work. 并非供给热机的所有热量都被转变为有用的功。错译：所有供给热机的热量都没有被转变为有用的功。

（2）Every one cannot do these tests. 并非人人都能做这些试验。错译：每个人都不能做这些试验。

（3）Both instruments are not precise. 两台仪器并不都是精密的。错译：两台仪器都不是精密的。

（4）This plant does not always make such machine tools. 这个工厂并不总是制造这样的机床。错译：这个工厂总是不制造这样的机床。

但是当（总括词 + 肯定式谓语 + 含否定意义的单词……）时，则是表示全部否。例如：All germs are invisible to the naked eye. 一切细菌都是肉眼看不见的。Every design made by her is impossible of execution. 她所做的一切设计都是不能执行的。Both data are incomplete. 两个

数据都不完整。In practice, error sometimes always seems unavoidable. 在实践中，差错有时似乎总是不可避免的。

4. 定语从句的汉译

从汉译的角度来看，英语的定语从句确实要比其他各种从句难些，而且它应用极广，出现的频率很高，科技英语里的许多长句又都离不开定语从句，所以，如何译好定语从句是科技英语汉译工作中的一个重要课题。

语言现象千变万化，定语从句更是如此，因此要想找出一条汉译英语定语从句的规律，确非易事。以下看法，仅供参考。

（1）不论是限制性还是非限制性定语从句，只要是比较短的，或者虽然较长，但汉译后放在被修饰语之前仍然很通顺，一般就放在被修饰语之前，这种译法叫作**逆序合译法**。例如：

The speed of wave is the distance **it** advances per unit time. 波速是波在单位时间内前进的距离。

The light wave that has bounced off the reflecting surface is called the reflected ray. 从反射表面跳回的光波称为反射线。

Stainless steel which is very popular for its resistance to rusting contains large percentage of chromium. 具有突出防锈性能的不锈钢含铬的百分比很高。

（2）定语从句较长，或者虽然不长，但汉译时放在被修饰语之前实在不通顺的就后置，作为词组或分句。这种译法叫做**顺序分译法**。例如：

Each kind of atom seems to have a definite number of "hand" that it can use to hold on to others. 每一种原子似乎都有一定数目的"手"，用来抓牢其他原子 (顺序分译法)。 每一种原子似乎都有一定数目用于抓牢其他原子的手 (逆序合译法)。这句限制性定语从句虽然不长，但用顺序分译法译出的译文要比用逆序合译法更为通顺。

Let AB in the figure above represent an inclined plane the surface of which is smooth and unbending. 设上图中 AB 代表一个倾斜平面，其表面光滑不弯 (顺序分译法) 。设上图中 AB 代表一个其表面为光滑不弯的倾斜平面 (逆序合译法)。

上面两种译法，看来也是用顺序分译法比用逆序合译法更为通顺简明。

（3）定语从句较长，与主句关联又不紧密，汉译时就作为独立句放在主句之后。这种译法仍然是**顺序分译法**。例如：

① Such a slow compression carries the gas through a series of states each of **which** is very nearly an equilibrium state and **it** is called a quasi-static or a "nearly static" process.

这样的缓慢压缩能使这种气体经历一系列的状态，各状态都很接近于平衡状态，所以叫作准静态过程，或"近似静态"过程。

② Friction wears away metal in the moving parts, which shortens **their** working life.

运动部件间的摩擦力使金属磨损，这就缩短了运动部件的使用寿命。

（4）There + be 句型中的限制性定语从句汉译时往往可以把主句中的主语和定语从句溶合一起，译成一个独立的句子。这种译法叫作**溶合法**，也叫拆译法。例如：

① There are bacteria that help plants grow, others that get rid of dead animals and plants by making **them** decay and some that live in soil and make **it** better for growing crops.

有些细菌能帮助植物生长，另一些细菌则通过腐蚀来消除死去的动物和植物，还有一些细菌则生活在土壤里，使土壤变得对种植庄稼更有好处。

② There is a one-seat car which you could learn to drive in fifty minutes.

有一种单座式汽车，五十分钟就能学会驾驶。

5. 科技翻译应符合逻辑

科技翻译不仅仅是个语言问题（词汇、语法、修辞等），它牵涉到许多非语言方面的因素。

逻辑便是其中最活跃、最重要的因素。苏联语言学家巴尔胡达罗夫曾举过这样一个例子：John is in the pen ,任何人也不会把句中的 pen 译为笔，而只能译为“牲口圈”，因为“人在钢笔里”是不合事理的。这说明在翻译中常常会碰到需要运用逻辑来判断和解决一些似乎不合逻辑的语言现象。

Before these metals in their natural state can be converted into useful forms to be of service to man, they must be separated from the other elements or substances with which they are combined. Chemists, who are well acquainted with the properties of metals, have been able to develop processes for separating metals from substances with which they are combined in nature.

原译：处于天然状态的金属在转换成为人类服务的有用形式之前，必须从和它结合在一起的其他元素或物质中分离出来。*化学家们十分熟悉金属的性能。他们已研究出一些方法，*把金属从和它在自然界中结合在一起的物质中分离出来. 译文将定语从句“who…metals”拆译成独立的句子，译成“化学家们十分熟悉金属的性能” 不合逻辑，因为并不是任何化学家都十分熟悉金属的性能。应译为“熟悉金属性能的化学家们已经研究出来一些方法，能够……”

三、科技英语的翻译技巧

要提高翻译质量，使译文达到“准确”“通顺”“简练”这三个标准，就必须运用翻译技巧。翻译技巧就是在翻译过程中用词造句的处理方法，如词义的引申、增减和词类转换等。

1. 引申译法

当英语句子中的某个词按词典的释义直译不符合汉语修辞习惯或语言规范时，则可以在不脱离该英语词本义的前提下，灵活选择恰当的汉语词语或词组译出。例如：We will fix this problem during the recent shut down of the equipment. 我们会在最近的设备停产时解决这一问题。“fix” 字典意思为“固定、修理”，这里引申译为“解决、处理”。

2. 增减词译法

增词就是在译句中增加或补充英语句子中原来没有或省略了的词语，以便更完善、更清楚地表达英语句子所阐述的内容。在英语句子中，有的词从语法结构上讲是必不可少的，但并无什么实际意义，只是在句子中起着单纯的语法作用；有的词虽有实际意义，但按照字面译出又显多余。这样的词在翻译时往往可以省略不译。

3. 词类转换

英语翻译中，常常需要将英语句子中属于某种词类的词，译成另一种词类的汉语词，以适应汉语的表达习惯或达到某种修辞目的。这种翻译处理方法就是转换词性法，简称词类转换。例如：In any case, the performance test have priority. 不管怎样进行，性能测试都要优先。这里将名词“priority” 转译为动词“优先”。

4. 词序处理法

英汉两种语言的词序规则基本相同，但也存在着某些差别。不同的英语句子，在翻译中的词序处理方式也常常不同。例如：An insufficient power supply makes the motor immovable. 电力不足就会使马达停转。这里将“insufficient power”（不足电力）改序翻译为“电力不足”较为合理。

Lesson 1

Chemical Engineering

Chemical engineering is the development of processes and the design and operation of plants in which materials undergo changes in physical or chemical state on a technical scale. Applied throughout the process industries, it is founded on the principles of chemistry, physics, and mathematics. The laws of physical chemistry and physics govern the practicability and efficiency of chemical engineering operations. Energy changes, deriving from thermodynamic considerations, are particularly important. Mathematics is a basic tool in optimization and modeling. Optimization means arranging materials, facilities, and energy to yield as productive and economical an operation as possible. Modeling is the construction of theoretical mathematical prototypes of complex process systems, commonly with the aid of computers.

Chemical engineering is as old as the process industries. Its heritage dates from the fermentation and evaporation processes operated by early civilizations. Modern chemical engineering emerged with the development of large-scale, chemical-manufacturing operations in the second half of the 19th century. Throughout its development as an independent discipline, chemical engineering has been directed toward solving problems of designing and operating large plants for continuous production.

Manufacture of chemicals in the mid-19th century consisted of modest craft operations. Increase in demand, public concern at the emission of noxious effluents, and competition between rival processes provided the incentives for greater efficiency. This led to the emergence of combines with resources for larger operations and caused the transition from a craft to a science-based industry. The result was a demand for chemists with knowledge of manufacturing processes, known as industrial chemists or chemical technologists. The term chemical engineer was in general use by about 1900. Despite its emergence in traditional chemicals manufacturing, it was through its role in the development of the petroleum industry that chemical engineering became firmly established as a unique discipline. The demand for plants capable of operating physical separation processes continuously at high levels of efficiency was a challenge that could not be met by the traditional chemist or mechanical engineer.

A landmark in the development of chemical engineering was the publication in 1901 of the first textbook on the subject, by George E. Davis, a British chemical consultant. This concentrated on the design of plant items for specific operations. The notion of a processing plant encompassing a number of operations, such as mixing, evaporation, and filtration, and of these operations being essentially similar, whatever the product, led to the concept of unit operations[1]. This was first enunciated by the American chemical engineer Arthur D. Little in 1915 and formed the basis for a classification of chemical engineering that dominated the subject for the next 40 years. The number of unit operations—the building blocks of a chemical plant—is not large. The complexity arises from the variety of conditions under which the unit operations are conducted.

In the same way that a complex plant can be divided into basic unit operations, so chemical reactions involved in the process industries can be classified into certain groups, or unit processes (e.g., polymerizations, esterifications, and nitrations), having common characteristics[2]. This classification into unit processes brought rationalization to the study of process engineering.

The unit approach suffered from the disadvantage inherent in such classifications: a restricted outlook based on existing practice. Since World War Ⅱ, closer examination of the fundamental phenomena involved in the various unit operations has shown these to depend on the basic laws of mass transfer, heat transfer, and fluid flow. This has given unity to the diverse unit operations and has led to the development of chemical engineering science in its own right; as a result, many applications have been found in fields outside the traditional chemical industry.

Study of the fundamental phenomena upon which chemical engineering is based has necessitated their description in mathematical form and has led to more sophisticated mathematical techniques[3]. The advent of digital computers has allowed laborious design calculations to be performed rapidly, opening the way to accurate optimization of industrial processes. Variations due to different parameters, such as energy source used, plant layout, and environmental factors, can be predicted accurately and quickly so that the best combination can be chosen[4].

Chemical Engineering Functions. Chemical engineers are employed in the design and development of both processes and plant items. In each case, datas and predictions often have to be obtained or confirmed with pilot experiments. Plant operation and control is increasingly the sphere of the chemical engineer rather than the chemist. Chemical engineering provides an ideal background for the economic evaluation of new projects and, in the plant construction sector, for marketing.

Branches of Chemical Engineering. The fundamental principles of chemical engineering underlie the operation of processes extending well beyond the boundaries of the chemical industry, and chemical engineers are employed in a range of operations outside traditional areas. Plastics, polymers, and synthetic fibers involve chemical reaction engineering problems in their manufacture, with fluid flow and heat transfer considerations dominating their fabrication[5]. The dyeing of a fiber is a mass-transfer problem. Pulp and paper manufactures involve considerations of fluid flow and heat transfer. While the scale and materials are different, these again are found in modern continuous production of foodstuffs. The pharmaceuticals industry presents chemical engineering problems, the solutions of which have been essential to the availability of modern drugs. The nuclear industry makes similar demands on the chemical engineer, particularly for fuel manufacture and reprocessing. Chemical engineers are involved in many sectors of the metals processing industry, which extends from steel manufacture to separation of rare metals[6].

Further applications of chemical engineering are found in the fuel industries. In the second half of the 20th century, considerable numbers of chemical engineers have been involved in space exploration, from the design of fuel cells to the manufacture of propellants[7]. Looking to the future, it is probable that chemical engineering will provide the solution to at least two of the world's major problems: supply of adequate fresh water in all regions through desalination of seawater and environmental control through prevention of pollution.

Selected from "English for Chemical Engineers, by Ma Zhengfei etc., Southeast University Press, 2006, 1-4"

New Words

1. thermodynamics [ˈθəməudaiˈnæmiks] *n.* 热力学
2. prototype[ˈprəutətaip] *n.* 原型，主型
3. heritage[ˈheritidʒ] *n.* 遗产，继承物
4. manufacture [mænjuˈfæktʃə] *n.* 产品，制造
5. emergence [iˈmə:dʒəns] *n.* 出现，浮现
6. craft [kræft] *n.* 手艺，技艺
7. enunciate [iˈnʌnsieit] *v.* 明确叙述
8.rationalization [ˌræʃənəlaiˈzeiʃən] *n.* 合理化
9. foodstuff [ˈfu:dstʌf] *n.* 食品，粮食
10. desalination [disɔ:liˈneiʃən] *n.* 脱盐
11. pollution [pəˈlu:ʃən] *n.* 污染

Notes

1. The notion of a processing plant encompassing a number of operations, such as mixing, evaporation, and filtration, and of these operations being essentially similar, whatever the product, led to the concept of unit operations. 参考译文：注意到加工厂包括的一系列操作，如混合、蒸发、过滤，无论产物是什么，这些操作都基本相同，从而导致了单元操作的概念。

2. In the same way that a complex plant can be divided into basic unit operations, so chemical reactions involved in the process industries can be classified into certain groups, or unit processes (e.g., polymerization, esterifications, and nitrations), having common characteristics. 参考译文：同复杂的工厂可划分为基本的单元操作一样，过程工业中涉及的化学反应也可分成一定的单元过程（如聚合、酯化和硝化），它们具有共同的特性。本句中，group 和 unit process 具有相同含义，前者为普通用词，后者为科技用词。在科技文章中，常有此种情况出现，注意此类现象，可帮助理解。

3. Study of the fundamental phenomena upon which chemical engineering is based has necessitated their description in mathematical form and has led to more sophisticated mathematical techniques. 参考译文：研究化工依赖的基本现象需采用数学形式来描述，并借助复杂的数学技术来解决。

4. Variations due to different parameters, such as energy source used, plant layout, and environmental factors, can be predicted accurately and quickly so that the best combination can be chosen. 参考译文：如所用的能量来源、工厂布置和环境因素这样的不同参数引起的变化可正确和快速地得到预测，就可能选择出最佳的组合。

5. Plastics, polymers, and synthetic fibers involve chemical reaction engineering problems in their manufacture, with fluid flow and heat transfer considerations dominating their fabrication. 参考译文：塑料、聚合物和合成纤维在生产中涉及化学反应工程问题，其中流体流动和传热是生产中主要考虑的因素。

6. rare metals 为稀有金属，而 rare earth 为稀土。

7. In the second half of the 20th century, considerable numbers of chemical engineers have been involved in space exploration, from the design of fuel cells to the manufacture of propellants. 参考译文：20 世纪下半叶，从燃料电池的设计到推进剂的生产，相当数量的化学工程师参与了空间的探索。

Exercise

1. Put the following into Chinese:

thermodynamics manufacture craft foodstuff

desalination	mathematics	evaporation	filtration
rare metal	telecommunication	unglamorous	definition

2. Put the following into English:

主型	出现	明确叙述	合理化
技艺	污染	单元操作	合成纤维

3. Comprehension and toward interpretation

a.what are chemical engineering and its content?

b.what concept is the landmark in the development of chemical engineering?

c.what are the basic laws of chemical engineering science?

d.Name the functions and branches of chemical engineering you know.

Reading Material

What is Chemical Engineering

Society can associate civil engineers with huge new building complexes and bridges, electronic and electrical engineers with telecommunications and power generation, and mechanical engineers with advanced machinery and automobiles. However, chemical engineers have no obvious monuments which create an immediate awareness of the discipline in the public mind. Nevertheless, the range of products in daily use which are efficiently produced as a result of the application of chemical engineering expertise is enormous. The list given in Table 1-1 is not exhaustive, and any reader who grasps the key element, which involves the conversion of raw materials into a useful product, will be able to extend it. Although the products are unglamorous, the creation and operation of cost-effective processes to produce them is often challenging and exciting.

The term "chemical engineer" implies that the person is primarily an engineer whose first professional concern is with manufacturing processes—making something, or making some process work. The adjective "chemical" implies a particular interest in processes which involve chemical changes. While the main term is correct, the adjective is too restrictive and the literal definition will not suffice. Taken at face value, it would exclude many areas in which chemical engineers have made their mark, for example, textiles, nuclear fuels and the food industry. Thus the Institution of Chemical Engineers defines chemical engineering as "that branch of engineering which is concerned with processes in which materials undergo a required change in composition, energy content or physical state: with the means of processing; with the resulting products, and with their application to useful ends". It is perhaps too presumptuous to insist that the term "process engineer" should replace the term "chemical engineer", and so the two will be used synonymously.

It should also be noted that large-scale processes involving biological systems (such as waste water treatment and production of protein) fit the definition as well as traditional chemical processes such as the production of fertilizers and pharmaceuticals.

The work of chemical engineers will be examined by way of four case studies in the second part of this chapter, but to complete the definition, explicit mention of the concern that process operations be both safe and economic must be made.