教育部高职高专规划教材

化学化工专业英语

第二版

符德学　主编

化学工业出版社
教材出版中心

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·北京·

本书选文侧重实际工艺及技术操作，内容涵盖了化学基础知识、化工单元操作、化工设备、无机工艺、石油化工及有机工艺、高分子材料、精细化工、环境保护、循环经济和清洁生产、煤化工、计算机在化工中的应用、生物技术、电化学工程、化工安全、化工产品说明书等。为提高学生专业英语的阅读、翻译和写作能力，在本书中还穿插介绍了专业英语的特点和学习方法、专业英语翻译、专业英语写作。为适应新形式的需要，在本书的最后还增加了化工市场方面的内容。附录内容有化学化工常用构词和总词汇表。

本书可作为高职高专院校化学化工专业英语教材，也可供相关人员参考使用。

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第二版前言

本书自2003年2月第一版出版发行以来，在全国高职高专化学化工专业得到普遍使用，收到了一定的效果。但随着化工新工艺、新技术的不断引进和发展，化工企业对外技术交流和贸易的不断扩大，社会对化工人才专业英语的要求越来越高。为体现化工新工艺、新技术的发展，树立科学发展观，适应新的教学形势的需要，对本书第一版的部分内容进行了补充和修订。关于第二版的内容，特作如下说明：

1. 保留了第一版的主要内容和编写思路；

2. 删去了表面涂装内容，增加了煤的液化方面的内容，以体现石油资源短缺情况下新的化工原料发展方向；

3. 删去了镁化合物的内容，增加了循环经济和清洁生产的内容；

4. 调整了部分阅读材料顺序，使其内容与课文更加匹配。

第二版的修订工作由焦作大学符德学教授负责，河南理工大学缪娟教授、毕文彦老师参加了部分内容的编写修订工作。化学工业出版社对第二版的修订给予了支持，同时还得到全国各地的同行和读者热情支持和帮助，在此一并表示感谢！

由于编者水平有限，书中不妥之处在所难免，敬请读者批评指正。

编者

2006年3月

第一版前言

随着中国化学工业的发展以及加入世界贸易组织（WTO）后的需要，社会对化学化工人才的素质要求越来越高，既掌握化工专业知识和技能，又能熟练地掌握化工专业英语的技术人才受到大中型化工企业尤其是中外合资企业的欢迎。为适应新时期高职高专化工专业对学生的能力培养和综合素质的要求，全国高等职业教育化工专业教材编审委员会和化学工业出版社组织全国部分高等院校编写本书。

本教材特点如下。

1. 所选内容通俗易懂，专业适应性强，覆盖面宽。选文侧重实际工艺及技术操作，内容涵盖了化学基础知识、化工单元操作、化工设备、无机工艺、石油化工及有机工艺、高分子材料、精细化工、环境保护、计算机在化工中的应用、生物技术、电化学工程、化工安全、化工产品说明书等。全书共16课，分四部分（PART）。第一部分介绍化学基础知识和化学工业概述；第二部分为化工典型单元操作和化工设备；第三部分介绍化工产品的生产工艺；第四部分为选修内容，包括生物化工、化工安全技术、环境保护、计算机在化工中的应用、新材料和电化学工程等。为提高学生的专业英语的阅读、翻译和写作能力，在本书中还介绍了专业英语的特点和学习方法、专业英语翻译、专业英语的写作。为适应加入WTO后的需要，在本书的最后还增加了化工市场方面的内容。附录内容有化学化工常用构词和总词汇表。

2. 本书对课文中出现的生词、化工技术术语、操作用语等专门列出进行注释。

3. 本书练习着重化工专业技术术语及操作用语的英汉对译训练，练习内容大多选用产品说明书、设备说明书、化工产品市场等内容，突出高职特色。

本书内容广泛，知识介绍循序渐进，图文并茂便于学生学习。可作为化工工艺、应用化学等专业高职高专学生的教材，也可作为广大科技人员的参考书。

本书1、2、7、12、13、14、15、16课及化工产品市场部分由焦作大学符德学编写，3、4、5、6、8、9、10、11课由吉林职业技术学院的李雨名编写，全书由符德学统稿，南京化工职业技术学院的张小军主审。化学工业出版社对本书的编写给予了支持。南京化工职业技术学院丁志平副院长，吉林工业职业技术学院的杨春华、魏安邦、马涛及许多高校的同志对本书稿也提出了许多宝贵的意见，在此一并感谢。

由于编者水平有限，疏漏和不妥之处在所难免，恳请提出宝贵意见，以便完善。

编者

2002年9月

出版说明

高职高专教材建设工作是整个高职高专教学工作中的重要组成部分。改革开放以来，在各级教育行政部门、有关学校和出版社的共同努力下，各地先后出版了一些高职高专教育教材。但从整体上看，具有高职高专教育特色的教材极其匮乏，不少院校尚在借用本科或中专教材，教材建设落后于高职高专教育的发展需要。为此，1999年教育部组织制定了《高职高专教育专门课课程基本要求》（以下简称《基本要求》）和《高职高专教育专业人才培养目标及规格》（以下简称《培养规格》），通过推荐、招标及遴选，组织了一批学术水平高、教学经验丰富、实践能力强的教师，成立了“教育部高职高专规划教材”编写队伍，并在有关出版社的积极配合下，推出一批“教育部高职高专规划教材”。

“教育部高职高专规划教材”计划出版500种，用5年左右时间完成。这500种教材中，专门课（专业基础课、专业理论与专业能力课）教材将占很高的比例。专门课教材建设在很大程度上影响着高职高专教学质量。专门课教材是按照《培养规格》的要求，在对有关专业的人才培养模式和教学内容体系改革进行充分调查研究和论证的基础上，充分汲取高职、高专和成人高等学校在探索培养技术应用型专门人才方面取得的成功经验和教学成果编写而成的。这套教材充分体现了高等职业教育的应用特色和能力本位，调整了新世纪人才必须具备的文化基础和技术基础，突出了人才的创新素质和创新能力的培养。在有关课程开发委员会组织下，专门课教材建设得到了举办高职高专教育的广大院校的积极支持。我们计划先用2～3年的时间，在继承原有高职高专和成人高等学校教材建设成果的基础上，充分汲取近几年来各类学校在探索培养技术应用型专门人才方面取得的成功经验，解决新形势下高职高专教育教材的有无问题；然后再用2～3年的时间，在《新世纪高职高专教育人才培养模式和教学内容体系改革与建设项目计划》立项研究的基础上，通过研究、改革和建设，推出一大批教育部高职高专规划教材，从而形成优化配套的高职高专教育教材体系。

本套教材适用于各级各类举办高职高专教育的院校使用。希望各用书学校积极选用这批经过系统论证、严格审查、正式出版的规划教材，并组织本校教师以对事业的责任感对教材教学开展研究工作，不断推动规划教材建设工作的发展与提高。

教育部高等教育司

2001年4月3日

Contents

PART 1 CHEMISTRY AND CHEMICAL INDUSTRY

Lesson One Elements and Compounds

Elements are pure substances that can not be decomposed into simpler substances by ordinary chemical changes. At present there are 109 known elements. Some common elements that are familiar to you are carbon, oxygen, aluminum, iron, copper, nitrogen, and gold. The elements are the building blocks of matter just as the numerals 0 through 9 are the building blocks for numbers. To the best of our knowledge, the elements that have been found on the earth also comprise the entire universe.

About 85% of the elements can be found in nature, usually combined with other elements in minerals and vegetable matter or in substances like water and carbon dioxide. Copper, silver, gold, and about 20 other elements can be found in highly pure forms. Sixteen elements are not found in nature; they have been produced in generally small amounts in nuclear explosions and nuclear research. They are man-made elements.

Pure substances composed of two or more elements are called compounds. Because they contain two or more elements, compounds, unlike elements, are capable of being decomposed into simpler substances by chemical changes. The ultimate chemical decomposition of compounds produces the elements from which they are made.

The atoms of the elements in a compound are combined in whole number ratio, not in fractional parts of an atom. Atoms combined with one another form compounds which exist as either molecule or ions. A molecule is a small, uncharged individual unit of a compound formed by the union of two or more atoms, if we subdivide a drop of water into smaller and smaller particles, we ultimately obtain a single unit of water known as a molecule of water. This water molecule consists of two hydrogen atoms and one oxygen atom bonded together. We cannot subdivide this unit further without destroying the molecule, breaking it up into its elements. Thus, a water molecule is the smallest unit of the compound water.

An ion is a positive or negative electrically charged atom or group of atoms. The ions in a compound are held together in a crystalline structure by the attractive forces of their positive and negative charges. Compounds consisting of ions do not exist as molecules. Sodium chloride is an example of a non-molecular compound. Although this type of compound consists of large numbers of positive and negative ions, its formula is usually represented by the simplest ratio of the atoms in the compound. Thus, the ratio of ions in sodium chloride is one sodium ion to one chlorine ion.

Compounds exist either as molecules which consist of two or more elements bonded together or in the form of positive and negative ions held together by the attractive force of their positive and negative charges.

The compound carbon monoxide (CO) is composed of carbon and oxygen in the ratio of one atom of carbon to one atom of oxygen. Hydrogen chloride (HCl) contains a ratio of one atom of hydrogen to one atom of chlorine. Compounds may contain more than one atom of the same element. Methane ("natural gas" CH_4) is composed of carbon and hydrogen in a ratio of one carbon atom to four hydrogen atoms; ordinary table sugar (sucrose, $C_{12}H_{22}O_{11}$) contains a ratio of 12 atoms of carbon to 22 atoms of hydrogen to 11 atoms of oxygen. These atoms are held together in the compound by chemical bonds.

There are over three million known compounds, with no end in sight as to the number that can and will be prepared in the future. Each compound is unique and has characteristic physical and chemical properties. Let us consider in some detail two compounds——water and mercuric oxide. Water is a colorless, odorless, tasteless liquid that can be changed to a solid, ice, at 0℃ and to a gas, steam at 100℃. It is composed of two atoms of hydrogen and one atom of oxygen per molecule, which represents 11.2 percent hydrogen and 88.8 percent oxygen by mass. Water reacts chemically with sodium to produce hydrogen gas and sodium hydroxide, with lime to produce calcium hydroxide, and with sulfur trioxide to produce sulfuric acid. No other compound has all these exact physical and chemical properties; they are characteristic of water alone.

Mercuric oxide is a dense, orange-red powder composed of a ratio of one atom of mercury to one atom of oxygen. Its composition by mass is 92.6 percent mercury and 7.4 percent oxygen, When it is heated to temperatures greater than 360℃, a colorless gas, oxygen, and a silvery liquid metal, mercury, are produced. Here again are specific physical and chemical properties belonging to mercuric oxide and to no other substance. Thus, a compound may be identified and distinguished from all other compounds by its characteristic properties.

New Words

compound [ˈkɔmpaund] *n.* 化合物
decompose [ˌdiːkəmˈpəuz] *vt.* 分解
carbon [ˈkɑːbən] *n.* 碳
oxygen [ˈɔksidʒən] *n.* 氧
aluminum [əˈljuːminəm] *n.* 铝
nitrogen [ˈnaitridʒən] *n.* 氮
copper [ˈkɔpə] *n.* 铜
silver [ˈsilvə] *n.* 银
gold [gəuld] *n.* 金
nuclear [ˈnjuːkliə] *a.* 核的，核能的
ion [ˈaiən] *n.* 离子
positive [ˈpɔzətiv] *a.* 正的，阳性的

negative ['negətiv] *a.* 负的，阴性的
bond [bɔnd] *n.* 键；*vt.* 结合
chlorine ['klɔːriːn] *n.* 氯
methane ['meθein] *n.* 甲烷，沼气
mercury ['məːkjuri] *n.* 汞
mercuric [məː'kjuərik] *a.* 汞的，水银的
sodium ['səudjəm] *n.* 钠
calcium ['kælsiəm] *n.* 钙
sulfur ['sʌlfə] *n.* 硫

Expressions and Technical Terms

be composed of 由……组成
be decomposed into 被分解成
whole number ratio 整数比
percent by mass 质量百分比
identified and distinguished 鉴别和区别
ratio of 比率
carbon dioxide 二氧化碳
positive and negative charges 正电荷和负电荷
ordinary table sugar 普通方糖

Notes

① The ultimate chemical decomposition of compounds produces the elements from which they be made. 化合物化学分解的最终产物为组成它们的元素。

② No end in sight as to the number that can and will be prepared in the future. 在未来能够和将要被制造（化合物）的数目是数不清的。as to 对于……，关于……，that…引出定语从句修饰 number。

③ Water is a colorless，odorless，tasteless liquid that can be changed to a solid，ice，at 0℃ and to a gas，steam，at 100℃. 水是无色、无嗅、无味的液体，它在 0℃变成冰，100℃变成水蒸气。

④ Water reacts chemically with sodium to produce hydrogen gas and sodium hydroxide, with lime to produce calcium hydroxide, and with sulfur trioxide to produce sulfuric acid. 水与钠反应生成氢氧化钠和氢气，与石灰反应生成氢氧化钙，与三氧化硫反应生成硫酸。with…，with…表示并列关系。

Exercises

1. Put the following into Chinese

Magnesia (MgO) is generally derived from the mineral magnesite (magnesium carbonate, $MgCO_3$) or from magnesium salts in seawater and some naturally occurring brines. Magnesite deposits account for approximately 80% of total magnesia production. Two types of magnesia are used by industry: caustic calcined magnesia and refractory magnesia.

Caustic calcined magnesia is produced by calcining magnesite in furnaces, typically at temperatures of 800～900℃. Global production is estimated at around 1.6～1.7Mt/a, of which China accounts for 35%～40%. It has a variety of agricultural, environmental, chemical and industrial applications and is also the precursor for refractory magnesias.

2. Put the following into English

硫酸　硝酸　盐酸　硫酸铜　氧化铁　氯化钠

Reading Material

Chemical Equilibrium

Recognizing equilibrium systems

1. They can be approached from either end.

e. g. chromate ions can be changed into dichromate ions by adding acid, and dichromate ions can be turned into chromate ions by adding hydroxide ions, which remove the hydroxonium ions.

$$2CrO_4^{2-} + 2H_3O^+ \rightleftharpoons Cr_2O_7^{2-} + 3H_2O$$

2. If the temperature is changed, an equilibrium system will change, but if the original temperature is restored, the system will go back to its original state.

Proving the dynamic nature of an equilibrium system

This is done using radioactive tracers.

1. Set up an equilibrium system and allow it to reach equilibrium.
2. By sampling and measuring, find the exact composition of the whole system.
3. Now set up an identical system by adding the exact amount you have just measured, but with one component made of a radioactive isotope, say one of the reactants.
4. Leave the system for a time and sample them again and show that there are radioactive products, thus proving that even at equilibrium matter is being converted either way.

Reversible reactions

Reversible reactions make products which themselves react to give back the products. These reactions never stop because once some product is made, it can regenerate the reactants from which it came.

e. g. acid reacts with alcohol to make ester and water, but ester reacts with water to make acid and alcohol.

To show a system, like this the equilibrium sign $\rightleftharpoons$ is used

$$\text{acid} + \text{alcohol} \rightleftharpoons \text{ester} + \text{water}$$

Look at the way concentration and rate change with time here.

After time t, products are being made at exactly the same rate as they are reacting to make reactants. Because the two opposite rates are exactly equal, there is no external change and the system is said to be in dynamic equilibrium.

The equilibrium law

The equilibrium law states that for any systems in equilibrium, there is a numerical relationship between the concentrations of the products, raised to the power of their stoichiometric numbers, and the concentrations of the reactants, raised to the powers of their stoichiometric numbers. This relationship is called the equilibrium constant, K_c (when trying to explain this in an answer you must give an example like this).

e. g. for the system $N_2 + 3H_2 \rightleftharpoons 2NH_3$

The equilibrium law states that:

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

Square brackets, [ ], mean concentration of whatever is inside them.

The equilibrium constant, K_c, for homogeneous liquid systems

Many equilibrium systems are made up of ions in solution. They are all in the same liquid phase. Here K_c is written in terms of concentration. For example:

$$Fe^{3+}(aq) + SCN^-(aq) \rightleftharpoons FeSCN^{2-}(aq)$$

$$K_c = \frac{[FeSCN^{2-}]}{[Fe^{3+}][SCN^-]}$$

$$Cu^{2+}(aq) + 4Cl^-(aq) \rightleftharpoons CuCl_4^{2-}(aq)$$

$$K_c = \frac{[CuCl_4^{2-}]}{[Cu^{2+}][Cl^-]^4}$$

The equilibrium constant for heterogeneous systems

Many systems contain more than one phase and so are heterogeneous. If one of the phase is a pure solid or liquid, then although the amount of the solid or liquid may change, its concentration will not. In these cases it is usual to write an equilibrium law expression that does not contain the pure solid or liquid phase's concentration (which is actually included in the modified equilibrium constant). These example show this point:

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

$$K_c = [CO_2] \text{ and } K_p = p_{CO_2}$$

$$Fe_2O_3(s) + 3CO(g) \rightleftharpoons 2Fe(s) + 3CO_2(g)$$

$$K_c = \frac{[CO_2]^3}{[CO]^3} \text{ and } K_p = \frac{p^3_{CO_2}}{p^3_{CO}}$$

The equilibrium constant, K_p, for homogeneous gaseous systems

For gases it is usually more convenient to measure the pressure of the gas than its concentration. In a mixture of gases the gas is causing only part of the pressure, so the idea of partial pressure is used.

The partial pressure of a gas in a mixture is the pressure that the gas would exert, if it alone occupied the space containing the mixture.

The partial caused by a gas is proportional to the number of particle of the gas, so we can write:

$$\frac{\text{partial pressure of the gas, } p_g}{\text{total pressure of the gas mixture, } p_T} \qquad \frac{\text{number of particles of the gas, } n_g}{\text{total number of particles in the mixture, } n_T}$$

which can be rearranged to give $p_g = n_g/n_T \times p_T$

n_g/n_T is the mole fraction of the gas.

So the partial pressure of a gas equals the mole fraction of that gas multiplied by the total pressure.

Using partial pressures, a form of the equilibrium law can be written in terms of a different equilibrium constant K_p. For example:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad 2SO_2 + O_2 \rightleftharpoons 2SO_3$$

$$K_p = \frac{p_{NH_3}^2}{p_{N_2} p_{H_2}^3} \qquad K_p = \frac{p_{SO_3}^2}{p_{SO_2}^2 p_{O_2}}$$

The equilibrium constant

The size of the equilibrium constant

The value of size of K_c tell us whether there are more reactants or products in the systems at equilibrium. So

If K_c is $>10^2$, there will be far more products than reactants

If K_c is $<10^{-2}$, there will be far more reactants than products

If K_c is between 10^{-2} and 10^2, both reactants and products will be in the system in noticeable amounts.

The equilibrium position

The position of an equilibrium system is a term used to describe qualitatively what the equilibrium constant does quantitatively. It gives an indication of whether the reactants or products are more plentiful in the system. Remember, reactants are written on the left, products on the right in an equation, so

If the position lied to the left then the reactants dominate:

$$CH_3COOH(l) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq) \quad K_c = 1 \times 10^{-5}$$

If the position lied to the right the reactants dominate:

$$HCl(g) + H_2O(l) \rightleftharpoons H_3O^+(aq) + Cl^-(aq) \quad K_c = 5.55 \times 10^8$$

The units of the equilibrium constant

Equilibrium constants for different systems can have different units. Just remembers that the units of concentration are mol dL^{-1} and that the units on each side of the equation must balance, so

For the system: $N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$

So the units of K_c will be $= \frac{\text{mol} \cdot L^{-1} \times \text{mol} \cdot L^{-1}}{\text{mol} \cdot L^{-1} \times \text{mol} \cdot L^{-1}}$

New Words

equilibrium [ˌiːkwiˈlibriəm] *n.* 平衡

dynamic [daiˈnæmik] *a.* 动力的，动态的

converted [kən'vəːtid] *a.* 改装的
regenerate [ri'dʒenərit] *a.* 再生的；*n.* 再生；*v.* 再生
ester ['estə] *n.* 酯

Expressions and Technical Terms

chemical equilibrium 化学平衡
chromate ions and dichromate ions 铬酸根离子和重铬酸根离子
radioactive isotope 放射性同位素
reversible reaction 可逆反应
homogeneous gaseous system 均相气体系统
dynamic equilibrium 动态平衡
stoichiometric number 化学计量数
equilibrium constant 平衡常数

Lesson Two The Anatomy of a Chemical Manufacturing Process

The basic components of a typical chemical process are shown in Fig. 1, in which each block represents a stage in the overall process for producing a product from the raw materials. Fig. 1 represents a generalized process; not all the stages will be needed for any particular process, and the complexity of each stage will depend on the nature of the process. Chemical engineering design is concerned with the selection and arrangement of the stages, and the selection, specification and design of the equipment required to perform the stage functions.

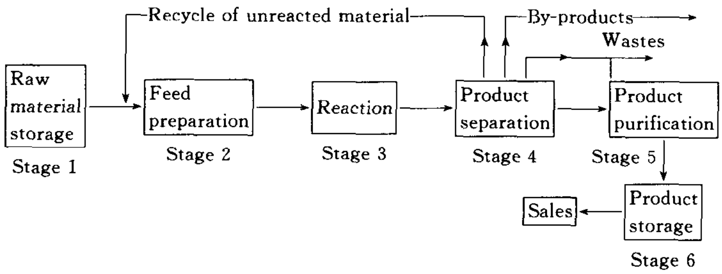

Fig. 1 Anatomy of a chemical process

Stage 1. Raw material storage

Unless the raw materials (also called essential materials, or feedstocks) are supplied as intermediate products (intermediates) from a neighboring plant, some provision will have to be made to hold several days, or weeks storage to smooth out fluctuations and interruptions in supply. Even when the materials come from an adjacent plant, some provision is usually made to hold a few hours, or even a few days, supply to decouple the processes. The storage required will depend on the nature of the raw materials, the method of delivery, and what assurance can be placed on the continuity of supply. If materials are delivered by ship (tanker or bulk carrier), several weeks stocks may be necessary; whereas if they are received by road or rail, in smaller lots, less storage will be needed.

Stage 2. Feed preparation

Some purification, and preparation, of file raw materials will usually be necessary before they are sufficiently pure, or in the right form, to be fed to the reaction stage. For example, acetylene generated by the carbide process contains arsenical and sulphur compounds, and other impurities, which must be removed by scrubbing with concentrated sulphuric acid (or other processes) before it is sufficiently pure for reaction with hydrochloric acid to produce dichloroethane. Liquid feeds will need to be vaporized before being fed to