普通高等教育“十二五”规划教材

石油化学化工专业英语

ENGLISH

孟祥海　段爱军　主编



中国石化出版社
HTTP://WWW.SINOPEC-PRESS.COM

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内 容 提 要

本书是为化工及其相关专业编写的专业英语教材，旨在提高读者英语科技文献阅读能力及专业交流水平。主要内容选自国内外化工专业书籍、专业英语网络资料以及科技前沿文献。所包含的化工知识覆盖面广、内容丰富、词汇全面、难度适中，编排由浅入深，点面结合。全书共包括六个部分，涵盖了化学化工行业概况、四大基础化学、化学工程专业基础、石油炼制与化工、化工过程安全与环境工程能源化工概况等相关知识，课后给出了与课文相关的阅读材料，便于读者自学。本书可作为高等院校化工及相关专业的本科专业英语教材，也可作为从事化工领域的教学、科研和工程技术人员的参考用书。

图书在版编目(CIP)数据

石油化学化工专业英语／孟祥海，段爱军主编．—北京：中国石化出版社，2014．4
ISBN 978－7－5114－2703－8

Ⅰ．①石… Ⅱ．①孟… ②段… Ⅲ．①石油化学－英语－②石油化工－英语 Ⅳ．①H31

中国版本图书馆CIP数据核字(2014)第041732号

中国石化出版社出版发行
地址：北京市东城区安定门外大街58号
邮编：100011　电话：(010)84271850
读者服务部电话：(010)84289974
http://www.sinopec-press.com
E-mail:press@sinopec.com
北京富泰印刷有限责任公司印刷
全国各地新华书店经销
*
710×1000毫米16开本13.75印张256千字
2014年5月第1版　2014年5月第1次印刷
定价：35.00元

前言

伴随我国石油炼制和石油化工行业的快速发展以及企业国际化程度的逐步提升，企业对化工人才的素质提出了更高的要求。优秀的化工人才不仅要具备扎实宽广的专业知识，还要拥有通过英文文献获取和提供信息的能力，以及与国外同行进行口语和书面交流的能力。

本书旨在为高校化工相关专业的学生和石油炼制与化工从业人员提供一本合适的专业英语学习材料。本书内容选自国内化学化工专业英语教材、国外化工专业书籍、专业英语学习网站以及英文科技文章。全书共包括六个部分，第一部分介绍化学化工概况以及化工常用单位体系；第二部分介绍化学基础知识，包括无机化学、有机化学、分析化学、物理化学；第三部分介绍化学工程基础知识，包括传质过程、传热过程、化学反应工程、反应器类型、化工热力学定律、化工仪器分析；第四部分介绍石油与石油炼制基本知识，包括石油及其性质、石油组成与分类、石油产品、石油炼制工艺、乙烯生产；第五部分介绍化工过程安全与环境工程；第六部分介绍能源，包括能源概述、可再生能源与不可再生能源等。

本书的特点如下：①学习难度由浅入深；②选材广泛，内容涉及化学基础、化工基础、石油炼制与化工、化工安全与环境、能源等相关知识；③专业词汇系统，便于对比学习和集中记忆；④自学内容丰富，课后给出了与课文相关的阅读材料，便于学生阅读和自学。

本书由中国石油大学(北京)的孟祥海和段爱军老师主编。参加编写工作的教师有：杜巍(第一部分 Unit 2 与第五部分 Unit 2)，史权(第二部分 Unit 5 与第三部分 Unit 6)，姜桂元(第二部分 Unit 6)，商辉(第四部分 Unit 5)。感谢赵亮与韩晔华老师所做的大量校对工作。

本书在编写过程中参考了国内现有的化工专业英语教材以及国外的化工专业书籍，并已在参考文献部分列出，在此对这些资料的作者深表谢意。

书中错误与不妥之处在所难免，敬请广大读者给予批评指正。

编者

2014 年 1 月

Preface

With the rapid development of petroleum refining and petrochemical industry in China as well as the gradual improvement of the internationalization of enterprises, the chemical companies propose a higher quality requirement for the chemical talents. Excellent chemical engineers need to have not only the solid and broad expertise, but also the ability of getting information from English literatur, as well as the abilities of oral and written communication with foreign counterparts.

This book is designed to provide some professional English learning materials for college students, workers or technicians in chemical engineering and related fields. The main contents of this book are selected from the domestic English textbooks, foreign chemical professional books, professional English learning websites and some scientific papers in English. This book includes six parts. The first part introduces the overview of chemistry and common units systems in chemical engineering. The second part describes the basic knowledge of chemistry, including inorganic chemistry, organic chemistry, analytical chemistry and physical chemistry. The third part introduces the principles of chemical engineering, including mass transfer process, heat transfer process, chemical reaction engineering, reactor types, laws of thermodynamics and instrumental analysis. The fourth part describes the elementary knowledge of petroleum and its refining, including petroleum and its properties, petroleum compositions and classifications, petroleum products, petroleum refining processes and ethylene production.

The fifth part introduces the chemical process safety and environmental engineering in chemical production. The sixth part introduces energy, including energy overview, renewable energy and non - renewable energy.

The characteristics of this book are as follows: ①the learning materials go from the easy to the difficult; ②a wide range of selections for the main contents, involving chemistry fundamentals, chemical engineering fundamentals, petroleum refining and petrochemicals, chemical safety and environment, energy and other related knowledge; ③ systematic professional vocabulary lists, facilitating contrastive learning and memory; ④ lots of reading materials for self - learning, which are related to the teaching materials and given after each text.

This book is edited by Professor Meng Xianghai and Associate Professor Duan Aijun from China University of Petroleum, Beijing. Other contributors include Du Wei (Part 1 Unit 2 and Part 5 Unit 2), Shi Quan (Part 2 Unit 5 and Part 3 Unit 6), Jiang Guiyuan (Part 2 Unit 6), Liu Bei (Part 3 Unit 5), Shang Hui (Part 4 Unit 5), and Yuan Pei (Part 6). Thanks Zhao Liang and Han Yehua for doing a lot of proofreading.

This book references some domestic and foreign textbooks and professional books, which have been listed in the references. Here, we truly thank the authors of the literature references.

Please point out the mistakes for correction if any.

Editor

2014. 1

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Part 1 Introduction of Chemistry and Chemical Engineering

Unit 1 Chemistry and Chemical Engineering

1.1 What Is Chemistry About?

Different kinds of matter that compose the universe are termed materials. Each material has its own distinguishing characteristics, which is termed its properties. These properties enable the material to be recognized or separated from other materials.

The study of materials is the joint concern of chemistry and physics. Roughly stated, physics is concerned with the general properties and energy and with events which results in what are termed physical changes. Physical changes are those in which materials are not so thoroughly altered as to be converted into other materials distinct from those present in the beginning.

Chemistry, by contrast, is chiefly concerned with properties that distinguish materials from one another and with events which results in chemical changes. Chemical changes are those in which materials are transformed into completely different materials. Such thoroughgoing transformations, in which all the properties of a material are altered, so that a completely different material is obtained, are called chemical transformations, chemical changes, or chemical reactions.

Chemistry as an art is concerned with identifying, separating and transforming materials, in applying them to definite uses. Chemistry as a science is a manner of thinking about transformations of materials which helps us to understand, predict and control them. It provides directing intelligence in the use of materials.

1.2 Working Areas of Chemists

Many chemists work in traditional fields of chemistry. Biochemists are interested in chemical processes that occur in living organisms. Physical chemists work with fundamental principles of physics and chemistry in an attempt to answer the basic questions that apply to all of chemistry: why do some substances react with one another while others do not? How fast will a particular chemical reaction occur? How much useful energy can be extracted from a chemical reaction?

Analytical chemists are investigators; they study ways to separate and identify chemical substances. Many of the techniques developed by analytical chemists are used extensively by environmental scientists. Organic chemists focus their attention on substances that contain carbon and hydrogen in combination with some other elements. The vast majority of substances are organic chemicals. Inorganic chemists focus on most of the elements other than carbon, though the fields of organic and inorganic chemists overlap in some ways.

Although chemistry is considered to be a "mature" science, the landscape of chemistry is dotted with unanswered questions and challenges. Modern technology demands new materials with unusual properties, and chemists must devise new methods of producing these materials. Society requires improved methods of pollution control, substitutes for scarce materials, non-hazardous means of disposing of toxic wastes, and more efficient ways to extract energy from fuels. Chemists are at work in all these areas.

1.3 What Is Chemical Engineering About?

Chemical engineering is the profession concerned with the creative application of the scientific principles underlying the transport of momentum, heat and mass, and the physical and chemical change of matter. It revolves around chemical processes where raw materials are converted into useful, high value-added products that improve out standards of living. Examples of such products are fuels, plastics, processed foods, and pharmaceuticals.

Chemical engineering is the application of science, in particular chemistry, along with mathematics and economics to the process of converting raw materials or chemicals into more useful or valuable forms. It largely involves the design and maintenance of chemical processes for large-scale manufacture. The primary emphasis of chemical engineers was initially devoted to the general subject of how to use the results of laboratory experiments to design process equipment capable of meeting industrial production rates.

This led naturally to the characterization of design procedures in terms of the unit operations, those elements were common to many different processes. The basic unit operations include fluid flow, heat exchange, extraction, distillation, etc. A typical manufacturing process will be made up of combinations of the unit operations. Chemical engineers understand that engineering factors also affect the progress of chemical reactions, such as mixing, heat transfer, mass transfer, process control strategies and reactor design—fundamental chemical engineering subjects. They are more actively involved in control, design and optimization of chemical processes.

Areas of concern to the chemical engineer include process and equipment design, plant layout, management of day-to-day operations, troubleshooting, material and energy balances, process control, process safety, energy conservation, and waste treatment.

Words and Expressions

化学	chemistry
化学工程	chemical engineering
化学工程师	chemical engineer
无机化学	inorganic chemistry
有机化学	organic chemistry
物理化学	physical chemistry
分析化学	analytical chemistry
生物化学	biochemistry
应用化学	applied chemistry
结构化学	structural chemistry
催化原理	principle of catalysis
仪器分析	instrumental analysis
化学热力学	chemical thermodynamics
化工热力学	chemical engineering thermodynamics
化工原理	principle of chemical engineering
化学反应工程	chemical reaction engineering
传递过程原理	principle of transport processes
分离工程	separation engineering
化工系统工程	chemical system engineering
石油化学	petroleum chemistry
石油加工工程	petroleum refining/processing engineering
近代炼油技术	modern petroleum processing technology
有机化工工艺	organic chemical technology
有机化学品合成与工艺	organic chemicals synthesis and technology

生产实习	production practice
认识实习	general/cognition practice
化工专业英语	English for chemical engineering and technology
化工过程技术	chemical process technology
化工设计	chemical engineering design
化工装备	chemical equipment

Reading Material

Chemical Industry

The chemical industry comprises the companies that produce industrial chemicals. It is central to modern world economy, converting raw materials (oil, natural gas, air, water, metals, and minerals) into more than 70,000 different products.

(1) Chemical products

Polymers and plastics, especially polyethylene, polypropylene, polyvinyl chloride, polystyrene, and polycarbonate comprise about 80% of the industry's output worldwide. Chemicals are used to make a wide variety of consumer goods, as well as thousands inputs to agriculture, manufacturing, construction, and service industries. The chemical industry itself consumes 26% of its own output. Major industrial customers include rubber and plastic products, textiles, apparel, petroleum refining, pulp and paper, and primary metals. Chemicals are nearly a $3 trillion global enterprise, and the EU and U. S. chemical companies are the world's largest producers.

(2) Product category breakdown

Sales of the chemical business can be divided into a few broad categories, including basic chemicals (about 35 to 37 percent of the dollar output), life sciences (30 percent), specialty chemicals (20 to 25 percent), and consumer products (about 10 percent).

Basic chemicals are a broad chemical category including polymers, bulk petrochemicals and intermediates, other derivatives and basic industrials, inorganic chemicals, and fertilizers. Typical growth rates for basic chemicals are about 0.5 to 0.7 times GDP. Polymers include all categories of plastics and man-made fibers. The major markets for plastics are packaging, followed by home construction, containers, appliances, pipe, transportation, toys, and games. The principal raw materials for polymers are bulk petrochemicals.

Chemicals in the bulk petrochemicals and intermediates are primarily made from natural gas and crude oil. Their sales volume is close to 30 percent of overall basic chemicals. Typical large-volume products include ethylene, propylene, benzene, toluene, xylenes, methanol, vinyl chloride monomer, styrene, butadiene, and ethylene oxide. These chemicals are the starting points for most polymers and other organic chemicals as well as much of the specialty chemicals category.

Other derivatives and basic industrials include synthetic rubber, resins, surfactants, dyes and pigments, carbon black, explosives, and rubber products and contribute about 20 percent of the basic chemicals' external sales. Inorganic chemicals (about 12 percent of the revenue output) make up the oldest of the chemical categories. Products include salt, chlorine, caustic soda, soda ash, acids (such as nitric, phosphoric, and sulfuric), titanium dioxide, and hydrogen peroxide. Fertilizers are the smallest category (about 6 percent) and include phosphates, ammonia, and potash chemicals.

Life sciences include differentiated chemical and biological substances, pharmaceuticals, diagnostics, animal health products, vitamins, and crop protection chemicals. While much smaller in volume than other chemical sectors, their products tend to have very high prices and growth rates of 1.5 to 6 times GDP, and research and development spending at 15 to 25 percent of sales. Life science products are usually produced with very high specifications and are closely scrutinized by government agencies such as the Food and Drug Administration. Crop protection chemicals, about 10 percent of this category, include herbicides, insecticides, and fungicides.

Specialty chemicals (sometimes referred to as "fine chemicals") are a category of relatively high valued, rapidly growing chemicals with diverse end product markets. Typical growth rates are one to three times GDP. They are generally characterized by their innovative aspects. Products are sold for what they can do rather than for what chemicals they contain. Products include electronic chemicals, industrial gases, adhesives and sealants as well as coatings, industrial and institutional cleaning chemicals, and catalysts.

Consumer products include direct product sale of chemicals such as soaps, detergents, and cosmetics. Typical growth rates are 0.8 to 1.0 times GDP.

(3) Technology

As accepted by chemical engineers, the chemical industry involves the use of chemical processes such as chemical reactions and refining methods to produce a wide variety of solid, liquid, and gaseous materials. Most of these products are used in manufacture of other items, although a smaller number are used directly by consumers. Solvents, pesticides, lye, washing soda, and cement are a few examples of product used by consumers. The industry includes manufacturers of inorganic and organic industrial chemicals, ceramic products, petrochemicals, agrochemicals, polymers and rubber, oleochemicals (oils, fats, and waxes), explosives, fragrances and flavors.

Although the pharmaceutical industry is often considered a chemical industry, it has many different characteristics that put it in a separate category. Other closely related industries include petroleum, glass, paint, ink, sealant, adhesive, and food processing manufacturers.

Chemical processes such as chemical reactions are used in chemical plants to form new substances in various types of reaction vessels. In many cases the reactions are conducted in special corrosion resistant equipment at elevated temperatures and pressures with the use of catalysts. The products of these reactions are separated using a variety of techniques including distillation especially fractional distillation, precipitation, crystallization, adsorption, filtration, sublimation, and drying. The processes and product are usually tested during and after manufacture by dedicated instruments and on-site quality control laboratories to insure safe operation and to assure that the product will meet required specifications. The products are packaged and delivered by many methods, including pipelines, tank-cars, and tank-trucks (for both solids and liquids), cylinders, drums, bottles, and boxes. Chemical companies often have a research and development laboratory for developing and testing products and processes. These facilities may include pilot plants, and such research facilities may be located at a site separated from the production plant.

Unit 2 Unit Systems

The official international system of units is SI (Système International d'Unités). Strong efforts are underway for its universal adoption as the exclusive system for all engineering and science, but older systems, particularly the centimeter-gram-second (cgs) and foot-pound-second (fps) engineering systems, are still in use for some time. It is necessary to be expert in the use of all three systems.

2.1 Physical Quantities

Any physical quantity consists of two parts: a unit, which tells what the quantity is and gives the standard by which it is measured, and a number, which tells how many units are needed to make up the quantity. For example, the statement that the distance between two points is 3 meter means all this: A definite length has been measured; to measure it, a standard length, called the meter, has been chosen as a unit; and three 1 – meter units, laid end to end, are needed to cover the distance. If an integral number of units are either too few or too many to cover a given distance, submultiples, which are fractions of the unit, are defined by dividing the unit into fractions, so that a measurement can be made to any degree of precision in terms of the fractional units. No physical quantity is defined until both the number and the unit are given.

2.2 SI Units

The SI system covers the entire field of science and engineering. The units are derivable from ①four proportionalities of chemistry and physics; ②arbitrary standards for mass, length, time, temperature, and the mole; and ③arbitrary choices for the numerical values of two proportionality constants.

(1) Basic equations

The basic proportionalities, each written as an equation with its own proportionality factor, are

$$F = k_1 \frac{\mathrm{d}}{\mathrm{d}t}(mu) \qquad (1-1)$$

$$F = k_2 \frac{m_a m_b}{r^2} \qquad (1-2)$$

$$Q_c = k_3 W_c \qquad (1-3)$$

$$T = k_4 \lim_{p \to 0} \frac{pV}{m} \qquad (1-4)$$

Where: F = force, t = time, m = mass, u = velocity, r = distance, W_c = work, Q_c = heat, p = pressure, V = volume, T = thermodynamic absolute temperature, k_1, k_2, k_3, k_4 = proportionality factors.

Equation (1 - 1) is Newton's second law of motion, showing the proportionality between the resultant of all the forces acting on a particle of mass m and the time rate of increase in momentum of the particle in the direction of the resultant force.

Equation (1 - 2) is Newton's law of gravitation, giving the force of attraction between two particles of masses m_a and m_b at a distance r apart.

Equation (1 - 3) is one statement of the first law of thermodynamics. It affirms the proportionality between the work performed within a closed system during a cycle and the heat absorbed by that system during the same cycle.

Equation (1 - 4) shows the proportionality between the thermodynamic absolute temperature and the zero-pressure limit of the pressure, volume product of a definite mass of any gas.

Each equation states that if means are available for measuring the values of all variables in that equation and if the numerical value of k is calculated, then the value of k is constant and depends only on the units used for measuring the variables in the equation.

(2) Standards

By international agreement, standard are fixed arbitrarily for the quantities of mass, length, time, temperature, and the mole. These are five of the base units of SI. Currently, the standards are as follows.

The standard of mass is the kilogram (kg), defined as the mass of the international kilogram, a platinum cylinder preserved at Sèvres, France.

The standard of length is the meter (m), defined (since 1983) as the length of the path traveled by light in vacuum during a time interval of 1/299, 792, 458 of a second.

The standard of time is the second (s), defined as 9, 192, 631.770 frequency cycles of a certain quantum transition in an atom of ^{133}Ce.

The standard of temperature is the Kelvin (K), defined by assigning the value 273.16 K to the temperature of pure water at its triple point, the unique temperature at which liquid water, ice, and steam can exist at equilibrium.

The mole (abbreviated mol) is defined as the amount of a substance comprising as many elementary units as there are atoms in 12 g of ^{12}C.