化学工程与工艺专业英语

ENGLISH FOR CHEMICAL ENGINEERING AND TECHNOLOGY

李文玲◎编著

蘭州大學出版社

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前　言

随着世界范围内化学、化工领域的快速发展，很多新技术、新工艺都逐步成为化工行业的主流，但目前与21世纪化工领域新发展紧密衔接的化工专业英语教材并不多，因此很有必要对化工专业英语教材的内容进行及时的补充和更新，才能更好地使即将进入化工领域的本科毕业生更具竞争力。为此，在多年从事化学工程与工艺专业英语教学的经验基础之上，本人着手编写了这部教材。

本教材在吸收国内同类书籍优点的同时，根据现代化学工业的快速发展补充了一些相关新知识。本书选材来源于化学类英文原版专著、杂志、英文化学化工网站以及大学化学化工专业教学用书，选材面广，专业性强，难易适中，循序渐进，适合作为高等院校化学工程与工艺专业本科专业英语的教学用书，也可作为从事化学化工领域的教学、科研和工程技术人员的参考用书。

本书分为两部分，第一部分由16个单元构成，每个单元由课文、词汇解释、难点注释、课后练习、相关阅读文章组成，内容涉及21世纪的化学工业发展、化学工程师、基本无机化学工业、石油化工产品及加工工艺、化工单元操作、精细化学品工业、制药工业、聚合物工业及材料化学等。在第二部分的辅助阅读材料中，精选了有关科技英语阅读技巧、专业文章写作常识、文献查阅方法、实验记录规范等内容，以拓展学生对专业英语的实践技能。最后，在附录中介绍了无机化合物及有机化合物命名规则、化学化工常用构词法、化学化工专业常用英文缩写与符号、化学实验室常用仪器设备中英文名称及总词汇表等，可供读者查阅。

本书由兰州交通大学“青蓝”人才工程资助出版，在此表示感谢。

由于本人专业及英语水平的限制，再加上时间仓促，书中难免存在不足之处，恳请广大读者提出宝贵意见。

编者

2011年12月

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Part A Chemical Engineering and Technology

Unit 1
Industrial Chemistry

Before we define industrial chemistry, it may be helpful to know that the development of industrial chemistry started when a need to know how various chemicals are produced in much more than the laboratory scale, arose. Chemistry knowledge was applied to furnish the rapidly expanding chemical industries with "recipes" which we now call chemical processes. Industrial chemistry keeps up with the progress in science and technology. It incorporates other emerging disciplines such as biotechnology, microelectronics, pharmacology and material science. The discipline is also concerned with economics and the need to protect the environment. We define industrial chemistry as the branch of chemistry which applies physical and chemical procedures towards the transformation of natural raw materials and their derivatives to products that are of benefit to humanity.

Classical chemistry (organic, inorganic and physical chemistry) is very essential for advancing the science of chemistry by discovering and reporting new products, routes and techniques. On the other hand industrial chemistry helps us to close the gap between classical chemistry as it is taught in colleges and universities, and chemistry as it is practiced commercially. The scope of industrial chemistry therefore includes:

The exploitation of materials and energy in appropriate scale;

Application of science and technology to enable humanity experience the benefits of chemistry in areas such as food production, health and hygiene, shelter, protection, decoration, recreation and entertainment.

1 Chemical Industry

The chemical industry can also be classified according to the type of main raw materials used and/or type of principal products made. We therefore have industrial inorganic chemical industries and industrial organic chemical industries. Industrial inorganic chemical industries extract inorganic chemical substances, make composites of the same and also synthesize inorganic chemicals. Heavy industrial organic chemical industries produce petroleum fuels, polymers, petrochemicals and other synthetic materials, mostly from petroleum. Light industrial organic chemical industries produce specialty chemicals which include pharmaceuticals, dyes, pigments and paints, pesticides, soaps and detergents, cosmetic products and miscellaneous products.

1.1 The Structure of the Global Chemical Industry

We normally put a value to something according to how much it has cost us. Some things are of high value while others are of low value. For low valued products, you need to produce them in large volumes to make significant profit. This means that the raw materials are cheap and easily accessible. There is also an existing, relatively simple, and easily accessible processing technology. To sell a large volume of product, there must be a large market. This brings stiff competition which also makes the price to remain low.

We are now ready to describe the structure of the global chemical industry.

Commodity Chemicals

The global chemical industry is founded on basic inorganic chemicals (BIC) and basic organic chemicals (BOC) and their intermediates. Because they are produced directly from natural resources or immediate derivatives of natural resources, they are produced in large quantities.

In the top ten BIC, almost all the time, are sulphuric acid, nitrogen, oxygen, ammonia, lime, sodium hydroxide, phosphoric acid and chlorine dominate. The reason sulphuric acid is always number one is because it is used in the manufacture of fertilizers, polymers, drugs, paints, detergents and paper. It is also used in petroleum refining, metallurgy and in many other processes. The top ranking of oxygen is to do with its use in the steel industry.

Ethylene and propylene are usually among the top ten BOC. They are used in the production of many organic chemicals including polymers. BIC and BOC are referred to as commodity or industrial chemicals. Commodity chemicals are therefore defined as low-valued products produced in large quantities mostly in continuous processes. They are of technical or general purpose grade.

Specialty Chemicals

High-value adding involves the production of small quantities of chemical products for specific end uses. Such products are called specialty chemicals. These are high value-added products produced in low volumes and sold on the basis of a specific function.

In this category are the so-called performance chemicals which are high value products produced in low volumes and used in extremely low quantities. They are judged by performance and efficiency. Enzymes and dyes are performance chemicals.

Other examples of specialty chemicals include medicinal chemicals, agrochemicals, pigments, flavour and fragrances, personal care products, surfactants and adhesives.

Specialty chemicals are mainly used in the form of formulations. Purity is of vital importance in their formulation. This calls for organic synthesis of highly valued pure chemicals known as fine chemicals.

Fine Chemicals

At times you will find that the raw materials for your product need to be very pure for the product to function as desired. Research chemicals are in this category as also are pharmaceutical ingredients. Such purified or refined chemicals are called fine chemicals. By definition they are high value-added pure organic chemical substances produced in relatively low volumes and sold on the basis of exact specifications of purity rather than functional characteristics.

The global market share for each type is roughly as follows:

Commodities 80%; Specialties 18%; Fine 2%.

1.2 Raw Material for the Chemical Industry

We have paid some attention to products from the chemical industry. But, since there would be no chemical industry without raw materials, the subject of raw materials is due for discussion at this stage.

All chemicals are derived from raw materials available in nature. The price of chemicals depends on the availability of their raw materials. Major chemical industries have therefore developed around the most plentiful raw materials. The natural environment is the source of raw materials for the chemical industry.

Raw materials from the atmosphere

The atmosphere is the field above ground level. It is the source of air from which six industrial gases namely N_2, O_2, Ne, Ar, Kr and Xe are manufactured. The mass of the earth's atmosphere is approximately 5×10^{15} tons and therefore the supply of the gases is virtually unlimited.

Raw materials from the hydrosphere

Ocean water which amounts to about 1.5×10^{21} liters contains about 3.5 percent by mass dissolved material. Seawater is a good source of sodium chloride, magnesium and bromine.

Raw materials from the lithosphere

The vast majority of elements are obtained from the earth's crust in the form of mineral ores, carbon and hydrocarbons. Coal, natural gas and crude petroleum besides being energy sources are also converted to thousands of chemicals.

Raw materials from the biosphere

Vegetation and animals contribute raw materials to the so-called agro-based industries. Oils, fats, waxes, resins, sugar, natural fibres and leather are examples of thousands of natural products.

2 Chemical Processes

Every industrial process is designed to produce a desired product from a variety of starting raw materials using energy through a succession of treatment steps integrated in a rational fashion. The treatments steps are either physical or chemical in nature.

Energy is an input to or output in chemical processes. The layout of a chemical process indicates areas where:

- raw materials are pre-treated;
- conversion takes place;
- separation of products from by-products is carried out;
- refining/purification of products takes place;
- entry and exit points of services such as cooling water and steam.

A chemical process consists of a combination of chemical reactions such as synthesis, calcination, ion exchange, electrolysis, oxidation, hydration and operations based on physical phenomena such as evaporation, crystallization, distillation and extraction. A chemical process is therefore any single processing unit or a combination of processing units used for the conversion of raw materials through any combination of chemical and physical treatment changes into finished products.

Unit processes

Unit processes are the chemical transformations or conversions that are performed in a process. In Table 1.1, examples of some unit processes are given.

Table 1.1 Examples of unit processes

Acylation	Calcinations	Dehydrogenation	Hydrolysis
Alcoholysis	Carboxylation	Decomposition	Ion Exchange
Alkylation	Causitization	Electrolysis	Isomerization
Amination	Combustion	Esterification	Neutralization
Ammonolysis	Condensation	Fermentation	Oxidation
Aromatization	Dehydration	Hydrogenation	Pyrolysis

There are many types of chemical processes that make up the global chemical industry. However, each may be broken down into a series of steps called unit operations. These are the physical treatment steps, which are required to:

·put the raw materials in a form in which they can be reacted chemically;

·put the product in a form which is suitable for the market.

In Table1.2, some common unit operations are given.

Table 1.2 Examples of unit operations

Agitation	Dispersion	Heat transfer
Atomization	Distillation	Humidification
Centrifuging	Evaporation	Mixing
Classification	Filtration	Pumping
Crushing	Flotation	Settling
Decanting	Gas absorption	Size reduction

It is the arrangement or sequencing of various unit operations coupled with unit processes and together with material inputs, which give each process its individual character. The individual operations have common techniques and are based on the same scientific principles. For example, in many processes, solids and fluids must be moved; heat or other forms of energy may be transferred from one substance to another; drying, size reduction, distillation and evaporation are performed.

By studying systematically these unit operations, which cut across industry and process lines, the treatment of all processes is unified and simplified.

Flow Diagrams

A picture says more than a thousand words. Some chemical processes are quite simple; others such as oil refineries and petrochemical plants can be very complex. The process description of some processes could take a lot of text and time to read and still not yield 100%

comprehension. Errors resulting from misunderstanding processes can be extremely costly.

To simplify process description, flow diagrams also known as flow sheets are used. A flow diagram is a road map of the process, which gives a great deal of information in a small space. Chemical engineers use it to show the sequence of equipment and unit operations in the overall process to simplify the visualization of the manufacturing procedures and to indicate the quantities of material and energy transferred.

A flow diagram is not a scale drawing but it:

· pictorially identifies the chemical process steps in their proper/logical sequence;

· includes sufficient details in order that a proper mechanical interpretation may be made.

Two types of flow diagrams are in common use, namely, the block diagrams and the process flow diagrams.

Block Diagrams

This is a schematic diagram, which shows:

· what is to be done rather than how it is to be done. Details of unit operations processes are not given;

· flow by means of lines and arrows;

· unit operations and processes by figures such as rectangles and circles;

· raw materials, intermediate and final products.

Process Flow Diagram / Flow Sheet

Chemical plants are built from process flow drawings or flow sheets drawn by chemical engineers to communicate concepts and designs. Communication is impaired if the reader is not given clear and unmistakable picture of the design. Time is also wasted as reader questions or puzzles out the flow diagram. The reader may make serious mistakes based on erroneous interpretation of the flow diagram.

Communication is improved if accepted symbols are used. The advantages of correct use of symbols include:

· the function being performed is emphasized by eliminating distractions caused by detail;

· possibility of error that is likely to occur when detail is repeated many times is virtually done away with;

· equipment symbols should neither dominate the drawing nor be too small for clear understanding.

Flow sheet symbols are pictorial quick-to-draw, easy-to-understand symbols that transcend language barriers. Some have already been accepted as national standards while others are symbols commonly used in chemical process industries, which have been proven to be effective. Engineers are constantly devising their own symbols where standards do not exist.

Therefore, symbols and presentation may vary from one designer or company to another.

Words and Expressions

1. recipe [ˈresəpi] *n.* 烹饪法, 食谱,方法, 秘诀, 诀窍
2. discipline [ˈdisiplin] *n.* 学科, 训练, 纪律, 行为准则
3. pharmacology [ˌfɑːməˈkɔlədʒi] *n.* 药理学, 药物学
4. hygiene [ˈhaidʒiːn] *n.* 卫生学, 保健学
5. recreation [ˌrekriˈeiʃən] *n.* 娱乐(方式)
6. composite [ˈkɔmpəzit] *adj.* 混合成的, 复合的; *n.* 合成物;混合物
7. petrochemical [ˌpetrəuˈkemikəl] *n.* 石油化学产品
8. synthesize [ˈsinθiˌsaiz] *vt.* 使合成, 人工合成
9. specialty [ˈspeʃəlti] *n.* 专业;专长, 特制品, 特性
10. pharmaceuticals [ˌfɑːməˈsjuːtikəlz] *n.* 医药品
11. pigment [ˈpigmənt] *n.* (粉状)颜料, 天然色素
12. pesticide [ˈpestisaid] *n.* 杀虫剂, 除害药物
13. detergent [diˈtəːdʒənt] *n.* 洗涤剂, 去垢剂, 洗衣粉
14. cosmetic [kɔzˈmetik] *n.* 化妆品; *adj.* 化妆用的, 美容的
15. miscellaneous [ˌmisəˈleiniəs] *adj.* 不同种类的, 多种多样的, 混杂的
16. sulphuric [sʌlˈfjuərik] *adj.* 硫黄的, 含多量硫黄的
17. ammonia [əˈməuniə] *n.* 氨, 氨水
18. sodium hydroxide *n.* 氢氧化钠
19. phosphoric [fɔsˈfɔrik] *adj.* 磷的,含磷的(尤指含五价磷的)
20. chlorine [ˈklɔːriːn] *n.* 氯, 氯气
21. refining [riˈfainiŋ] *n.* 精炼
22. metallurgy [miˈtælədʒi] *n.* 冶金学
23. ethylene [ˈeθəˌliːn] *n.* 乙烯
24. propylene [ˈprəupiliːn] *n.* 丙烯
25. commodity [kəˈmɔditi] *n.* 商品, 货物, 有用的东西
26. flavour [ˈfleivə] *n.* 味道, 特色; *vt.* 调味
27. fragrance [ˈfreigrəns] *n.* 芳香, 香味, 香水
28. surfactant [səːˈfæktənt] 表面活性剂(的)
29. adhesive [ədˈhiːsiv] *n.* 黏合剂; *adj.* 可黏着的, 黏性的
30. formulation [ˌfɔːmjuˈleiʃən] *n.* 公式化, 规划, 构想
31. ingredient [inˈgriːdiənt] *n.* (混合物的)组成部分;(构成)要素

32. hydrosphere [ˈhaidrəsfiə] *n.* 水圈, 水气, 水界
33. magnesium [mægˈni:ziəm] *n.* 镁(金属元素)
34. bromine [ˈbrəumi:n] *n.* 溴
35. crust [krʌst] *n.* 外皮,壳;地壳
36. hydrocarbon [ˌhaidrəˈkɑ:bən] *n.* 碳氢化合物, 烃
37. biosphere [ˈbaiəˌsfiə] *n.* 生物圈
38. resin [ˈrezin] *n.* 树脂, 合成树脂
39. fibre [ˈfaibə] *n.* (动植物的)纤维, 纤维质
40. leather [ˈleðə] *n.* 皮, 皮革, 皮外套
41. succession [səkˈseʃən] *n.* 继续, 连续, 继任, 继承权
42. rational [ˈræʃənl] *adj.* 理性的, 合理的
43. layout [ˈleiaut] *n.* 布局, 安排, 陈设
44. by-product [ˈbaiprɔdʌkt] *n.* 副产品, 意外结果, 副作用
45. calcination [kælsiˈneiʃən] *n.* 煅烧
46. acylation [ˈæsileiʃən] *n.* 酰化(作用)
47. dehydrogenation [di:ˌhaidrədʒəˈneiʃən] *n.* 脱氢作用
48. hydrolysis [haiˈdrɔlisis] *n.* 水解
49. alcoholysis [ælkəˈhɔlisis] *n.* 醇解
50. carboxylation [kɑ:ˌbɔksəˈleiʃən] *n.* 羧化作用
51. decomposition [ˌdi:kɔmpəˈziʃən] *n.* 分解
52. ion exchange 离子交换
53. alkylation [ˌælkiˈleiʃən] *n.* 烷化, 烃化
54. causitization [ˌkauzitiˈzeiʃən] *n.* 苛性化
55. electrolysis [ilekˈtrɔlisis] *n.* 电解, 电蚀
56. isomerization [aiˌsɔməraiˈzeiʃən] *n.* 异构化(作用)
57. amination [æmiˈneiʃən] *n.* 胺
58. combustion [kəmˈbʌstʃən] *n.* 燃烧, 烧毁
59. esterification [esˌterifiˈkeiʃən] *n.* 酯化作用
60. neutralization [ˌnju:trəlaiˈzeiʃən] *n.* 中立化, 中立状态, 中和
61. ammonolysis [æməˈnɔlisis] *n.* 氨解作用
62. condensation [ˌkɔndenˈseiʃən] *n.* 冷凝, 凝聚
63. fermentation [ˌfə:mənˈteiʃən] *n.* 发酵
64. oxidation [ˌɔksiˈdeiʃən] *n.* 氧化
65. aromatization [əˈrəuməˌtaiˈzeiʃən] *n.* 芳构化
66. dehydration [ˌdi:haiˈdreiʃən] *n.* 脱水