普通高等教育“十二五”规划教材

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冶金工程专业英语

李 进 王碧侠 王 苗 编著

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内 容 提 要

本书共分16个单元，按矿石处理、火法冶金、湿法冶金、电冶金、金属成型的工艺顺序编写，内容包括冶金原理、工艺及设备等诸多方面。每单元分为三部分，Section A 的文章用于课堂教学，文后附有生词表、难句解析等；Section B 的文章作为学生课后阅读材料，其内容与本单元的主题相关，并附有思考题；Section C 作为附课，主要向学生介绍科技英语知识，包括科技英语的语法特点、专业词汇的构成、英文摘要的写作、图表的写作以及英语科技论文的结构等内容。

本书可作为冶金工程专业的本科教学用书，也可供冶金工作者在学习专业英语时进行参考。

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序

21 世纪是知识经济和信息的时代。在科技日新月异的今天，广大冶金工作者越来越深刻地认识到学习专业英语的必要性和迫切性，因为未来冶金专业的发展和创新更需要既有扎实的专业技能，又具备外语素质的复合型人才。

专业英语是公共基础英语教学的延伸和实践，它侧重培养学生的英语应用能力，使他们能掌握查阅、翻译、撰写专业文献资料的技巧和基本功，为进一步提高专业英语水平夯实基础。本书无疑可提供这方面的帮助。

纵观全书，有以下特点：

一是选择的内容系统性强、覆盖面广。本书共分 16 个单元：第 1 单元对冶金工艺做了概括性介绍，从第 2 单元到第 16 单元，则是按照冶金工艺路线，讲述了从主要原料矿石的处理到金属成型的全过程。其中，不仅涵盖火法冶金、湿法冶金、电冶金等各种方法，而且涉及黑色金属及有色金属的冶金原理、工艺及设备等内容。各个单元虽然篇幅不长，但信息量很大，足以从专业英语角度保证学生全面了解冶金领域的知识。

二是在编排上将读、译、写融为一体。本书每个单元由三部分组成：第一部分是课文，由老师引领，培养学生准确阅读理解；第二部分是文献资料，并附有思考题，供学生自我提升阅读理解和翻译能力；第三部分是专业英语应用知识，着眼于加强专业英语的应用性训练。这种有针对性的编排模式，可望获得更佳的教学效果。

三是力求与互联网时代的学习特点接轨。对如何利用网络资源提升学习能力和拓展视野，作者在本书中力所能及地进行了大胆的探索和尝试。

作者之一李进，从事冶金专业英语的教学工作已有十余年，积累了丰

富的经验。为了激发学生学习专业英语的积极性和主动性，进一步提高学习效果，为了使学生将所学的专业英语知识能够在今后的工作中派上用场，李进、王碧侠和王苗对在教学实践中已使用了近十年的讲义进行修改，并使之规范化，终成现在可以正式出版的《冶金工程专业英语》教科书。相信本书对冶金专业在校学生和广大学习专业英语的冶金工作者都有指导作用。

俞荣禄

2012 年 11 月

前　言

本教材共分16个单元，由矿石处理、火法冶金、湿法冶金、电冶金、金属成型等部分组成。教材中所有的英文资料，精选自比较经典的英文专业著作。内容涵盖了冶金专业各部分的基本原理、冶炼工艺和冶炼设备等。每单元由课文、阅读及有关的科技英语知识三部分组成，每篇课文后附有本篇中出现的专业词汇，可供查询；阅读之后设计了帮助阅读理解本篇内容的问题；为了提高读者专业英语应用能力，每单元的第三部分是有关科技英语知识的内容。这部分主要包括：科技英语的语法特点、专业词汇的构成、英文摘要的写作、图表的写作及英语科技论文的结构等。本教材旨在培养完成大学基础英语学习后的冶金工程专业高年级学生应用专业英语的能力，可用于冶金工程专业的本科教学以及具有中等英语水平读者的专业英语学习。

本教材作为讲义在冶金工程专业英语的教学中已使用近十年，附课部分有关科技英语的知识都是根据学生的需要而设置。书中有些材料直接来源于教学实践，例如，关于“英文摘要常见错误”，就是对教学中所发现的学生常见问题的总结。

本教材Text及Reading部分，第1～10单元及第16单元由李进编写，第11～15单元由王碧侠编写，第9单元的阅读部分由王苗编写；附课部分，第1单元、第2单元及第6～11单元由李进编写，第12～16单元由王碧侠编写，第3～5单元由王苗编写；全书句子分析中关于语法的部分由李进校订。本教材得到了冶金物理化学陕西省重点学科支持，在出版过程中还得到了西安建筑科技大学冶金工程学院和冶金工程研究所领导的支持，在此表示感谢。感谢俞景禄教授为本书作序。

由于水平所限，加之经验不足，书中错误之处在所难免，望广大读者批评指正。

编　者

2012年11月

目　录

Unit 1 Metal Extraction Processes Introduction

【内容提要】本单元主要介绍金属在地壳中的存在形式、重要的冶金工艺路线以及对冶金工程专业知识结构和课程设置的意见。

Section A Text

Metals occur in the earth's crust in the following chemical states:

1. Oxides, e. g. ❶Fe_2O_3, TiO_2, Cu_2O, SnO_2;
2. Sulphides, e. g. PbS, ZnS, Cu_2S, Ni_2S_3, HgS;
3. Oxysalts, such as silicates, sulphates, titanates, carbonates, e. g. Fe_2CO_3, $ZrSiO_3$;

and to a lesser extent in other forms such as in "native" (elemental) form or as arsenides, e. g. $PtAs_2$.

By far the most important groups with respect to quantity and occurrence are sulphides and oxides. Apart from the precious metals (Au, Ag, Pt), metals rarely occur in the uncombined or "native" form. This is due to the reactive nature of metals which combine with the environment producing such compounds as oxides and sulphides. Precious metals are least reactive.

Metal ores are concentrations of the above metal compounds associated with other unwanted minerals (gangue) such as silicates. It is therefore necessary to separate the metal-bearing component (value) from the unwanted gangue prior to the extraction process. If this is not done the subsequent extraction of the metal will be less efficient, more costly and it will be more difficult to produce the metal in a state of high purity.

Once the metal-beating constituent and the gangue have been separated the concentrate produced can be subjected to the extraction process. There are three main routes that can be used:

1. *Pyrometallurgy*——incorporates smelting, converting and fire refining of the metal concentrate;
2. *Hydrometallurgy*——provides the metal in the form of an aqueous solution followed by subsequent precipitation of the metal;

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❶本书中出现的拉丁文缩写符号及其含义：

e. g. :举个例子，比如。等同于"for example"。

i. e. :那就是说，换句话说。等同于"that is, in other words"。

viz. :即，就是；亦即。等同于"namely, that is to say, videlicet"。

etc. :等等。等同于"and so on"。

3. *Electrometallurgy*——uses electrolysis to extract the metal. Electrowinning is the extraction of the metal from the electrolyte while electrorefining is the refining of the impure metal which is in the form of the anode.

The choice of extraction route will largely depend on the cost per tonne of metal extracted which, in turn, will depend on the type of ore, availability and cost of fuel (coal, oil, natural gas or electricity), production quantity and rate and the required metal purity. Unless cheap hydroelectric power is available or the metal is highly reactive, such as aluminum, electrometallurgy is an expensive route but it usually provides the metal in an extremely pure state of more than 99.9%. Electrorefining is often used as a final refining process after pyrometallurgical extraction. Hydrometallurgy tends to be slower than pyrometallurgical extraction and reagent costs tend to be high but it is ideal for extracting metals from lean ores. Again, a final electrorefining process is often adopted. Owing to the abundance and relatively low cost of fossil fuels (oil, coal, coke and natural gas) and the fact that pyrometallurgy is more adaptable than hydrometallurgy and electrometallurgy to high production rates, pyrometallurgical processes provide the main routes for the extraction of metals. For this reason, the major portion of the present chapter will be spent on pyrometallurgical extraction.

Thermodynamics and reaction kinetics are used to determine the most suitable process steps, heat balances (enthalpy) and reaction rates but material balances, that is the calculation of the required amount of input raw materials to give the necessary production rates, must also be deduced. Often, material and heat balances give valuable information regarding process efficiency and indicate areas where improvements can be made.

Words and Expressions

aluminum [ə'lju:minəm] n. 铝 Al
anode ['ænəud] n. 阳极,正极
aqueous ['eikwiəs] adj. 水的,含水的
arsenide ['ɑ:sinaid] n. 砷化物
carbonate ['kɑ:bəneit] vt. 使渗碳,使碳化;n. 碳的盐
coke [kəuk] n. 焦炭,焦煤
component [kəm'pəunənt] adj. 组成的,合成的;n. 成分,组件
electrolyte [i'lektrəlait] n. 电解液,电解质
electrometallurgy [i,lektrəume'tælədʒi] n. 电冶金学,电冶金,电气冶金
electrowinning [i,lektrəu'winiŋ] n. 电解冶金法,电解沉积
fossile ['fɔsl] n. 化石;adj. 化石的
gangue [gæŋ] n. 脉石
hydrometallurgy [,haidrəu'metlɜ:dʒi] n. 水冶,湿法冶金学
kinetics [kai'netiks] n. 动力学
oxide ['ɔksaid] n. 氧化物

oxysalt [ˌɔksi'sɔ:lt] n. 含氧盐
precipitation [priˌsipi'teiʃən] n. 沉淀,沉析,沉降
pyrometallurgy [ˌpaiərə'metəlɜ:dʒi] n. 火法冶金学
reagent [ri'eidʒənt] n. 试剂,反应物
silicate ['silikit] n. 硅酸盐
sulphate ['sʌlfeit] n. 硫酸盐
sulphide ['sʌlfaid] n. 硫化物
thermodynamics [ˌθɜrmoudai'næmiks] n. 热力学
titanate ['taitəneit] n. 钛酸盐

Notes

1. The choice of extraction route will largely depend on the cost per tonne of metal extracted which, in turn, will depend on the type of ore, availability and cost of fuel (coal, oil, natural gas or electricity), production quantity and rate and the required metal purity.

[**例句分析**]这句话的主句是"The choice of extraction route will largely depend on…";which 引导的定语从句修饰"metal";从句的谓语是"will depend on"。

[**参考释义**]提取冶金工艺路线的选择,主要取决于所要提取金属每吨的成本,其成本依次受矿石的类型、燃料(煤、油、天然气或电)的可用性和成本、产量和生产速率及所需的金属纯度的影响。

2. Owing to the abundance and relatively low cost of fossil fuels (oil, coal, coke and natural gas) and the fact that pyrometallurgy is more adaptable than hydrometallurgy and electrometallurgy to high production rates, pyrometallurgical processes provide the main routes for the extraction of metals.

[**例句分析**]这句话的主句为"pyrometallurgical processes provide the main routes for…";"Owing to"这个介词短语引出的原因由两部分构成,并由 and 连接;这个原因的后一部分为"the fact that…";that 引导的从句说明"the fact"。

[**参考释义**]由于化石燃料来源丰富、成本低廉,并且火法冶金比湿法和电冶金更适于高速率生产,因此,火法冶金是金属提取的主要工艺。

3. Thermodynamics and reaction kinetics are used to determine the most suitable process steps, heat balances (enthalpy) and reaction rates but material balances, that is the calculation of the required amount of input raw materials to give the necessary production rates, must also be deduced.

[**例句分析**]此句第一个逗号之前为完整的一句话。逗号之后的句子,主语部分为"heat balances (enthalpy) and reaction rates but material balances",主语部分由并列连接词"…and …but…"连接;谓语部分为"must also be deduced";that 引导的名词性从句前后用逗号与主句隔开,作为插入语说明"material balances"。

[**语法提示**]以上例句中并列连词的用法值得注意。在英语中并列连词有常见的 and、or、but、while,以及不常见的 whereas 等。正确分析并列连词的作用,对准确理解句子含义有很大帮助。首先,并列连词 and 是"与",or 是"或",but 是"非",while 及 whereas 是用来连接需要对比说明的一对事物或一个事物的两个方面。其次,在分析句子时,一定要清楚,以上的并列连词连接的是句子中两个相等的语法结构,比如两个谓语、两个状语等,因此,一定要

找对并列连词连接的成分，才可准确理解句子的含义。

[**参考释义**]用热力学和反应动力学来确定合适的工艺步骤，(同时)必须对热平衡及反应速率而不是物料平衡进行推演计算(以确保这些工艺步骤是合适的)，物料平衡是与所需的生产速率相对应的原料收入的计算。

并列连词用法举例：

(1) while

Electrowinning is the extraction of the metal from the electrolyte while electrorefining is the refining of the impure metal which is in the form of the anode. (Unit 1)

[**例句分析**]此句中 while 连接两个句子，这两个句子的关系是一个事物的两个方面，即电冶金的两种情况，用 while 连接时，是对比的描述。书中第二单元"classification"一节有类似的句子，可以尝试用此方法进行翻译。

[**参考释义**]电解冶金是从电解液中提取金属，而电精炼是将不纯的金属作为阳极进行精炼。

(2) and

The evaporation of water is endothermic (+44kJ/mol) and thus requires heat to bring the mineral to the appropriate temperature and for the evaporation process. (Unit 3)

[**例句分析**]此句中两个 and，第一个 and 连接句子的两个谓语，即"is endothermic"和"requires"；第二个 and 连接"to"和"for"这两个介词引出的状语。

[**参考释义**]水的蒸发是放热的，因此需要热把矿物提升到适合的温度同时需要热用于蒸发过程本身。

本书中类似于以上"while" 和"and"用法的句子很多，可以类比进行分析理解。

Section B Reading

In the past, most textbooks on extractive metallurgy have been of a rather descriptive nature. Various processes for the production of various metals have been listed and described, and the emphasis has been on the technology rather than on the basic principles involved. The chemistry of the processes has often been limited to a list of chemical reactions which are believed to have taken place. As the amount of industrial experience increases, it becomes more and more difficult to give a comprehensive review of all possible and impossible metallurgical processes. Also, by limiting the teaching to the technology of yesterday the students will be less prepared to develop the technology of tomorrow.

By concentrating on the fundamental principles of metal extraction, the author hopes to overcome some of these obstacles. The emphasis of the present text is not on how the various processes are performed, but rather on what is actually happening and why the processes are carried out in a certain way. Such an understanding may show what possibilities exist with respect to future development.

The teaching and learning of the principles of extractive metallurgy is connected with certain inherent difficulties. A metallurgical process is first of all governed by chemical reactions. The extrac-

tive metallurgist, therefore, should be well schooled in chemistry, in particular in chemical thermodynamics and reaction kinetics. Second, the design of a metallurgical reactor is based on the application of engineering principles of heat and mass balance, and of heat and mass flow. Finally, the extractive metallurgist should know something about existing techniques, and he should be trained to use his imagination to improve these techniques.

Present university courses give a certain, but often inadequate background in chemistry and chemical thermodynamics. Thermodynamics courses are often very formal, and have a tendency to become sterile. In the present text it is, therefore, felt necessary to give a review of thermodynamics, based on first principles and with emphasis on its application to metallurgy. Also, present courses in general engineering are not always geared to the need of the extractive metallurgist. Subjects such as heat transfer and fluid flow are therefore discussed in the present text. The chapters, therefore, represent a review of those fundamental principles: thermodynamics, kinetics, and engineering principles, which are of importance to extractive metallurgy. These chapters may be used as a separate text, or they may be omitted entirely by those readers who already have an adequate background in these fields.

The major part of the text is devoted to the various metallurgical unit processes: roasting, reduction, smelting, electrolysis, and is illustrated by existing techniques for the extraction of the most common metal. The emphasis is mainly on the chemistry and dynamics of the processes, and with only brief reference to reactor design. In the description of metallurgical reactors, the principal concern has been to show how these function and how they actually look. A more detailed discussion of reactor design is considered outside the scope of the text.

Metal extraction is in the end always decided by economic consideration. The most elegant use of thermodynamics and reactor design is of little value if the process is uneconomical or if there is no market for the product. A discussion on plant economics is considered outside the scope of the present text, and only incidental reference is made to the economics of the processes discussed. Both the operating metallurgist and the person engaged in industrial research are well advised, however, always to keep their eyes open to the economic consequences of their activities.

With the exception of certain key publications, it has not been possible to include references to all information given. A great deal is part of the common heritage of the metallurgical profession, and the author has drawn information also from other textbooks in the field. As a tribute to these books and a guide for the reader who wants further information, each chapter includes a bibliography of recommended reading. Also each chapter includes a list of problems ranging from simple calculations to problems which require imagination and ability for creative synthesis.

The tables and graphs of thermodynamic quantities for most substances of metallurgical importance may be used to calculate heat (enthalpy) balances and chemical equilibrium constants.

The text is intended to give a broad review of metal extraction based on first principles, and is primarily aimed at the junior or senior under-graduate student. It may be supplemented by more specialized texts on subjects of special benefit to the course or to the individual student.

Questions

1. What obstacles does the author hope to overcome in the teaching to the technologies of extractive metallurgy?
2. What kind of knowledge should an extractive metallurgist be well schooled in?
3. What is the decisive factor for the designing of a metal extractive process?

Section C 附课 1——科技英语的语法特点(一)

科技英语是庄重的书面语体,长句多,复合句多,被动句多;而短句少,简单句少,省略句少,句子结构比较严谨,而且多呈扩展的句子结构。虽然科技英语语体同其他英语语体所遵循的是共同的语法结构和句型,但在科技文章中某些语法现象会比其他语体文章中出现得多些,而某些语法现象又会出现得少些。为更好的学习和应用科技英语,现总结如下。

1. 动词的一般现在时(The Present Indefinite Tense)

由于科技英语较多地用来叙述普遍真理,描述过程、特性或功能,因而文章中使用一般现在时较多。熟悉掌握一般现在时在科技文章中的用法对科技英语的阅读和写作很重要,可把它归纳为以下几点。

(1)叙述自然规律和定律时使用一般现在时。

Apart from the precious metals (Au, Ag, Pt), metals rarely occur in the uncombined or "native" form. (Unit 1)

[**参考释义**]除了贵金属(金、银、铂)之外,金属几乎从不以单质或未化合的形式存在。

(2)科技书刊中关于图表的介绍、内容提要、前言等文中概述的动词也多用一般现在时。

Reactions which involve both SO_2 and O_2 are seen to have a diagonal line since the equilibrium phases are produced on the partial pressure of both gases. (Unit 2)

[**参考释义**]由于平衡相是在两种气体分压的共同影响下生成的,同时包含 SO_2 和 O_2 两种气体的反应,在图中的反应线是一条对角线。

(3)科技文章的公式、方程式较多,它们的口头表达也都用一般现在时。

$$CaCO_3 \longrightarrow CaO + CO_2 \qquad \text{(Unit 3)}$$

[**参考读法**]The decomposition of calcium carbonate produces calcium oxide and carbon monoxide.

(4)在表示规律、公式等的宾语从句中不受主句时态的限制仍用一般现在时。

Basically the theory proposed among other things that the maximum speed possible in the universe is that of light; that mass appears to increase with speed; that …

[**参考释义**]基本上,这个理论除了别的以外还提出:宇宙间能达到的最大速度是光速;质量随速度而增加;……。

(5)时间、条件状语从句中用一般现在时代替将来时。

When you look into this mirror, you will see an enlarged erect image.

[参考释义]你朝这面镜子看去时,你将会看见一个放大的正像。

这种带时间或条件状语从句的句子,往往也含有表示一般规律、现象的意味。

(6)一般现在时代替现在进行时:科技人员叙述一定的工艺过程或实验操作过程时,用一般现在时,不用或少用现在进行时。

"Now watch me. I switch on the current, and stand back…"

[参考释义]"注意,我现在通上电流,往后站,……"

2. 动词的被动语态(The Passive Voice)

在科技文章中被动语态使用极为广泛,这是因为科技文章中往往论及的是存在的现象及客观过程,而很少涉及人们的动作、思想感情等,因而使用被动句,把所叙述的现象事实放在主语位置上就显得更引人注目和客观。由于英语的这种表达习惯不同于汉语,在翻译时,最容易犯的毛病是见到被动句子在译成汉语时就加上一个"被"字,而使译文生硬,不符合汉语习惯。同样在进行英译时,也会因此出现无主句等不合乎英语语法的句子。因而汉译时要正确理解被动句,然后按汉语习惯进行翻译。英译时也要先理解汉语的句意,再找合适的英语被动句的模式进行对译。被动句的汉译大致可遵循以下几种译法。

(1)基本上按原文的被动句译,加上"被"、"由"、"受"、"为……所"、"由……所"等。

This is achieved using the different physical properties of the various particles present, such as magnetic, electrical conductivity and surface properties. (Unit 2)

[参考释义]这是由利用(矿浆中)存在的各种颗粒的不同的物理性质,如磁性、导电性和表面性能而完成的。

(2)省去"被"、"由"等字。

The ore, coke and flux material are charged to the furnace at the top of the stack or shaft. (Unit 4)

[参考释义]矿石、焦炭和熔剂在炉体顶部装进炉内。

Elements can be classified as metals or nonmetals.

[参考释义]元素可分为金属和非金属。

(3)正确理解句子后译成主动句。

To explore the moon's surface, rockets were launched again and again.

[参考释义]为了探索月球表面,人们一次又一次地发射火箭。

在这种英语被动句中,虽然没有行为的主体,但译成汉语时,可以根据意思恰当地增加主语,而把原句的主语变为宾语。与此类似的还有用先行词及连词 that 构成的带有主语从句的主从复合句。如:

It is to be hoped that … 我们希望……

It was said that … 大家听说……(据说……)

More than one hundred elements have been found by chemical workers at present.

[参考释义]目前化学工作者已经发现一百多种元素。

Modern scientific discoveries lead to conclusion that energy may be created from matter and that matter, in turn, may be created from energy.

[**参考释义**]近代科学的发现得出这样的结论:物质可以产生能,能又可以产生物质。

以上两句汉译时将原文中的主语变为宾语,而将行为的主体变为主语,从而译成主动句。

(4)译成汉语的无主句。

The pick up of Si, S, Mn, can be controlled to some extent by slag basicity and temperature on examination of the thermodynamic relationships involved. (Unit 9)

[**参考释义**]对所涉及的热力学关系进行研究,通过对炉渣碱度和温度(的控制)可以把硅、硫、锰的收得率控制在某个范围内。

有些原文的被动句中有行为主体,可把行为主体作为方式状语译成无主句。

Acids and bases can be identified by their effects on litmus paper.

[**参考释义**]酸和碱可通过它们对石蕊试纸的作用来鉴别。

(5)被动句还可译成"是……的"。

All matter is made up of tiny particles called molecules.

[**参考释义**]一切物质都是由叫作分子的微小粒子组成的。

【单元小结】通过本单元的学习,可以使学习者对提取冶金有概括的认识;并且,通过本单元课后科技英语知识的学习,可以使学习者了解科技英语的语法特点,为其学习用英语在专业领域准确阅读理解、正确写作打基础。