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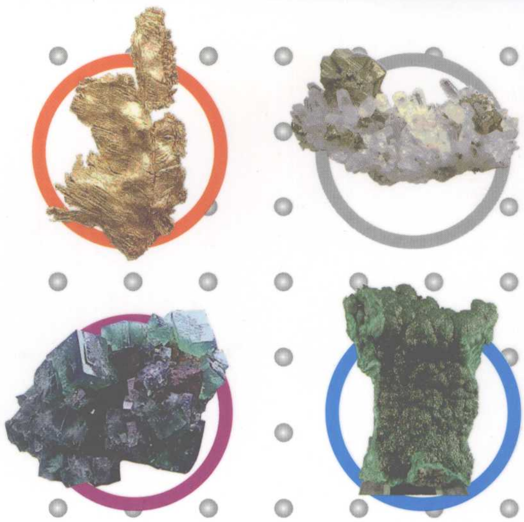
矿物加工专业英语

English for Mineral Processing Technology



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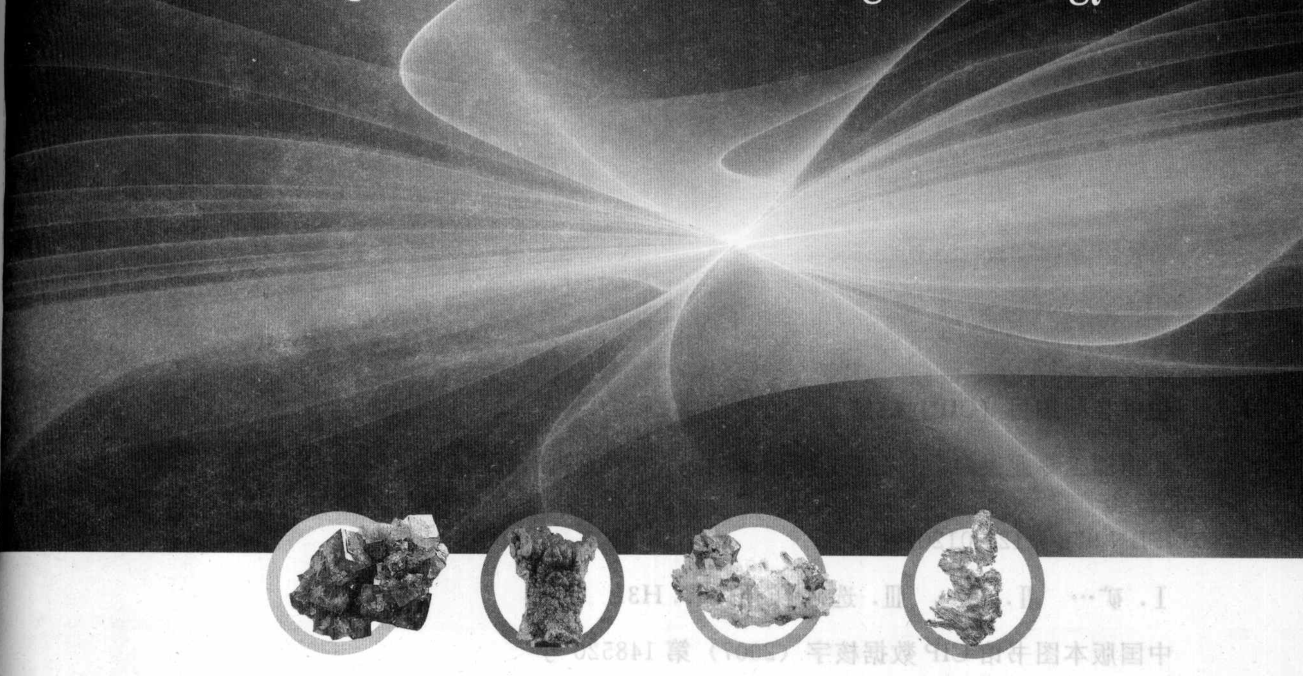

化学工业出版社

·北京·

本书课文多选自英语原文著作和公开发表的科技文献，语言规范，词汇丰富。以矿物加工工程专业的工艺过程和主要工艺方法为主线，全面介绍了矿物加工工程专业的基本原理、工艺方法和主要设备。本书内容覆盖面广，涵盖了矿物学基础、破碎与磨矿、筛分与分级、重力分选、重介质分选、磁电分选、浮选、黄金提取，以及产品脱水与尾矿处理等内容。

全书共分 9 个单元、42 课，每篇课文后附有生词、注释和练习题，书后附有常见金属、非金属矿物名称英汉对照表。主要作为矿物加工工程及相关专业大中专院校学生的教材，也可作为该专业研究生英语的参考教材，还可供该领域工程技术人员、外贸人员等参考。

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前　言

矿产资源的开发利用是国民经济和社会发展的重要物质基础，矿物加工工程是矿产资源开发利用的一个重要学科。随着科学技术的发展和对外经济技术交流的不断增加，对大学生和科技人员英语能力的要求也在不断提高，专业英语也是矿物加工工程专业本科生的必选课程。为适应这一要求，我们编写了这本《矿物加工专业英语》，旨在培养学生阅读和翻译专业科技文献的能力，使学生掌握必要的专业词汇、熟悉科技英语文献的写作特点和翻译技巧，并通过课后练习等环节使学生具备初步的专业英语翻译和表达能力。全书共分 9 个单元、42 课，适用于 80 学时左右的课堂教学安排。

本书第一单元、第七单元和第九单元课文由吕宪俊编写；第二单元课文由马少健、杨金林编写；第三单元课文由马少健、王桂芳编写；第四单元和第五单元课文由邱俊编写；第六单元和第八单元课文由崔学奇编写；课后生词、注释、练习和附录由唐建敏编写。全书由吕宪俊担任主编，马少健和唐建敏担任副主编，负责全文的统一整理和校核。

在编写过程中得到了山东科技大学化学与环境工程学院、外国语学院，广西大学资源工程学院等单位的大力支持和帮助，在此一并表示衷心感谢！

由于编者水平所限，书中难免存在疏漏和不当之处，诚望广大读者批评指正。

编者
2007 年 9 月

CONTENT

UNIT ONE INTRODUCTION（绪论）

Lesson One Minerals and Ores（矿物与矿石）

Minerals

The forms in which metals are found in the crust of the earth and as seabed deposits depend on their reactivity with their environment, particularly with oxygen, sulphur and carbon dioxide. Gold and the platinum are found principally in the native and metallic form. Silver, copper and mercury are found native, as well as in the form of sulphides, carbonates, and chlorides. The more reactive metals are always in compound form, such as the oxides and sulphides of iron and the oxides and silicates of aluminium and beryllium. The naturally occurring compounds are known as minerals, most of which have been given names according to their composition (e. g. galena-lead sulphide, PbS; sphalerite-zinc sulphide, ZnS; cassiterite-tin oxide, SnO_2).

Minerals by definition are natural inorganic substances possessing definite chemical compositions and atomic structures. Some flexibility, however, is allowed in this definition. Many minerals exhibit isomorphism, where substitution of atoms within the crystal structure by similar atoms takes place without affecting the atomic structure. The mineral olivine, for example, has the chemical composition $(Mg, Fe)_2SiO_4$, but the ratio of Mg atoms to Fe atoms varies in different olivines. The total number of Mg and Fe atoms in all olivines, however, has the same ratio to that of the Si and O atoms. Minerals can also exhibit polymorphism, different minerals having the same chemical composition, but markedly different physical properties due to a difference in atomic structure. Thus the two minerals graphite and diamond have exactly the same composition, being composed entirely of carbon atoms, but have widely different properties due to the arrangement of the carbon atoms within the crystal lattice. The term "mineral" is often used in a much more extended sense to include anything of economic value which is extracted from the earth. Thus coal, chalk, clay and granite do not come within the definition of a mineral, although details of their production are usually included in national figures for mineral production. Such minerals are, in fact, rocks, which are not homogeneous in chemical and physical composition, as are minerals, but generally consist of a variety of minerals and form large parts of the earth's crust. Granite, for instance, which is the most abundant igneous rock, i. e. a rock formed by cooling of molten material, or magma within the earth's crust, is composed of three main mineral constituents, feldspar, quartz and mica. These three homogeneous mineral components occur in varying proportions in different granites, and even in different parts of the same granite mass.

Metallic Ores

An ore can be described briefly as an accumulation of mineral in sufficient quantity as to be capable of economic extraction. This establishes the market price of the metal as a critical criterion in the definition, and this will vary according to the commercial demands. With the passage of time and depletion of richer or more readily accessible material, a mineral deposit may be updated to an ore. Improvement in metallurgical extraction and the introduction of new methods also become factors in making available deposits hitherto regarded as uneconomic. Thus the introduction of the flotation process in mineral processing permitted the extraction of copper from material containing less than 0.5% of the metal and formerly regarded as waste. Similarly the introduction of solvent extraction has enabled Nchanga Consolidated Copper Mines in Zambia to treat 9 million tonnes per year of flotation tailings, producing 80,000 tonnes of finished copper from what was previously regarded as waste material.

Ores are frequently classed according to the nature of the valuable mineral. Thus in native ores the metal is presented in the elementary form; sulphide ores contain the metal in the form of a sulphide, and in oxidised ores the valuable mineral may be present as oxide, sulphate, silicate, carbonate, or some hydrated from of these. Complex ores are those containing profitable amounts of more than one valuable mineral. Metallic minerals are often found in certain associations, within which they may occur as mixtures of a wide range of particle sizes or as single-phase solid solutions or compounds. Galena and sphalerite, for example, commonly associate, as do copper sulphide minerals and sphalerite to a lesser extent. Pyrite (FeS_2) is very often associated with these minerals.

Ores are also classified by the nature of their gangues, such as calcareous or basic (lime rich), or siliceous, or acidic (silica rich).

The minimum metal content required for a deposit to qualify as an ore varies from metal to metal. Many nonferrous ores contain, as mined, as little as 1% metal, and often much less. Gold may be recovered profitably in ores containing only 5 parts per million (ppm) of the metal, whereas iron ores containing less than about 20% metal are regarded as low grade.

There are many plants where minerals are recovered in secondary circuits, treating tailings, where the feed grades are much lower than would be economic on a mined ore. Typical ore grades for tungsten ores are in the range of 0.5%~1.5% WO_3, but the Climax Molybdenum plant in the United States treats 45,000 tonnes per day of tailings, containing less than 0.1% WO_3, and is one of the two major producers of tungsten concentrate in the United States.

Non-metallic Ores

Ores of economic value can be classed as metallic or non-metallic, according to the use of the mineral. Certain minerals may be mined and processed for more than one purpose. In one category the mineral may be a metal ore, i. e. when it is used to prepare the metal, as when bauxite (hydrated aluminium oxide) is used to make aluminium. The alternative is for the compound to be classified as a non-metallic ore, i. e. when bauxite or natural aluminium oxide is used to make material for refractory bricks or abrasives.

Many non-metallic ore minerals associate with metallic ore minerals and are mined and processed together, e. g. galena, the main source of lead often associates with fluorite (CaF_2) and barytes ($BaSO_4$), both important non-metallic minerals.

Words and Expressions

mineral [ˈminərəl] *n.* 矿物
ore [ɔː (r)] *n.* 矿石
deposit [diˈpɔzit] *n.* 矿床
galena [gəˈliːnə] *n.* 方铅矿
sphalerite [ˈsfeiliˌrait] *n.* 闪锌矿
cassiterite [kəˈsitəˌrait] *n.* 锡石
isomorphism [ˈaisəuˈmɔːfizm] *n.* 类质同象
olivine [ˌɔliˈviːn] *n.* 橄榄石
polymorphism [ˌpɔliˈmɔːfizəm] *n.* 同质多象、多形性
graphite [ˈgræfait] *n.* 石墨
chalk [tʃɔːk] *n.* 白垩
clay [klei] *n.* 黏土
granite [ˈgrænit] *n.* 花岗岩
rock [rɔk] *n.* 岩石
igneous [ˈigniəs] *adj.* 火成的
magma [ˈmægmə] *n.* 岩浆
feldspar [ˈfeldspɑː] *n.* 长石
quartz [kwɔːts] *n.* 石英
mica [ˈmaikə] *n.* 云母
pyrite [ˈpaiərait] *n.* 黄铁矿
gangue [gæŋ] *n.* 脉石
nonferrous [ˈnɔnˈferəs] *adj.* 不含铁的，非铁的
tailing [ˈteiliŋ] *n.* 残渣、尾矿
grade [greid] *n.* 品位
concentrate [ˈkɔnsentreit] *n.* 精矿
bauxite [ˈbɔːksait] *n.* 矾土，铝土矿
fluorite [ˈflu(ː)ərait] *n.* 萤石
barite [ˈbɛərait] *n.* 重晶石

Notes

1. The naturally occurring compounds are known as minerals, most of which have been given names according to their composition.

天然存在的化合物叫矿物，许多矿物已根据它们的组成而命名。

2. Many minerals exhibit isomorphism, where substitution of atoms within the crystal structure by similar atoms takes place without affecting the atomic structure.

许多矿物呈现类质同象，在这种晶体结构中，其晶体结构中的一些原子被类似原子取代但不影响原子构造。

在“where”引出的非限制性定语从句中，“substitution”为从句的主语，谓语是“takes place”。

3. Thus the two minerals graphite and diamond have exactly the same composition, being composed entirely of carbon atoms, but have widely different properties due to the arrangement of the carbon atoms within the crystal lattice.

因此，石墨和金刚石这两种矿物的组成完全相同——均由碳原子组成，但由于碳原子在晶格内排布不同，两者的性质相差悬殊。

4. Galena and sphalerite, for example, commonly associate, as do copper sulphide

minerals and sphalerite to a lesser extent.

例如，方铅矿和闪锌矿通常共生在一起，而硫化铜矿物与闪锌矿的共生相对较少。

5. There are many plants where minerals are recovered in secondary circuits, treating tailings, where the feed grades are much lower than would be economic on a mined ore.

许多选矿厂处理尾矿，从二次回路中回收矿物，其给矿品位比经济地处理新采矿石的品位低得多。

Exercises

Ⅰ. Choose the best answer according to the text.

1. Gold and platinum metals are found basically in ____.

A. native form B. compound form

C. metallic form D. native or metallic form

2. Most of minerals have been given names according to ____.

A. their composition B. atomic structure

C. crystal structure D. physical properties

3. Two minerals that have exactly the same composition can have ____ due to a difference in atomic structure, for example, graphite and diamond.

A. the same physical properties B. quite different physical properties

C. almost the same physical properties D. slightly different physical properties

4. Granite is composed of feldspar, quartz and mica, these three homogeneous mineral components can occur in ____ proportions in different parts of the same granite mass.

A. different B. same C. uniform D. almost the same

Ⅱ. Translate the following phrases into Chinese.

1. 天然无机化合物 2. 化学组成 3. 原子结构 4. 有色金属矿石

5. 有用矿物 6. 脉石矿物 7. 给矿品位 8. 非金属矿石

Ⅲ. Translate the following sentences into Chinese.

1. The abundance of metals in the ocean is related to some extent to the crustal abundancies, since they have come from the weathering of the crustal rocks.

2. It is apparent that if the minerals containing the important metals were uniformly distributed throughout the earth, they would be so thinly dispersed that their economic extraction would be impossible.

3. A particular mineral may be found mainly in associates with granitic rocks, or may be found associated with both igneous and sedimentary rocks, i. e. those produced by the deposition of material arising from the mechanical and chemical weathering of earlier rocks by water, ice and chemical decay.

Lesson Two Types and Application of Coal (煤的种类与应用)

Coal is a fossil fuel formed in swamp ecosystems where plant remains were saved by water and mud from oxidization and biodegradation. Coal is a readily combustible black or brownish-black rock. It is a sedimentary rock, but the harder forms, such as anthracite coal, can be regarded as metamorphic rocks because of later exposure to elevated temperature and pressure. It is composed primarily of carbon along with assorted other elements, including sulfur. It is the largest single source of fuel for the generation of electricity worldwide, as well as the largest source of carbon dioxide emissions, which is the primary cause of global warming. Coal is extracted from the ground by coal mining, either underground mining or open pit mining.

Types of Coal

As geological processes apply pressure to peat over time, it is transformed successively into the following types of coal.

Lignite—also referred to as brown coal, is the lowest rank of coal and used almost exclusively as fuel for steam-electric power generation. Jet is a compact form of lignite that is sometimes polished and has been used as an ornamental stone since the Iron Age.

Sub-bituminous coal—whose properties range from those of lignite to those of bituminous coal and is used primarily as fuel for steam-electric power generation.

Bituminous coal—a dense coal, usually black, sometimes dark brown, often with well-defined bands of bright and dull material, used primarily as fuel in steam-electric power generation, with substantial quantities also used for heat and power applications in manufacturing and to make coke.

Anthracite—the highest rank; a harder, glossy, black coal used primarily for residential and commercial space heating.

Graphite—technically the highest rank, but difficult to ignite and is not so commonly used for ignition.

Coal as Fuel

Coal is primarily used as a solid fuel to produce electricity and heat through combustion. World coal consumption is about 5.3 billion tonnes annually, of which about 75% is used for the production of electricity. The region including the People's Republic of China and India uses about 1.7 billion tonnes annually, forecast to exceed 2.7 billion tonnes in 2025. The USA consumes about 1.0 billion tons of coal each year, using 90% of it for generation of electricity. Coal is the fastest growing energy source in the world, with coal use increasing by 25% for the three-year period ending in December, 2004. The total known deposits recoverable by current technologies, including highly polluting, low energy content types of coal (i. e. lignite, bituminous), might be sufficient for 300 years' use at current consumption levels, although maximal production could be reached within decades.

Coking and Use of Coke

Coke is a solid carbonaceous residue derived from low-ash, low-sulfur bituminous coal from which the volatile constituents are driven off by baking in an oven without oxygen at temperature as high as 1,000℃ (1,832℉) so that the fixed carbon and residual ash are fused together. Metallurgic coke is used as a fuel and as a reducing agent in smelting iron ore in a blast furnace. Coke from coal is grey, hard and porous, and has a heating value of 29.6 MJ/kg. Byproducts of this conversion of coal to coke include coal tar, ammonia, light oils, and "coal gas".

Petroleum coke is the solid residue obtained in oil refining, which resembles coke but contains too many impurities to be useful in metallurgical applications.

Gasification

Coal gasification breaks down the coal into its components, usually by subjecting it to high temperature and pressure, using steam and measured amounts of oxygen. This leads to the production of syngas, a mixture mainly consisting of carbon monoxide (CO) and hydrogen (H_2).

In the past, coal was converted to make coal gas, which was piped to customers to burn for illumination, heating, and cooking. At present, the safer natural gas is used instead. South Africa still uses gasification of coal for much of its petrochemical needs.

Gasification is also a possibility for future energy use, as the produced syngas can be cleaned-up relatively easily leading to cleaner burning than burning coal directly. The cleanliness of the cleaned-up syngas is comparable to natural gas, enabling to burn it in a more efficient gas turbine rather than in a boiler used to drive a steam turbine.

Liquefaction

Coal can also be converted into liquid fuels like gasoline or diesel by several different processes.

The Fischer-Tropsch process of indirect synthesis of liquid hydrocarbons was used in Nazi Germany for many years and is today used by Sasol in South Africa. Coal would be gasified to make syngas (a balanced purified mixture of CO and H_2 gas) and the syngas can be condensed using Fischer-Tropsch catalysts to make light hydrocarbons which are further processed into gasoline and diesel.

A direct liquefaction process, Bergius process (liquefaction by hydrogenation), is also available but has not been used outside Germany, where such processes were operated both during World War Ⅰ and World War Ⅱ. SASOL in South Africa has experimented with direct hydrogenation. Several other direct liquefaction processes have been developed, among these being the SRC-Ⅰ and SRC-Ⅱ (Solvent Refined Coal) processes developed by Gulf Oil and implemented as pilot plants in the United States in the 1960s and 1970s.

Another direct hydrogenation process was explored by the NUS Corporation in 1976 and patented by Wilburn C. Schroeder. The process involved dried, pulverized coal mixed with roughly 1% molybdenum catalysis. Hydrogenation occurred by use of high temperature and pressure synthesis gas produced in a separate gasifier. The process ultimately yielded a synthetic crude product, naphtha, a limited amount of C_3/C_4 gas, light-medium weight liquids ($C_5 \sim C_{10}$) suitable for use as fuels, small amounts of NH_3 and significant amounts of CO_2.

Yet another process (Karrick process) to manufacture liquid hydrocarbons from coal is low temperature carbonization (LTC), which was developed by Lewis C. Karrick, an oil shale technologist at the U. S. Bureau of Mines in the 1920s. Coal is coked at temperatures between 450℃ and 700℃ compared to 800℃ to 1,000℃ for metallurgical coke. These temperatures optimize the production of coal tars richer in lighter hydrocarbons than normal coal tar. The coal tar is then further processed into fuels.

Words and Expressions

ecosystem [iːkəˈsistəm] *n.* 生态系统
biodegradation [ˌbaiəudigreiˈdeiʃən] *n.* 生物降解
sedimentary [sediˈmentəri] *adj.* 沉积的，沉淀性的
anthracite [ˈænθrəsait] *n.* 无烟煤
metamorphic [ˌmetəˈmɔːfik] *adj.* 变形的，变质的
peat [piːt] *n.* 泥煤，泥炭块泥煤、泥碳
lignite [ˈlignait] *n.* 褐煤
bituminous [biˈtjuːminəs] *adj.* 含沥青的
sub-bituminous coal 亚烟煤
bituminous coal 烟煤
graphite [ˈgræfait] *n.* 石墨
coke [kəuk, kuk] *n.* 焦炭
carbonaceous [kɑːbəˈneiʃəs] *adj.* 碳的，碳质的，含碳的
gasification [ˈgæsifiˈkeiʃən] *n.* 气化
syngas [ˈsingæs] *n.* 合成气
liquefaction [ˌlikwiˈfækʃən] *n.* 液化
hydrogenation [ˌhaidrədʒəˈneiʃən] *n.* 加氢，氢化（作用）
pulverize [ˈpʌlvəraiz] *v.* 粉碎，研磨成粉
naphtha [ˈnæfθə] *n.* 石脑油（一种石油馏分）
tar [tɑː] *n.* 焦油

Notes

1. Coal is a fossil fuel formed in swamp ecosystems where plant remains were saved by water and mud from oxidization and biodegradation.

煤是在沼泽生态环境中形成的化石燃料，在这种环境中由于水和泥的保护作用，使植物遗骸不受氧化和生物降解的影响。

2. The total known deposits recoverable by current technologies, including highly polluting, low energy content types of coal (i. e. lignite, bituminous), might be sufficient for 300 years' use at current consumption levels, although maximal production could be reached within decades.

尽管在近几十年内就可能达到煤的最大产量，然而，基于目前的消费水平，在现有技术条件下能够回收的矿床可满足 300 年的消费。

3. Coke is a solid carbonaceous residue derived from low-ash, low-sulfur bituminous coal from which the volatile constituents are driven off by baking in an oven without oxygen at temperatures as high as 1,000℃ (1,832℉) so that the fixed carbon and residual ash are fused together.

焦炭是一种从低灰、低硫的烟煤中获得的固态碳质残余物，烟煤在隔绝氧气的条件下和1000℃的高温下焙烧，驱除其中的挥发分，使固定碳和残留灰分熔融在一起。

4. Coal gasification breaks down the coal into its components, usually by subjecting it to high temperature and pressure, using steam and measured amounts of oxygen.

煤气化是将煤分解为不同的组分，通常是使用蒸汽和一定量的氧气气氛，在高温、高压条件下进行。

5. Gasification is also a possibility for future energy use, as the produced syngas can be cleaned-up relatively easily leading to cleaner burning than burning coal directly.

由于煤气化生成的合成气较容易净化，其燃烧比直接烧煤更为清洁，煤气化也可能作为一种未来的能源使用。

Exercises

Ⅰ. Answer the following questions according to the text.

1. Coal can be classified into several types, what are they?
2. What percentage of coal is used for the production of electricity?
3. What are the major uses of coal?
4. What is coal gasification?
5. How many processes are there for coal liquefaction?

Ⅱ. Translate the following phrases into English.

1. 沉积岩	2. 二氧化碳	3. 发电	4. 露天采矿
5. 低灰分烟煤	6. 挥发分	7. 煤气化	8. 直接液化

Ⅲ. Translate the following sentences into Chinese.

1. A direct liquefaction process, Bergius process (liquefaction by hydrogenation), is also available but has not been used outside Germany, where such processes were operated both during World War I and World War Ⅱ.

2. Among commercially mature technologies, advantages for indirect coal liquefaction over direct coal liquefaction are reported by Williams and Larson (2003).

3. All of these liquid fuel production methods release carbon dioxide (CO_2) in the conversion process, far more than is released in the extraction and refinement of liquid fuel production from petroleum.

4. Estimates are reported for sites in China where break-even cost for coal liquefaction may be in the range from 25 to 35 USD/barrel of oil.

Lesson Three Coal Assay (煤质分析)

Coal assay techniques are specific analytical methods designed to measure the particular physical and chemical properties of coals. These methods are used primarily to determine the suitability of coal for coking, power generation or for iron ore smelting in the manufacture of steel.

Chemical Properties of Coal

Coal comes in four main types or ranks: lignite or brown coal, bituminous coal or black coal, anthracite and graphite. Each type of coal has a certain set of physical parameters which are mostly controlled by moisture, volatile content (in terms of aliphatic or aromatic hydrocarbons) and carbon content.

Moisture: Moisture is an important property of coal, as all coals are mined wet. Groundwater and other extraneous moisture are known as adventitious moisture and are readily evaporated. Moisture held within the coal itself is known as inherent moisture and is analysed. Moisture may occur in four possible forms within coal. (1) Surface moisture: water held on the surface of coal particles or macerals. (2) Hydroscopic moisture: water held by capillary action within the microfractures of the coal. (3) Decomposition moisture: water held within the coal's decomposed organic compounds. (4) Mineral moisture: water which comprises part of the crystal structure of hydrous silicates such as clays.

Total moisture is analysed by loss of mass between an untreated sample and the sample once analysed. This is achieved by any of the following methods: (1) Heating the coal within a solution of toluene. (2) Drying in a minimum free-space oven at 150℃ within a nitrogen atmosphere. (3) Drying in air at 100～105℃ and relative loss of mass determined.

Methods 1 and 2 are suitable with low-rank coals but method 3 is only suitable for high-rank coals as free air drying low-rank coals may promote oxidation. Inherent moisture is analysed similarly, though it may be done in a vacuum.

Volatile Matter: Volatile matter in coal is the components of coal, except for moisture, which is liberated at high temperature in the absence of air. This is usually a mixture of short and long chain hydrocarbons, aromatic hydrocarbons and some sulphur. The volatile matter of coal is determined under rigidly controlled standards. In Australian and British laboratories this involves heating the coal sample to (900 ± 5)℃ for 7 minutes in a cylindrical silica crucible in a muffle furnace. American Standard procedures involve heating to (950 ± 25)℃ in a vertical platinum crucible. These two methods give different results and thus the method used must be stated.

Ash: Ash content of coal is the non-combustible residue after coal is burnt. It represents the bulk mineral matter after carbon, oxygen, sulphur and water (including from clays) has been driven off during combustion. Analysis is fairly straightforward, with the coal thoroughly burnt and the ash material expressed as a percentage of the original weight.

Fixed Carbon: The fixed carbon content of the coal is the carbon found in the material which is left after volatile materials are driven off. This differs from the ultimate carbon content of the coal because some carbon is lost in hydrocarbons with the volatiles. Fixed carbon is used as an estimate of the amount of coke that will be yielded from a sample of coal. Fixed carbon is determined by removing the mass of volatiles determined by the volatility test, above, from the original mass of the coal sample.

Chemical Analysis

Coal is also assayed for oxygen, hydrogen and sulphur content. Sulphur is also analysed to determine whether it is a sulfide mineral or in a sulfate form. This is achieved by dissolution of the sulfates in hydrochloric acid and precipitation as barium sulphate. Sulfide content is determined by measurement of iron content, as this will determine the amount of sulphur present as iron pyrite.

Carbonate minerals are analysed similarly, by measurement of the amount of carbon dioxide emitted when the coal is treated with hydrochloric acid. Calcium is also analysed. The carbonate content is necessary to determine the combustible carbon content and incombustible (carbonate carbon) content.

Chlorine, phosphorus and iron are also determined to characterise the coal's suitability for steel manufacture.

An analysis of coal ash may also be carried out to determine not only the composition of coal ash, but also to determine the levels at which trace elements occur in ash. This data is useful for environmental impact modelling, and may be obtained by spectroscopic methods.

Physical and Mechanical Properties

Relative density: Relative density or specific gravity of the coal depends on the rank of the coal and degree of mineral impurity. Knowledge of the density of each coal ply is necessary to determine the properties of composites and blends. The density of the coal seam is necessary for conversion of resources into reserves.

Relative density is normally determined by the loss of a sample's weight in water. This is best achieved using finely ground coal, as bulk samples are quite porous.

Particle size distribution: The particle size distribution of milled coal depends partly on the rank of the coal, which determines its brittleness, and on the handling, crushing, milling it has undergone. Generally coal is utilised in furnaces and coking ovens at a certain size, so the crushability of the coal must be determined. It is necessary to know this data before coal is mined, so that suitable crushing machinery can be designed to optimise the particle size for transport and use.

Float-sink Test: Coal is usually washed by passing it over a bath of liquid of known density. This removes high-ash content particles and increases the salability of the coal as