核能工程专业英语

Fundamentals and New Concepts for Nuclear Engineering

阎昌琪　主编

哈尔滨工程大学出版社

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内 容 简 介

本书包含了核能工程专业基础知识和专业知识的主要内容,介绍了近年来核能工程的新发展和新技术。书中阅读材料来源广泛,涉及到的专业英语词汇量多,内容丰富,知识性强。为了便于学习,每课课后除列出生词外,还配有关键词解释、课文注释和自测习题。

本书可作为核能工程类专业大学本科学生的专业英语阅读教材,也可作为该领域工程技术人员的自学用书;对非本专业的人员,也可通过阅读本书增加对核能工程基本概念和基础知识的了解。

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前　　言

核能工程是一个涉及内容很广的学科领域，包含有很多当今世界的高新技术。美、英等发达国家在该领域处于领先地位，很多新的研究成果和新技术的介绍都以英文发表，每个从事核能工程研究和设计的专业人员都要阅读大量的英文资料。为了满足越来越多的核能工程专业人员学习专业英语的需要，我们编写了本书。

本书内容涵盖了核能工程所涉及的主要学科，以介绍核反应堆物理及核反应堆热工等基础知识为主，同时也介绍了各种类型的核反应堆及主要设备的原理和使用特性等。主要内容包括：核反应堆物理的基础知识、核材料、核反应堆理论、核反应堆热工水力、各种类型的核反应堆、反应堆的主要系统和设备、核反应堆运行及核安全等。本书内容力求广泛选用不同风格的文章，做到内容新、知识面宽；使选用的课文内容概念性和知识性强、难度适中，不涉及复杂的专业理论。为了便于读者掌握专业词汇，每课课后对重要的关键词作了英、中文两种解释，同时还列出了生词，便于查阅和单词记忆；对课文中的难点作了注释；为了加深读者对课文内容的理解，课后还附有习题和答案。

在本书的编写过程中考虑了核能工程专业大学本科三、四年级学生所掌握的知识深度。内容安排由浅入深、由基础到专业，可适合不同层次的学生使用。全书围绕着核能动力工程这一主题，在专业部分中以核电站动力装置为主线，也介绍了其他核动力装置。书中的每一课都有相当的独立性，可以根据学生的兴趣和专业方向选择使用，同时也考虑了课文之间的衔接，保证全书内容是一个完整的整体。

本书共分 20 课，全部由阎昌琪编写。曹欣荣博士和高璞珍博

士对本书的内容提出了许多宝贵的意见；孙立成、刘洋等同学参加了书稿的校对工作，在此表示衷心的感谢。

由于编者水平所限，书中难免存在缺点和不足，敬请读者提出宝贵意见。

作　者

2001年10月

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Lesson 1 The Basic Concepts for Nuclear Physics

1.1 Atoms and Nuclei

The atoms of all elements, which at one time were thought to be the fundamental particles of nature, consist of numbers of three more fundamental particles-protons, neutrons and electrons. The arrangement of these particles within the atom, and in particular the number of protons and electrons, determine the chemical identity of the element. The atom consists of nucleus in which all the positively charged protons and uncharged neutrons are closely grouped together, and a number of negatively charged electrons moving in orbital paths around the nucleus. In an electrically neutral or unionized atom the number of protons is equal to the number of electrons, and this number, Z, is the atomic number of a particular element and identifies it. (This number corresponds to the position of the element in the Periodic Table.) The number of neutrons in the nucleus is denoted by N, and the sum of the number of neutrons and protons in the nucleus is called, for reasons that will shortly be apparent, the mass number, A.

$$N + Z = A$$

The term nucleon is applied to all particles, both protons and neutrons, in the nucleus.

Figure 1.1 is a useful, though not strictly accurate representation of an atom of carbon with six protons and six neutrons in the nucleus, and six orbital electrons. To be more accurate, the radius of the innermost electron orbit should be about ten thousand times the radius of the nucleus.

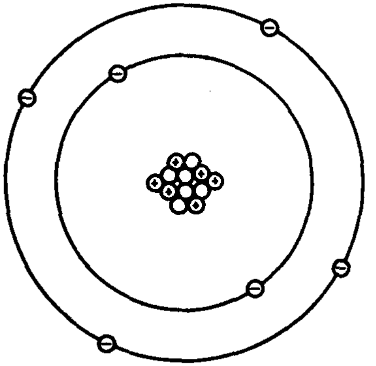

Fig. 1.1 Atomic structure of carbon 12

1.2 Isotopes

Atoms having the same atomic number Z, but different numbers of neutrons N are called isotopes of the element identified by Z, and all elements have a number of isotopes, in some cases twenty or more. The naturally occurring elements each have one or more stable isotopes which exist naturally, and other isotopes which are unstable or radioactive and can be produced by artificial means. Different isotopes of an element behave identically as far as their chemistry is concerned, which is not surprising as chemical bonds exist between electrons. Isotopes differ from one another physically in that the masses and other characteristics of their nuclei are different, which is to be expected as it is in the nuclei that the difference between two isotopes lies.[1]

The complete identification of an isotope is made by giving its chemical symbol, the atomic number Z as a subscript and the mass number A as a superscript. For example the symbol $^{16}_{8}O$ identifies the isotope of oxygen which has eight protons and eight neutrons in its nucleus. The isotope $^{17}_{8}O$ has eight protons and nine neutrons in its nucleus. Naturally occurring oxygen consists of a mixture of three isotopes, $^{16}_{8}O$, $^{17}_{8}O$ and $^{18}_{8}O$. There are also three radioactive isotopes of oxygen which do not occur naturally. The subscript Z is in fact unnecessary as the name oxygen identifies that element with eight protons in its nucleus and the symbols may be written as ^{16}O, ^{17}O and ^{18}O.

Hydrogen is an important element in nuclear engineering. Naturally occurring hydrogen consists of two isotopes, 99.985 per cent of the isotope ^{1}H and 0.015 per cent of the isotope ^{2}H called heavy hydrogen or deuterium. There is a third isotope ^{3}H called tritium which is radioactive. This is the only case in which the different isotopes of an element have different names; usually they are identified by their mass numbers.

1.3 The Units of Nuclear Physics

The properties of protons and electrons, and in particular their mass and charge, are important as they determine the way in which these particles behave.[2] This is therefore a convenient point to introduce some of the units in common use in atomic and nuclear physics and nuclear engineering.

The unit of mass is the unified atomic mass unit (u). It is defined as one twelfth of the mass of a neutral carbon 12 atom. Its value is

$$1\text{u} = 1.6604 \times 10^{-27}\text{kg}$$

or alternatively $1\text{kg} = 6.023 \times 10^{26}\text{u}$

The atomic mass of any isotope is equal to the mass of one atom of that isotope expressed in u. The atomic mass of an element is the weighted mean of the atomic masses of the naturally occurring isotopes of that element.

The mol, or to be more precise if SI units are being used, the kilogram-mol of any isotope is that quantity whose mass expressed in kilograms is numerically equal to its atomic mass. From the definition of the unified atomic mass unit stated above, it is evident that the mass of one mol of any isotope may be expressed in u as $6.023 \times 10^{26} \times$ the atomic mass.

Since for any isotope,

$$\text{number of atoms per mol} = \frac{\text{Mass of one mol}}{\text{Mass of one atom}},$$

and the mass of one atom expressed in u is the atomic mass, it follows that the number of atom per mol of any isotope is 6.023×10^{26}. This nubmer, called Avogadro's Number, is an important physical constant, applicable to all isotopes and elements.

$$\text{Avogadro's Number} = 6.023 \times 10^{26} \text{ atoms/kg-mol}$$

The statements above can also be applied to compounds and molecules, the mol being defined as that quantity whose mass, expressed in kilograms, is numerically equal to the molecular mass. Thus one mol of molecular oxygen, O_2, has a mass of 32kg and contains 6.023×10^{26} molecules.

The electronic charge of the proton and electron are equal in magnitude and opposite in sign. The magnitude of this charge, known as the electronic charge, is 1.602×10^{-19} coulomb.

The unit of energy is the electron-volt(eV) or alternatively the mega electron-volt(MeV). The electron-volt is defined as the energy acquired by a particle of unit electronic charge as it passes through a potential difference of 1 volt.

$$1\text{eV} = 1.602 \times 10^{-19} \text{joule}$$