动力工程专业英语

Fundamentals and Basic Concepts for Power Engineering

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内 容 简 介

本书涵盖了动力工程的主要学科。书中主要内容有:热力学基本知识、内燃机、燃气轮机、蒸汽动力、核动力、流体机械、制冷、舰船传动系统等。书中涉及到的词汇量多、内容丰富、注重介绍动力工程各学科的基本原理和使用特性,可读性好。为了便于学习,每课后除列出生词以外,还配有关键词解释、课文注释和自测习题。

本书可作为动力工程专业大学本科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动力工程的基本知识。

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前　言

本书内容涵盖了动力工程的主要学科分支，介绍了动力工程所用的基础知识、各种发动机的工作原理和使用特性等。主要内容包括热力学基础知识、舰船动力的发展概况、内燃机、燃气轮机、蒸汽动力、核动力、动力机械、制冷、舰船推进系统等。在本书内容的选取时力求英文阅读材料语法规范，要求概念性和知识性强，难度适中，不涉及复杂的专业内容。为了便于读者掌握专业词汇，每课后对重要的关键词作了中、英文两种解释，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。

在编写过程中考虑了动力工程专业大学本科二、三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。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。全书围绕着动力工程这一主题，考虑了课文之间的衔接，使全书内容形成一个完整的体系。

本书共分 20 课，其中 4、5、6 课由张文平编写，其余部分均由阎昌琪编写。李赫教授为本书的内容选取、大纲的制定等提出了宝贵的意见，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 7 月

目　　录

Lesson 1 Basic Concepts of Thermodynamics

1.1 Temperature

To understand the meaning of temperature it is necessary, first, to refer to the human sense of feeling. It is common experience to talk about some things feeling hot and other things feeling cold. No special training is necessary to make the decision whether one thing is hotter or colder than another. The decision is made as a result of the natural reaction of the sense of feeling.

In some cases, this sense of feeling is a satisfactory method for the determination of whether something is hot or cold enough. For example, before getting into a bath, it is quite good enough to feel the water to decide whether it is too hot or too cold. At each subsequent bath it would be possible to make the water about as hot or cold as before. The water would probably not be exactly as hot or cold as previously used, however, since the sense of feeling is not sufficiently accurate to admit of exact repetition. A further important point about this sense of feeling is that it differs slightly from person to person. What is 'too hot' for one person may be 'just right' for another and 'too cold' for somebody else. Feeling, therefore, is not particularly satisfactory where a high degree of accuracy is required. Accuracy is, of course, not the sort of thing required when talking a bath. There are, however, many things which require a high degree of accuracy when determining their degree of hotness or coldness. The sense of feeling is not good enough in these cases. It is therefore necessary to devise some method other than personal feeling for the determination of hotness or coldness.

A great many devices, both ancient and modern, have been designed and made for this purpose. Each device uses the effect that hotness or coldness has on some particular substance as the means by which the degree of hotness or coldness is measured. For example, all substances, to a greater or lesser extent, expand when heated and contract when cooled. The extent to which this expansion or contraction occurs can be used as a measure of the change in hotness or coldness. A scale of hotness or coldness must be devised, however, such that each device will record the same degree of hotness or coldness when used in the same conditions. Having fixed a scale, it is useful to have a single word to denote reference to this scale. The word is temperature and the scale is called the temperature scale. The subject of temperature investigation is called thermometry. It is necessary here, however, to investigate the temperature scales used.

Many attempts have been made in the past to lay down a scale of temperature. The work has culminated in the generally accepted use of two temperature scales. These are the Fahrenheit and the Celsius scales. The Fahrenheit scale is named after Daniel Gabriel Fahrenheit(1686 – 1736), born in Danzig, who devised this scale of temperature. The Celsius scale (often referred to as the centigrade scale) is named after Anders Celsius (1701 – 1744), born at Uppsala, who is described as the inventor of the scale. The Fahrenheit scale of temperature was mainly used by the English-speaking countries.

The Celsius scale was the most commonly used scale in the non-English-speaking world and countries using a metric system of units.

The customary temperature scale adopted for use with the SI system of units is the Celsius scale.

For customary use, the lower fixed point is the temperature of the melting of pure ice, commonly referred to as the freezing point. This point is designated 0℃.

The upper fixed point is the temperature at which pure water boils and this is designated 100℃.

It will be shown later, when dealing with the properties of solids, liquids and vapours, that the temperature at which a liquid freezes or boils depends upon the pressure exerted at the surface of the liquid. This temperature increases as the pressure increases in the case of boiling and slightly decreases with increase of pressure in the case of freezing. To standardise the freezing and boiling temperature on a thermometric scale, therefore, requires that the pressure at which the freezing or boiling occurs be also standardised. This pressure is taken as 760mm of mercury which is called the standard atmospheric pressure or the standard atmosphere, being a mean representative pressure of the atmosphere.

Figure 1.1 shows the way the customary Celsius scale is divided up.

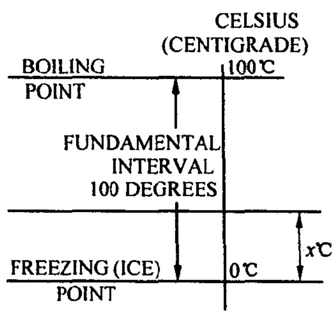

Fig. 1.1

The lower fixed point being 0℃ and the upper fixed point being 100℃, then there are 100 Celsius degrees between these two fixed points.

This 100 Celsius degrees is called the fundamental interval.

In the above discussion it will be noted that the choice of the fixed points was of an arbitrary nature. The freezing and boiling points of water were chosen for convenience. Other points on the International Temperature Scale are then chosen and referred to the originally conceived scale. Since the original choice of fixed points is of an arbitrary nature, the Celsius scale is sometimes referred to as the normal or empirical or customary or practical temperature scale.

Since the Celsius scale is only a part of the more extensive thermodynamic, or absolute temperature scale, it is sometimes called a truncated thermodynamic scale.

Subsequent work will show that there is the possibility of an absolute zero of temperature which will then suggest an absolute temperature scale.

An absolute zero of temperature would be the lowest temperature possible and this would, therefore, be a more reasonable temperature to adopt as the zero for a temperature scale.

The absolute thermodynamic temperature scale is called the Kelvin scale.

This scale was devised by Lord Kelvin, a British scientist, in about 1851.

The Kelvin unit of temperature is called the kelvin and is given the symbol K.

A temperature, T, on the Kelvin scale is written TK, not T°K.

The absolute zero of temperature appears impossible to reach in practice.

However, its identity is defined by giving to the triple point of water a value of 273.16 kelvin(273.16K).

With the absolute zero so defined, the zero of the Celsius thermodynamic scale is defined as 0℃ = 273.15K.

Thus,

$$t = T - 273.15 \qquad (1)$$

where, t = temperature on the Celsius thermodynamic scale = t℃

T = temperature on the Kelvin thermodynamic scale = TK

From equation(1),

$$T = t + 273.15 \text{(can use 273 for most calculations)} \qquad (2)$$

By choosing the zero of the Celsius thermodynamic scale as 0℃ = 273.15, this approximates very closely to the customary Celsius scale and thus 0℃ on the customary Celsius scale is very nearly equal to 0℃ on the Celsius thermodynamic scale. Also, 100℃ on the customary Celsius scale is very nearly equal to 100℃ on the Celsius thermodynamic scale.

1.2 Energy

Energy is defined as that capacity a body or substance possesses which can result in the performance of work. Here, work is defined, as in mechanics, as the result of moving a force through a distance.

The presence of energy can only be observed by its effects and these can appear in many different forms.

An example where some of the forms in which energy can appear is in the motor car.

The petrol put into the petrol tank must contain a potential chemical form of energy because by burning it in the engine, the motor car, through various mechanisms, is propelled along the road. Thus, work, by definition, is being done because a force is being moved through a distance.

As a result of burning the petrol in the engine, the general temperatures of the working substances in the engine, and the engine, will be increased and this increase in temperature must initially have been responsible for propelling the motor car.[1]

Due to the increase in temperature of the working substances then, since the motor car is moved and work is done, the working substance at the increased temperature must have contained a form of energy resultant from this increased temperature. This energy content resultant from the consideration of the temperature of a substance is called internal energy.

Some of this internal energy in the working substances of the engine will transfer to the cooling system of the engine because the cooling water becomes hot. A transfer of energy in this way, because of temperature differences, is called heat-transfer.

The motor car engine will probably have an electric generator which is rotated by the engine and is used to charge the battery. The battery, by its construction and chemical nature, stores energy which can appear at the battery terminals as electricity. The electricity from the battery can be used to rotate the engine starter which, in turn, rotates and starts the engine. By rotating the engine to start it, the electric motor must be doing work and thus, electricity must have the capacity for doing work, and hence is a form of energy.

To stop the motor car the brakes are applied. After the motor car has stopped the brake drums are hot and thus, as discussed above, the internal energy of the brake drum materials must have been increased. This internal energy increase resulted from the stopping of the motor car and hence there must have been a type of energy which the motor car possessed while it was in motion. This energy of motion is called kinetic energy.

From this discussion it will be seen that energy can appear in many forms and further, it appears that energy, through the action of various devices, can be converted from one form into another.

All the possible forms of energy have not been discussed here.