上海市本科教育高地建设
机械制造及其自动化系列教材

人工环境与设备工程专业英语

主　编　蔡颖玲
副主编　陈　帅　陈　煜

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内 容 简 介

本书在参考国内外同类专著和教材的基础上编写而成，以介绍工程热力学、传热学、工程流体力学的知识为基础，内容基本涵盖了人工环境与设备工程专业及相关专业领域，主要包括：空调工程、通风工程、制冷技术与设备、热泵技术、锅炉设备、热交换设备、泵与风机、太阳能、清洁能源利用、制冷剂与环境等。全书共分15个单元，每单元由课文、生词和词组、注释、科技英语翻译技巧和练习5个部分组成。全书有较强的整体性和系统性，书中对科技英语特点、翻译技巧、英文摘要与结论书写等内容的介绍，使读者不仅加深了对人工环境与设备工程专业的认识和理解，同时也有利于英语阅读和写作能力的提高。

本书可作为高等学校人工环境与设备工程专业及相关专业本科生的专业英语教材，还可供相关工程技术人员参考。

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序言

进入21世纪以来，我国制造业得到了飞速发展。中国已成为世界制造业大国，正面临从制造业大国向制造业强国转型的关键时期。培养大批适应中国机械工业发展的优秀工程技术人才，是实现这一重大转变的关键。

遵循高等教育、人才培养和社会主义市场经济的规律，围绕《上海优先发展先进制造业行动方案》，紧贴区域经济和社会需求的发展，上海工程技术大学机械工程学院抓住“上海市机械制造及其自动化本科教育高地建设”这一机遇，把握先进制造业和现代服务业互补、融合的趋向，把打造工程本位的复合应用型人才培养基地作为高地建设的核心，把培养具有深厚的科学理论基础和一定的工程实践能力和创新能力的优秀的复合应用型人才——“生产一线工程师”，作为高地建设的战略发展目标。

正是基于上述考虑，本编写委员会联合清华大学出版社推出上海市教育高地建设机械制造及其自动化系列规划教材，希望根据“以生为本，以师为重，以教为基，以训为媒，突出工程实践”的教育思想理念和当前的科技水平以及社会发展的需求，精心策划和编写本系列教材，培养出更多视野宽、基础厚、素质高、能力强和富于创造性的工程技术人才。

本系列教材的编写，注重文字通顺，深入浅出，图文并茂，表格清晰，使之符合最新国家与部门标准。在编写时，作者们重视基础性知识，精选传统内容，使传统内容与新知识之间建立起良好的知识构架；重视处理好教材各章节间的内部逻辑关系，力求符合学生的认识规律，使学习过程变得顺理成章；重视工程实践与教学实验，改变原教材过于偏重知识的倾向，力图引导学生通过实践训练，发展自己的工程实践能力；倡导创新实践训练，引导学生发现问题、提出问题、分析问题和解决问题，培养创新思维能力和群体协作能力。

本系列教材的编写和出版，是上海市本科教育高地建设的课程和教材改革中的一种尝试，一定会存在许多不足之处。希望全国同行和广大读者不断提出宝贵意见，使我们编写出的教材更好地为教育教学改革服务，更好地为培养高质量的人才服务。

陈关龙

2008年12月

前言

随着我国国民经济的快速发展和人民生活水平的不断提高，人工环境的热舒适营造越来越普及，技术要求也越来越高，暖通空调及相关行业正处在前所未有的快速发展阶段。然而，这势必会造成能源的大量消耗，并对自然环境构成威胁，实现能源、经济、环境的可持续发展是我国经济社会发展的必然选择。适应当前节能与环保的新形势，培养从事人工环境系统设计、安装调试、运行管理并掌握节约用能技术的高级应用型人才成为当务之急。

与此同时，随着国际交流与合作的日益增多，人工环境与设备工程专业的学生不仅要具备扎实的专业知识，还要了解本专业的国际研究进展、新技术的发展以及交流的渠道，这就需要对专业英语的知识有所了解。本书正是为满足人工环境与设备工程及相关专业学生的培养而编写的，其目的主要有：扩大专业词汇量，以便英语专业文献的阅读；掌握英语专业文献的翻译技巧；对本专业的国际动态有所了解。

本书在参考国内外同类专著和教材的基础上编写而成，以介绍工程热力学、传热学、工程流体力学的知识为基础，内容基本涵盖了人工环境与设备工程专业及相关专业领域，主要内容包括：空调工程、通风工程、制冷技术与设备、热泵技术、锅炉设备、热交换设备、泵与风机、太阳能、清洁能源利用、制冷剂与环境等。本书力求选用不同内容和风格的专业英文原始资料，做到选材广泛、专业特点突出、内容新、难度适中，着力培养学生的外语实际应用能力。

本书由上海工程技术大学蔡颖玲担任主编，上海工程技术大学陈帅和陈煜担任副主编。书中1,2,3,8单元由蔡颖玲编写，4,5,6,7,9,10单元由陈帅编写，11～15单元由上海工程技术大学陈煜编写。蔡颖玲、陈帅对全书进行策划和统稿。教材大纲的编制、审定，均经过编审委员会的反复讨论，在此，对编审委员会的各位专家表示衷心的感谢。

我们的编写工作是一个不断学习、不断尝试、不断提高的过程。由于编者水平有限，不当与错误之处难免，敬请广大读者批评指正。

编　者

2008年10月

Contents

Unit One

Fundamentals of Heat Transfer

Ⅰ. Text①

From the study of thermodynamics, you have learned that energy can be transferred by interactions of a system with its surroundings. These interactions are called work and heat. However, thermodynamics deals with the end states of the process during which an interaction occurs and provides no information concerning the nature of the interaction or the time rate at which it occurs.[1] The objective of this section is to extend thermodynamic analysis through study of the modes of heat transfer and through development of relations to calculate heat transfer rates.

We do so by raising several questions. What is heat transfer? How is heat transferred? Why is it important to study it? In answering these questions, we will begin to appreciate the physical mechanisms that underlie heat transfer processes and the relevance of these processes to our industrial and environmental problems.[2]

1. Introduction

A simple, yet general, definition provides sufficient response to the question: what is heat transfer?

Heat transfer (or heat) is energy in transit due to a temperature difference. Whenever there exists a temperature difference in a medium or between media, heat transfer must occur.

We refer to different types of heat transfer processes as modes. When a temperature gradient exists in a stationary medium, which may be a solid or a fluid, we use the term conduction to refer to the heat transfer that will occur across the medium. In contrast, the term convection refers to heat transfer that will occur between a surface and a moving fluid when they are at different temperatures. The third mode of heat transfer is termed thermal radiation. All surfaces of finite temperature emit energy in the form of electromagnetic waves. Hence, in the absence of an intervening medium, there is net heat transfer by radiation between two surfaces at different temperatures.

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① 摘编自：Incropera F P, De Witt D P. Introduction to Heat Transfer. 4th ed. New York: Wiley, 2001

2. Conduction

Examples of conduction heat transfer are legion. The exposed end of a metal spoon suddenly immersed in a cup of hot coffee will eventually be warmed due to the conduction of energy through the spoon. On a winter day there is significant energy loss from a heated room to the outside air. This loss is principally due to conduction heat transfer through the wall that separates the room air from the outside air.

It is possible to quantify heat transfer processes in terms of appropriate rate equations. These equations may be used to compute the amount of energy being transferred per unit time. For heat conduction, the rate equation is known as Fourier's Law. For the one-dimensional plane wall shown in Fig. 1.1, having a temperature distribution $T(x)$, the rate equation is expressed as

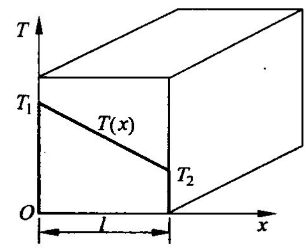

Figure 1.1 One-dimensional heat transfer by conduction (diffusion of energy)

$$q_x = -k\frac{dT}{dx} \tag{1-1}$$

The heat flux q_x (W/m^2) is the heat transfer rate in the x direction per unit area perpendicular to the direction of transfer, and it is proportional to the temperature gradient, dT/dx, in this direction. The proportional constant k is a transport property known as the thermal conductivity (W/(m·K)) and is a characteristic of the wall material. The minus sign is a consequence of the fact that heat is transferred in the direction of decreasing temperature. Under the steady-state conditions shown in Fig. 1.1 where the temperature distribution is linear, the temperature gradient may be expressed as

$$\frac{dT}{dx} = \frac{T_2 - T_1}{l} \tag{1-2}$$

and the heat flux is then

$$q_x = k\frac{\Delta T}{l} \tag{1-3}$$

3. Convection

The convection heat transfer mode is sustained both by random molecular motion and by the bulk motion of the fluid within the boundary layer. The contribution due to random molecular motion (diffusion) generally dominates near the surface where the fluid velocity is low. In fact, at the interface between the surface and the fluid ($y=0$), heat is transferred by this mechanism only. The contribution due to bulk fluid motion originates from the fact that the boundary layers grow as the flow progresses in the x direction.

Convection heat transfer may be categorized according to the nature of the flow. We speak of forced convection when the flow is caused by some external means, such as by a fan, a pump, or atmospheric winds. In contrast, for free (or natural) convection the flow is induced by buoyancy forces in the fluid. These forces arise from density variations caused by temperature variations in the fluid. An example is the free convection heat transfer that occurs from a hot pavement to the atmosphere on a still day. Air that is in contact with the hot pavement has a lower density than that of the cooler air above the pavement. Hence, a circulation pattern exists in which the warm air moves up from the pavement and the cooler air moves downward. However, in the presence of atmospheric winds, heat transfer from the pavement to the air is likely to be dominated by forced convection, even though the free convection mode still exists.[3]

We have described the convection heat transfer mode as energy transfer occurring within a fluid due to the combined effects of conduction and bulk fluid motion. In general, the energy that is being transferred is the sensible, or internal thermal, energy of the fluid. However, there are convection processes for which there is, in addition, latent heat exchange. This latent heat exchange is generally associated with a phase change between the liquid and vapor states of the fluid. Two special cases of interest are boiling and condensation.

Regardless of the particular nature of the convection heat transfer mode, the appropriate rate equation is of the form,

$$q = h(T_s - T_\infty) \qquad (1\text{-}4)$$

where q, the convective heat flux (W/m^2), is proportional to the difference between the surface and fluid temperatures, T_s and T_∞, respectively. This expression is known as Newton's Law of Cooling, and the proportionality constant h ($W/(m^2 \cdot K)$) is referred to as the convection heat transfer coefficient, the film conductance, or the film coefficient. It encompasses all the effects that influence the convection mode. It depends on conditions in the boundary layer, which are influenced by surface geometry, the nature of the fluid motion, and a number of the fluid thermodynamic and transport properties.[4] Moreover, any study of convection ultimately reduces to a study of the means by which h may be determined.

4. Radiation

Thermal radiation is energy emitted by matter that is at a finite temperature. Although we focus primarily on radiation from solid surfaces, emission may also occur from liquids and gases. Regardless of the form of matter, the emission may be attributed to changes in the electron configurations of the constituent atoms or molecules. The energy of the radiation field is transported by electromagnetic waves (or alternatively, photons). While the transfer of energy by conduction or convection requires the presence of a material medium, radiation does not. In fact, radiation transfer occurs most efficiently in a vacuum.

The maximum heat flux (W/m^2) at which radiation may be emitted from a surface is given by the Stefan-Boltzmann Law:

$$q = \sigma T_S^4 \qquad (1\text{-}5)$$

where T_S is the absolute temperature (K) of the surface and σ is the Stefan-Boltzmann constant ($\sigma = 5.67 \times 10^{-8} W/(m^2 \cdot K^4)$). Such a surface is called an ideal radiator or blackbody. The heat flux emitted by a real surface is less than that of the ideal radiator and is given by

$$q=\varepsilon\sigma T_S^4 \tag{1-6}$$

where ε is a radiative property of the surface called the emissivity. This property indicates how efficiently the surface emits compared to an ideal radiator.

Equation (1-6) determines the rate at which energy is emitted by a surface. Determination of the net rate at which radiation is exchanged between surfaces is generally a good deal complicated. However, a special case that occurs very frequently in practice involves the net exchange between a small surface and a much larger surface that completely surrounds the smaller one. The surface and the surroundings are separated by a gas that has no effect on the radiation transfer. The net rate of radiation heat exchange between the surface and its surroundings, expressed per unit area of the surface, is

$$q=\varepsilon\sigma(T_S^4-T_{sur}^4) \tag{1-7}$$

In this expression, ε is the emissivity of the surface, while T_{sur} is the temperature of the surroundings. For this special case, the area and emissivity of the surroundings do not influence the net heat exchange rate.

Ⅱ. Words and Expressions

attribute *n.* 属性,特征
v. 归于,属于
conduction *n.* 传导
configuration *n.* 结构,布局,形态
constituent *n.* 成分,构成物
adj. 构成的,组织的
convection *n.* 对流,传达
distribution *n.* 分布,分配,分发
emissivity *n.* 辐射率,热辐射系数
finite *adj.* 有限的
intervening *n.* 中介
mechanism *n.* 机械,机构,原理,机制
perpendicular *n.* 垂直线,垂直的位置
adj. 垂直的,直立的
quantify *v.* 定量,量化
temperature gradient 温度梯度
thermal radiation 热辐射
thermodynamics *n.* 热力学

Ⅲ. Notes

1. 析：...during which...和...at which...分别引导一个限制性定语从句,during which 的

先行词是 process, at which 的先行词是 time rate。

译：而热力学研究热力过程的初终状态，并不涉及热力过程的本质和过程进行的速度。

2. 析：In answering these questions ...分词短语是目的状语，the physical mechanisms 和 the relevance of these processes 是 appreciate 的宾语，... that underlie heat transfer processes... 是定语从句，修饰 the physical mechanisms。

译：为了回答这些问题，我们应该先了解传热的物理机理以及传热与工业和环境问题的关系。

3. 析：...heat transfer...是本句的主语，...is likely to be dominated by forced convection... 译为"主要是受迫对流的作用"。even though 引导状语从句。

4. 析：which 引导一个非限制性定语从句，修饰 conditions；... a number of the fluid thermodynamic and transport properties...译为"流体的很多热力学和流动特性"。

Ⅳ. Translation Skill

科技英语翻译与写作技巧(一)
科技文章的特点

有关科学著作、论文、研究与实验报告、各类科技情报和文字资料、科技实用手段(包括仪器、仪表、机械、工具等)的结构说明和操作说明等方面的资料均属科技文体。此类文体不同于文学类或其他类型文体，具有自身的特点和规律。了解和掌握科技文体的特点和规律对于翻译实践非常有益。

1. 第三人称句多

科技文章主要是为了说明科学技术活动所带来的结果、证明的理论或发现的科学现象或客观规律，而不是介绍发明者的主观感受，因此，科技文章往往不用第一、第二人称句，而多用第三人称句。

The convection heat transfer mode is sustained both by random molecular motion and by the bulk motion of the fluid within the boundary layer. The contribution due to random molecular motion (diffusion) generally dominates near the surface where the fluid velocity is low. In fact, at the interface between the surface and the fluid ($y=0$), heat is transferred by this mechanism only. The contribution due to bulk fluid motion originates from the fact that the boundary layers grow as the flow progresses in the x direction.

很明显，以上段落中没有第一、第二人称句。

2. 大量使用名词化结构

科技英语通常强调存在的事实，而非某一行为，所以大量使用名词化结构，而且常将主要信息置于句首。

例如：

The earth rotates on its own axis, which causes the change from day to night.

The rotation of the earth on own axis causes the change from day to night.

名词化结构 The rotation of the earth on own axis 使复合句简化成简单句，且使表达的概念更加确切、严密。

3. 广泛使用被动句

科技文章侧重叙事、推理，强调客观、准确，因而常采用第三人称叙述，使用被动语态。科技英语中的谓语不少是被动语态。

例如：

Heat is transported from the heat production plant to the heat centre, which may be some distance away, in the heat transmission pipeline.

4. 非谓语动词多

科技文章力求书写简练、结构紧凑，因而大量使用非谓语动词，常常使用分词短语代替定语从句；使用分词独立结构代替状语从句或并列分句；使用动词不定式代替各种从句；“介词 + 动名词”代替定语从句或状语从句。

例如：

1. Depending on the terrain coved by the water transmission line, pumping stations may be required to maintain the pressure drop between the supply and return pipelines.

分析：coved by the water transmission line，分词短语代替定语从句做定语，修饰“terrain”; Depending on...分词独立结构代替状语从句。这样，既可缩短句子，又比较醒目。

2. A further factor with an extraction turbine system is that electricity output decreases, as the extraction temperature increases, resulting in greater fuel consumption to provide the same energy output.

分析：resulting in...分词短语做结果状语；...to provide the same energy output 使用动词不定式短语代替目的状语从句。

5. 后置定语

科技文章的另一特点是大量使用后置定语。常用的句子结构有：介词短语后置、形容词及形容词短语后置、副词后置、定语从句后置。

例如：

A further factor with an extraction turbine system is that electricity output decreases...（介词短语后置）

6. 长句

为了表达一个复杂概念，使之逻辑严密，科技文章常常出现许多长句。

例如：

The cost of hot water heat distribution, which includes pumping as well as control systems in the local heat network, depends on a number of factors, incliding: the heat demand density; the supply and return temperatures; the characteristics of the terrain and the local infrastructure; and whether the development is new or involves retrofitting.

译为：热水供热分配网的成本（包括泵及局部热网的控制系统）取决于一系列因素，包括需热密度、供水和回水温度、地形特征和当地基础设施以及供热系统是新建还是改造等因素。

V. Exercises

1. Say whether the following statements are true (T) or false (F) according to the text.

(1) The term convection refers to heat transfer that will occur between a surface and a moving fluid when they are at different temperatures.

(2) The exposed end of a metal spoon suddenly immersed in a cup of hot coffee will eventually be warmed due to the convection of energy through the spoon.

(3) This latent heat exchange is generally associated with a phase change between the solid and vapor states of the fluid.

(4) Although we focus primarily on radiation from solid surfaces, emission may also occur from liquids and gases.

(5) The transfer of energy by radiation requires the presence of a material medium.

2. Fill in the blank with the information given in the text.

(1) ________ deals with the end states of the process during which an interaction occures and provides no information concerning the natural of the time rate at which it occures.

(2) It is possible to quantify heat transfer processes in terms of appropriate ________.

(3) The convection heat transfer mode is sustained both by ________ molecular motion and by the ________ motion of the fluid within the boundary layer.

(4) When a temperature ________ exists in a stationary medium, which may be a solid or fluid, we use the term conduction to refer to the heat transfer that will occur across the medium.

(5) The energy of the radiation field is transported by ________ (or alternatively, photons).

3. Fill in the blanks with the words and expressions given below. Change the forms if necessary.

bulk buoyancy emissivity intervene configuration interaction

(1) For free convection the flow is induced by ________ forces in the fluid.

(2) In the absence of ________ medium, there is net heat transfer by radiation between two surfaces at different temperatures.

(3) The contribution due to ________ fluid motion originates from the fact that the boundary layers grow as the flow progresses in the x direction.

(4) The radiative property of the surface is described as the ________.

(5) Thermodynamics deals with the end states of the process during which ________ occurs.

Unit Two

Introduction to Fluid Mechanics

Ⅰ. Text①

1. Historical development of fluid mechanics

The science of fluid mechanics began with the need to control water for irrigation and navigation purposes in ancient China, Egypt, Mesopotamia, and India. Although these civilizations understood the nature of channel flow, there is no evidence that any quantitative relationships had been developed to guide them in their work. It was not until 250 B. C. that Archimedes discovered and recorded the principles of hydrostatics and buoyancy. In spite of the fact that the empirical understanding of hydrodynamics continued to improve with the development of fluid machinery, better sailing vessels, and more intricate cannal systems, the fundamental principles of classical hydrodynamics were not founded until the seventeenth and eighteenth centuries. Newton, Daniel Bernoulli, and Leonard Euler made the greatest contributions to the founding of these principles.

In the nineteenth century, two schools of thought arose in the treatment of fluid mechanics, one dealing with the theoretical and the other with practical aspects of fluid flow. Classical hydrodynamics, though a fascinating subject that appealed to mathematicians, was not applicable to many practical problems because the theory was based on inviscid fluids. The practicing engineers at that time needed design procedures that involved the flow of viscous fluids; consequently, they developed empirical equations that were usable but narrow in scope. [1] Thus, on the one hand, the mathematicians and physicists developed theories that in many cases could not be used by the engineers, and on the other hand, engineers used empirical equations that could not be used outside the limited range of application from which they were derived. [2] In a sense, these two schools of thought have persisted to the present day, resulting in the mathematical field of hydrodynamics and the practical science of hydraulics.

Near the beginning of the twentieth century, however, it was necessary to merge the

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① 摘编自: Roberson J A, Crowe C T. Engineering Fluid Mechanics. 3rd ed. Boston: Houghton Mifflin, 1985