HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY PRESS

能源动力类
英语阅读

English Reading —— For Energy and Power

朱玉群 主编

华中科技大学出版社

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图书在版编目(CIP)数据

能源动力类英语阅读/朱玉群　主编
武汉:华中科技大学出版社,1999年4月
English Reading——For Energy and Power
ISBN 7-5609-1930-8

Ⅰ.能…
Ⅱ.①朱…　②刘…　③晏…　④姜…
Ⅲ.能源工程-英语读物
Ⅳ.H31

English Reading——For Energy and Power
能源动力类英语阅读　　朱玉群　主编

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出版发行:华中科技大学出版社
武昌喻家山　邮编:430074　电话:(027)87557437

录　排:华中科技大学出版社照排室
印　刷:武汉理工大印刷厂

开本:787×1092　1/16　　印张:14.75　　字数:342 000
版次:1999年4月第1版　　印次:2006年12月第4次印刷　　定价:18.80元
ISBN 7-5609-1930-8/H・266

(本书若有印装质量问题,请向出版社发行部调换)

内 容 提 要

本书根据原国家教委1996年审定的《高等学校大学英语专业阅读阶段教学基本要求》的精神，结合十多年来的专业英语教学实践，在原有讲义基础上编写而成。内容范围涉及能源动力类学科各相关专业。作为专业英语阅读阶段的教材，着重选编了介绍本学科各主要分支的学术热点材料，同时也选择了一些叙述学科发展前沿和趋势的英文读物，共40个单元。每单元包括课文、词汇、注解和练习四个部分。本书可供高等学校能源动力类学科各相关专业大学生作为专业英语阅读的教材，也可供相关专业研究生、教师和科技人员参考。

前 言

本书是根据原国家教委1996年审定的《高等学校大学英语专业阅读阶段教学基本要求》的精神，结合十多年来的专业英语教学实践，在原有讲义的基础上编写而成的。主要目的是使已学完大学英语的高年级大学生，通过这一课程的学习，积累相当数量的专业词汇，提高阅读和理解专业文献和书籍的水平，增强应用科技英语的能力。考虑到学生的英语基础和将来在能源动力领域中工作的实际需要，在选材上，我们遵循如下原则。

1. 选材面宽。为适应培养"宽口径"人才的要求，所选材料涉及能源动力类各相关领域。

2. 强调共性。针对能源动力类涵盖面广而篇幅有限的实际情况，重点选择那些与各专业密切相关的具有共性的素材。

3. 特色鲜明。采用了一部分能反映各相关专业主要学术方向的题材，勾划出能源动力类的学科主流。同时精选了体现学术新方向、学术重点及重要应用的材料。

4. 语言规范。所选材料绝大部分来自英语国家的正式出版物，少量选自国际著名杂志，在尽量保持原文真实性的前提下，对少量材料进行了必要的删节、编排、简化，使之适合于教学要求。全书计量单位采用SI制。

全书由40个独立单元组成，每个单元包括课文、词汇、注解和练习四部分，用两个学时完成。练习主要在课外完成，也可在课堂上进行。各教学班可根据自己的特点和学时选择相应的单元。

本书由朱玉群担任主编(编写第5、6、7、15、16、21、22、29、30、31、32、38、40单元)，参加编写的还有刘扬娟(编写第3、11、17、19、20、26、27、28、35、36、37单元)，晏水平(编写第1、2、8、10、12、13、14、18、25、34单元)和姜铁兵(编写第4、9、23、24、33、39单元)。在编写过程中得到华中理工大学动力系黄素逸教授、刘伟教授、蔡兆林教授和许多担任专业英语教学的老师们的热情指导和帮助；特别是外语系熊敦礼教授在百忙之中审阅了全书，对保证本书的语言规范起到了重要作用，在此一并表示感谢。

由于时间紧迫，编者水平有限，错误和疏漏之处一定不少，热忱欢迎读者批评指正。

编 者

1999年1月

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1 The Steam Power Plant

A power plant, of whatever variety, consists of three essential elements: the heat source, the heat utilizer, and the waste heat reservior or refrigerator. To generate power or produce useful work it is required that the heat be supplied to a working fluid, from the heat source. The utilizer is required to convert a portion of the heat supplied to the working fluid into useful power. Since, by the second law of thermodynamics, not all the heat can be converted to useful power, a refrigerator is required to dispose of the remainder of the heat.

A modern steam plant may be divided into two main halves. One half consists of the boiler (or heat source) and its auxiliaries; the other, the turbine cycle, consists of turbine, generator, condenser, pumps and feedwaetr heaters. The turbine cycle includes not only the heat utilizer but also the refrigerator.

Considering first the boiler half of the cycle, feedwater is supplied through an economizer to the boiler drum. The economizer reclaims part of the heat in the stack gases and transfers it to the feedwater, thus decreasing the heat to be supplied in the boiler while reducing the temperature of the stack gases. In the boiler drum, the water is boiled and converted to dry and saturated steam, which enters the superheater where the heat of superheat is added. The major part of the steam leaving the superheater is taken to the steam turbine. In many plants some of the steam is bled off for use in a steam-jet air-ejector. Steam passing through the steam turbine produces mechanical power on the turbine shaft, which drives the alternator, where electrical energy is generated for distribution. In passing through the turbine in the regenerative cycle, some of the steam is bled from the turbine at a series of three or four openings (more or less), for use in feedwater heaters. Approximately 70% to 75% of the steam supplied to the turbine at the throttle, continues all the way through the turbine to the exhaust hood, whence it passes to the condenser.

In the condenser, which is a large surface-type heat exchanger, the steam is condensed, by transferring its latent heat to circulating water taken from a nearby river or lake. The circulating water is supplied to the condenser by circulating water pumps, either motor or steam-turbine driven. Since tremendous quantities of steam pass into the condenser, it is unavoidable that a certain proportion of non-condensable gases accompanies it. In order that a very low pressure, approximating a perfect vacuum, may be maintained in the condenser, these "non-condensables" must be removed from the shell of the condenser. Usually they are removed by means of a steam-jet air-ejector, consisting principally of a nozzle through which steam passes at high velocity and in which the non-condensable vapors are entrained. The steam passing through the nozzle (motive steam) and the non-condensable gases mechanically entrained in it are then taken to a heat-transfer device known as an after-condenser, where the steam is condensed at atmosphere. The steam-jet air-ejector, built in either one or two stages, is essentially a compressor for raising the pressure of the non-condensable vapors from an almost perfect vacuum to atmospheric pressure, to dispose of them.

The main steam, having condensed in the condenser, is now in the form of liquid water at a very low pressure and approximately saturation temperature. This water drains by gravity to the bottom of the condenser, where it enters a hotwell. Usually the level of the water in the hotwell is maintained by a control applied to the hotwell pump. The hotwell pump removes the water from the hotwell and pumps it through the lower part of the feedwater heating system to another pump, the boiler feed pump. The water discharged from the hotwell pump is taken first to a low-pressure heater in which heat is supplied by the lowest pressure extraction. The low-pressure heater is equipped with a drain pump, the duty of which is to remove the drains (formed by the condensing steam) from the heater and to pump them into the main condensate line, beyond the heater. This type of heater is known as a pumped heater.

From the lower-pressure heater the condensate passes to a deaerating heater. The deaerating heater, a direct contact type, served as a means of boiling the condensate to eliminate any entrained oxygen. Removal of oxygen in the deaerating heater is based on the principle that solubility of non-condensable gases in water is greatly reduced as the temperature of the water approaches the boiling point. Steam extracted from the turbine supplies the heat required to raise to the boiling point the temperature of the condensate entering the deaerator. The non-condensable gases discharged from the surface of the water must be removed. Normally the deaerator is operated at a pressure higher than atmospheric, so that these gases may be vented through a vent condenser. Usual practice is to cool the vent condenser with incoming condensate, to cool the non-condensable gases, and simultaneously to condense the steam, some of which unavoidably escapes from the deaerator with gases. By proper design of the vent condenser, the steam may be condensed and permitted to drain back into the deaerator, while the non-condensable gases are vented to atmosphere through a orifice.

Occasionally in the original design it may be planned that the deaerator operate at pressures below atmospheric. Even when the full-load design pressure is considerably higher than atmospheric, it is found that at the lighter loads the pressure becomes subatmospheric. It is then essential that the non-condensables continue to be removed from the deaerator, and a steam-jet ejector is necessary for accomplishing this result. The expense and complication in operation occasioned by such an installation make it undesirable. For this reason it is common practice to provide for the shifting of extraction stages at light loads so that the deaerator steam supply is furnished by the next-higher extraction point. A simple arrangement is to install a crossover pipe containing a controlling valve, with a check valve in the lower-pressure extraction line before its junction with this crossover pipe[1]. In such an installation opening of the valve in the crossover line automatically supplies higher-pressure steam to the deaerator, and the check valve closes, prevening backflow to the lower extraction stage.

In many power plants a surge tank containing reserve stored water is connected in parallel with the deaerator. The function of the surge tank is to serve as an emergency supply of distilled water, in the event of failure of other sources, or as a reservior for excess water during load changes, etc. Normally the storage capacity of the deaerator is sufficient to operate the power plant for several minutes, but most designers consider it wise to augment this storage capacity with a large surge tank.

In the majority of large power plants the boiler-feed pump is connected to the discharge of the deaerator. Since the water in deaerator is at its boiling point, it is essential that the boiler-feed pump be located a considerable distance (usually 6m or more) below the deaerator, to avoid flashing of the water in the boiler-feed pump suction. Water leaving the deaerator goes to the boiler-feed pump suction and is pumped into the next higher heater. This heater is a drain cooler heater, that is, a heater the drains from which pass through a heat exchanger (drain cooler), giving up heat to the incoming condensate. After leaving this heater, the condensate goes to the top or high-pressure heater, in which the condensate is heated to the final feedwater temperature. The top heater is a flashed heater, so called because its drains are permitted to pass through a controlling orifice or trap to the next-lower heater where part of the saturated water flashes into steam. This arrangement eliminates the use of drain pumps and drain coolers, but causes a considerable thermodynamic loss. The final feedwater temperature leaving the top heater is in the order of 150℃ to 230℃ in large power plants, and occasionally higher.

Words and Expressions

refrigerator[ri'fridʒəreitə] *n.* 冰箱，冷藏库
feedwater['fi:dwɔ:tə] *n.* 给水
exciter[ik'saitə] *n.* 励磁机
throttle['θrɔtl] *vt.* 使窒息，节流
economizer[i'kɔnəmaizə] *n.* 省煤器
reclaim[ri'kleim] *vt.* 回收，开垦，开拓
shaft[ʃæft] *n.* 轴

hood[hud] *n.* 罩,头巾
nozzle['nɔzl] *n.* 喷嘴,喷管,导向器(装置)
vent[vent] *n.* 孔,缺口 *vi.* 由孔排出
accompany[ə'kʌmpəni] *vt.* 陪伴,陪同,伴随
deaerator[diː'ɛəreitə] *n.* 除氧器
orifice['ɔrifis] *n.* 节流孔板
accomplish[ə'kʌmpliʃ] *vt.* 达到目的,完成
check valve *n.* 逆止阀
augment[ɔːg'ment] *vi.* 增加,扩大
eliminate[i'limineit] *vt.* 消灭,消除,排除

Note

1. A simple arrangement is to install a crossover pipe containing a controlling valve, with a check valve in the lower-pressure extraction line before its junction with this crossover pipe. 一种简单的办法是安装一根带控制阀的叉型管,在此管交叉处前面的低压抽汽段上装有逆止阀。

Exercises

A. Answer the following questions.
  1. Why is a refrigerator required in the process of converting the heat source into useful power?
  2. What is the role of a steam-jet air-ejector?
  3. According to the passage, how is the water level maintained in a hotwell?
  4. What is the working principle of a deaerator?
  5. What is the function of a check valve in extraction line?
  6. What is the advantage and disadvantage of a flashed heater?
  7. How many types of heaters are mentioned in the text?

B. Translate the following Chinese into English.
  1. 凝汽器是一种大型的表面式热交换器,排汽在其中被凝结,将其汽化潜热传给循环水。
  2. 除氧器通常在高于大气压的压力下运行。
  3. 由于除氧器中的水达到了沸点,为了避免水冲击,锅炉给水泵和除氧器之间有一定的距离。

▶▶▶▶▶▶

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2 Coal

Coal is a complex substance consisting of many variations of chemical compounds, but all coals contain the basic components of hydrogen and carbon, the elements that contribute the largest amount of heating value to coal.

The types of coal mined in the United States are classified as anthracite, bituminous, semianthracite and subbituminous, depending upon the amount of organic volatile matter contained in each type.

Anthracite is practically all carbon. It burns slowly with little smoke. Nearly all anthracite used in the United States comes from Pennsylvania. It is usually called hard coal and has a heating value of 30×10^6J/kg of dry coal. Since it contains little volatile matter, it burns with a very small flame. Anthracite has been the most commonly burned coal for heating residences and is available in several sizes for this use. The common names for types of anthracite are pea, nut stove, and egg. The sizes range from pea, with a maximum diameter of 2.22cm to egg at 8.23cm diameter. Semianthracite burns more rapidly and with a long flame than anthracite because of its high content of volatile matter. It produces less slag and little smoke.

Bituminous coals are by far the most commonly used in industry. Because of variations in their percentages of volatile matter, some bituminous coals burn freely with a short flame while others have a long flame, heating values of bituminous coal vary between 26×10^6 to 33×10^6J/kg.

Coal is sold at varying prices, depending upon quality, size and other factors, but the important considerations for a power plant operator are its Btu content and chemical composition.

There are two kinds of analysis for coal: the proximate analysis and the ultimate analysis. The proximate analysis determines the content in percentages of four components moisture, volatile matter, fixed carbon and ash. The proximate method is designed for quickly establishing the qualities in the coal important in the operation of a boiler, and it is a general practice to consider along with the analysis the heating value of the fuel. The tests in an analysis simulate the actions that occur when the coal is burned in a boiler, and in addition show the losses in the weight of a sample due to moisture.

To make a proximate analysis, we use the following procedure. Take a representative sample from a coal pile and crush it into a powered form that will pass through a 20-mesh sieve[1]. Place the powder, usually 2.3kg to 4.6kg, in an airtight container. Remove 60g to 85g from the container and set them aside, resealing the container to prevent moisture from entering.

Weigh 4 grams of the powder in a platinum crucible. The crucible should be weighed first before you place the powder in it. This should be more done as quickly as possible to prevent a loss of moisture into the atmosphere. Note the combined weight of the crucible and coal. Place the crucible in an oven and heat it to 115℃ for one hour. Remove the crucible from the oven and allow the crucible to cool in a dry box or dessicator. When cool, weigh the crucible holding the sample and note the amount of loss in weight. Place the crucible in the oven again and heat for a half hour. Again cool the crucible and weigh it. If there is no further reduction in weight all moisture has been removed from the coal, and the difference between the first and last readings indicates the moisture content.

Now weigh a new sample, about 1 gram, also in a platinum crucible with a tight-fitting cover. Place the crucible on a Bunsen burner and heat for 7 to 8 minutes. Cool the crucible as before and weigh it. The loss in weight is the sum of the volatile matter plus the moisture.

Remove the cover from the crucible that has just been used for the "volatile" test and heat the crucible over a Bunsen burner until all the carbon has burned off. Stir the contents of the crucible, which should be a powdery mass when combustion is completed. Cool as previously and weigh the crucible and its contents. The difference between this weight and the weight of the empty crucible is the weight of the ash. The weight of the carbon is determined by subtracting the sum of the weights of the moisture, ash, and volatile matter from the original weight of the sample.

The percentage of each constituent should give you a basis to judge the heating value and general suitability of the coal for power plant operation.

If the ash content is high, it can be assumed that the coal is generally of poor quality. The amount of volatility indicates whether the coal will be burn with a short or long flame and whether it will tend to produce smoke. The more volatile the coal, it will smoke and require more excess air to comply with Federal Environmental Protection Agency regulations[2]. The combustibles in any coal are the volatile matter and fixed carbon; generally a high percentage of these constituents indicates a coal of high heating value.

The ultimate analysis of coal is made to determine the percentage of the weight of all the chemical constituents of the coal. These are carbon, hydrogen, oxygen, nitrogen, and analytical chemist and a description of the process is not necessary here. After an ultimate analysis has been made, the heating value of the fuel is determined by substituting in the formula derived by Pierre Louis Dulong (1875～1938), a physicist and chemist who was a professor and director of the Ecole Polytechnique in Paris. His experiments to determine the specific heat of elements added immensely to knowledge of the subject. Dulong's formula is:

$$H = 3045C + 130200(H - O/8) + 8400S$$

H is the heating value of coal (in KJ/kg) and C, H, O, and S are the weights the carbon, hydrogen, oxygen and sulfur contained in one kilogram of coal. The weights of the constituents contained in one pound of the fuel may be determined by dividing the percentage values of the ultimate analysis by 100. If the ultimate analysis shows 86.68% of carbon, divided by 100, there is 0.8668 kg of carbon per kilogram of coal.

Words and Expressions

heating value 热值,发热量
anthracite['ænθrəsait] *n.* 无烟煤,硬煤
bituminous[bi'tju:mins] *a.* 沥青的,含沥青的
bituminous coal 烟煤
subbituminous coal 次烟煤
volatile matter 挥发分
slag[slæg] *n.* 炉渣,熔渣 *v.* 结渣
proximate analysis 工业分析
ultimate analysis 元素分析
moisture['mɔistʃə] *n.* 水分
fixed carbon 固定碳
platinum['plætinəm] *n.* 铂,白金
crucible['kru:sibl] *n.* 坩埚
Bunsen burner 本生灯
powdery['paudəri] *a.* 粉的,粉状的
calorimeter[ˌkælə'rimitə] *n.* 量热计

Notes

1. Take a representative sample from a coal pile and crush it into a powered form that will pass through a 20-mesh sieve. 从煤堆里取一块有代表性的样品并将其粉碎成 20 目以下的煤粉。
2. The more volatile the coal, it will smoke and require more excess air to comply with Federal Environmental Protection Agency regulations. 煤的挥发分越多,冒的黑烟也将越多,为了遵守联邦环境保护署的规定所需要的过量空气也越多。

Exercises

A. Answer the following questions.

1. Which elements contribute most of heating value to coal?
2. Why does semianthracite burn more rapidly and with a longer flame than anthracite?
3. What are the combustibles in coal?
4. What is the purpose of the ultimate analysis?

B. Translate the following Chinese into English.

1. 工业分析是评价煤质和选择电站用煤的重要依据。
2. 挥发分和固定碳的含量决定煤的发热量。
3. 煤是由碳、氢、氧、氮、硫等组成的成分复杂的化合物。

3 Type of Turbomachines

Introduction

Turbomachines constitute a large class of machines which are found virtually everywhere in the civilized world. This group includes such devices as pumps, turbines, and fans. Each of these has certain essential elements, the most important of which is the rotor, or rotating member. There is, of course, attached to this spinning component a substantial shaft through which power flows to or from the rotor, usually piercing a metallic envelope known as the casing. The casing is also pierced by fluid-carrying pipes which allow fluid to be admitted to and carried away from the enclosure bounded by the casing. Thus a turbomachine always involves an energy transfer between a flowing fluid and a rotor. If the transfer of energy is from rotor to fluid, the machine is a pump, fan, or compressor; if the flow of energy is from the fluid to the rotor, the machine is a turbine.

The purpose of the process described above is either to pressurize the fluid or to produce power. Useful work done by the fluid on the turbine rotor appears outside the casing as work done in turning; for example, it can turn the rotor of a generator. A pump, on the other hand, receives energy from an external electric motor and imparts this energy to the fluid in contact with the rotor, or impeller, of the pump.

The effect on the fluid of such devices is that its temperature and pressure are increased by a pumping-type turbomachine, and the same properties are reduced in passage through a work-producing turbomachine. A water pump might be used to raise the pressure of water, causing it to flow up into a reservoir through a pipe against the resistance of frictional and gravitational forces. On the other hand, the pressure at the bottom of a reservoir could be used to produce a flow through a hydraulic turbine, which would then produce a turning moment in the rotor against the resistance to turning offered by the connected electric generator.

Geometries

A typical turbomachine rotor, a centrifugal pump impeller, is shown schematically in

3. 1. Liquid enter the eye E of the impeller moving in an axial direction, and then turns to a radial direction to finally emerge at the discharge D having both a radial and a tangential component of velocity. The vanes V impart a curvilinear motion to the fluid particles, thus setting up a radial centrifugal force which is responsible for the outward flow of fluid against the resistance of wall friction and pressure forces.

The vanes of the rotor impart energy to the fluid by virture of pressure forces on their surfaces, which are undergoing a displacement as rotation takes place. Energy from an electric motor is thus supplied at a constant rate through the shaft S which is assumed to be turning at a constant angular speed.

If the direction of fluid flow in Fig 3. 1 is reversed, the rotor becomes part of a turbine, and power is delivered through the shaft S to an electric generator or other load. Typically, hydraulic turbines have such a configuration (see Fig 3. 4) and are used to generate large amounts of electric power by admitting high-pressure water stored in dams to the periphery of such a rotor. A pressure drop occurs between the inlet and the outlet of the turbine; the water exits axially and is conducted away and discharged at atmospheric pressure.

If the substance flowing through the impeller of Fig 3. 1 were a gas, then the device would be a centrifugal compressor, blower, or fan, depending on the magnitude of the pressure rise occurring during transit from inlet to outlet. For the reversed flow case, i. e., a radially inward flow, the machine would be called a radial-flow gas turbine or turboexpander.[4]

A different type of turbomachine is shown in Fig 3. 2. Here the flow direction is generally axial, i. e., parallel to the axis of rotation. The machine shown in this figure represents an axial-flow compressor or blower, or with a different blade shape an axial-flow gas or steam turbine, depending on the direction of energy flow and the kind of fluid present.

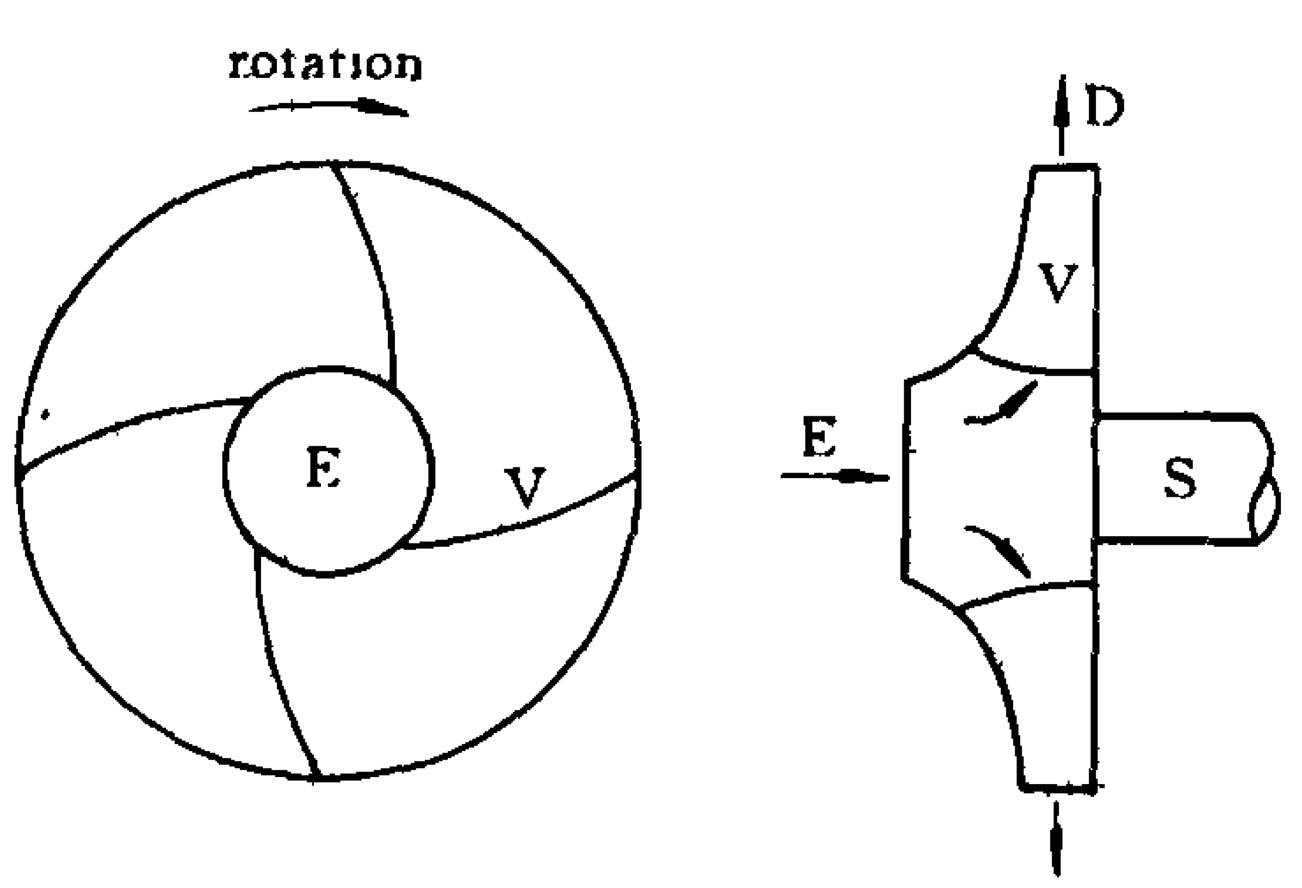

Fig 3. 1 Pump impeller

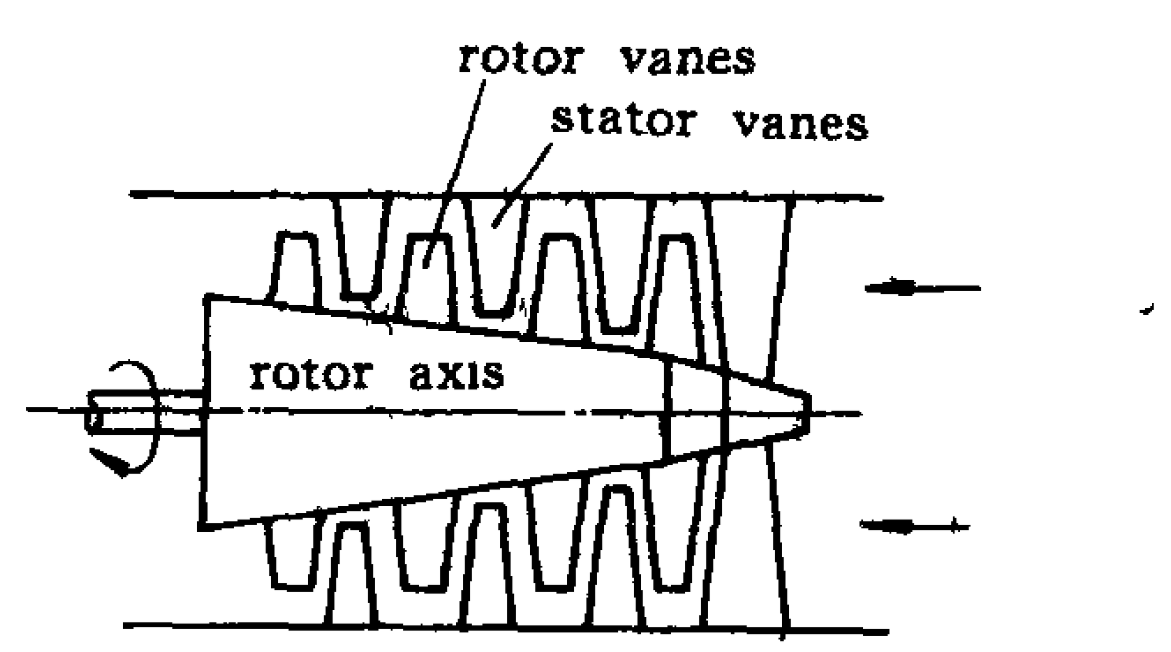

Fig 3. 2 Axial-flow blower

In all of the machines mentioned thus far, the working fluid undergoes a change in pressure in flowing from inlet to outlet, or vice versa. Generally, pressure change takes

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