普通高等教育"十一五"国家级规划教材

航海类专业精品系列教材

轮机英语

MARINE ENGINEERING ENGLISH

潘新祥 主编

大连海事大学出版社

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前言

海上运输是交通运输的重要组成部分，在促进外贸运输发展和推动对外贸易增长等方面以其他运输方式不可比拟的优势发挥出越来越重要的作用。

大连海事大学作为我国唯一的国家重点航海类专业院校，多年来为我国乃至国际海上运输业培养了大量的航海类专业高级人才，对促进航运业的发展起到了重要作用。近年来，随着科学技术的进步和交通运输业的发展，学校针对航海类专业的鲜明特色，在人才培养方案、教学内容及课程体系改革等方面进行了一系列的研究和实践。在此基础上，我校组织编写出一套与新的培养方案、教学内容及课程体系相适应的航海类专业精品系列教材，旨在加强航海类专业建设，提高航海类人才培养的质量和水平，进一步推动高等航海教育的发展。

为了保证航海类专业精品系列教材顺利出版，学校在资金、人力和物力等方面予以充分保证。组织校内航海类专业的资深专家、骨干教师和管理干部做了大量工作，从筹备、调研、编写、评审直至正式出版，历时三载有余。2005 年 5 月，学校先后组织召开了两次航海类专业教学改革研讨会，来自交通部海事局、辽宁海事局、中国远洋运输（集团）总公司、中国海运（集团）总公司、中国船级社等单位的专家为教材编写的筹备工作提出了中肯的意见和建议。2006 年初，教材编写工作正式启动，确定重新编写航海类专业教材 22 种，其中航海技术专业教材 13 种、轮机工程专业教材 9 种。教材编写大纲先后征求了中国远洋运输（集团）总公司、中国海运（集团）总公司及大连海事大学等单位 10 多位专家的意见。学校组织教材主要编写人员分赴北京、天津、青岛、上海、广州、武汉及厦门等多家航运企事业单位进行调研，收集了大量的最新技术资料，同时听取了有关领导和专家的意见。2007 年我校先后召开了五次评审会，来自交通部海事局、驻英大使馆海事处、中国海事服务中心考试中心、辽宁海事局、山东海事局、中国远洋运输（集团）总公司、中国海运（集团）总公司、大连引航站、上海海事大学、大连水面舰艇学院、大连水产学院、集美大学、青岛远洋船员学院及大连海事大学等单位的多名专家对 22 种教材的初稿就内容、文字及体例等方面逐一评审，反复推敲，几易其稿，逐步完善，反复审核，最终正式出版。该套教材中共有 16 种教材入选国家"十一五"教材规划选题。

这套航海类专业精品系列教材以履行修订后的 STCW 公约为前提，结合海上运输业发展的国际性和信息性等特点，以更新教学内容为重点，对原有教材做了大量的增删与修改，注重理论基础及内容阐述的逻辑性和准确性，力求反映国内外航海科技领域的新成就与新知识，适应 21 世纪海上运输业对航海类人才的知识、能力和素质结构的要求，兼顾各教材内容之间的衔接与整合，避免重复与遗漏。我衷心地希望，通过全体编写人员的不懈努力，这套精品系列教材，能够进一步加强我校航海类专业的建设，为国内兄弟院校航海类专业的发展提供有益的借鉴，为我国高等航海教育发展尽微薄之力。

教材在编写和出版过程中，得到了方方面面领导、专家和同仁的大力支持和热心帮助（具体名单附后）。我谨代表大连海事大学及教材编写全体成员对以上单位和个人致以最诚挚的谢意。各位专家和同仁渊博的专业知识、严谨的治学态度、精益求精的学术风范以及细致入微的工作作风为教材的顺利出版作出了卓越的贡献，在很大程度上可以说，这套教材的成功出版，是全体编写人员，各港航企事业的单位的领导、专家和同仁共同努力的成果。

航海类专业精品系列教材的编写是一项繁重而复杂的工作，鉴于时间和人力等方面的因素，这套教材在某些方面还不是十分完善，缺点和不妥之处在所难免，希望同行专家不吝指正。同时，希望以此为契机，吸引更多航海技术领域的专家、学者参与到这项工作中来，为我国航海教育献计献策，为我国乃至国际海上运输事业培养出大量高素质的航海类专业人才。

大连海事大学 校长

2008 年 3 月

对教材出版给予大力支持和帮助的单位及个人如下：（以姓氏笔画为序）

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编者的话

国际航运业的快速发展，船舶更新换代，轮机管理知识日新月异，国际海事公约的推陈出新，机务管理的国际化发展趋势，这些都表明《轮机英语》应该适应现代科技发展要求。

在继承蒲宝康、王建斌两位老师所编写教材的精华基础之上，新版教材更换了大部分课文及阅读材料内容，注意将电喷双燃料柴油机、新的海事公约管理技术等编入教材。同时，在写作方面，重新编写了轮机日志、船舶修理单、物料申领及订购、常用轮机报告和关键设备操作说明，列举的都是紧密结合当前航运业轮机业务实际的工作实例。教材还配有光盘，邀请外教对课文及阅读材料部分进行录音，便于学员自学。

本书的第一部分由潘新祥教授编写，第二部分书写内容由党坤副教授编写，澳大利亚籍教师 John David Redenbach 为教材配音，宋永欣老师负责光盘录音整理，全文由潘新祥统稿，王建斌主审，张兴彪、蒋福伟等老师提供了部分教材内容。王鹏、高路、宋立国、刘立国等研究生为材料的整理及单词表的编写做了大量工作，光盘所附软件由研究生沈静文编制。

编写过程中还得到了吴恒、蔡振雄等专家的指点，避免了许多谬误，在此深表谢意。为使本教材真正满足国家精品教材的要求，恳望各位专家和广大读者赐教。

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第一篇 轮机阅读

LESSON ONE Diesel Engines

The majority of ships around the world continue to be powered exclusively by diesel engines. The predominance of diesel engines has come from improved engine efficiencies and designs compared to other forms of propulsion such as steam or gas turbines. Many combinations and configurations of diesel engine power plant exist. All provide the energy to do the work of moving the ship using diesel engines.

Slow speed, two-stroke diesel engines

Slow speed diesel engines are large, especially tall, and heavy and operate on the two-stroke cycle. These are the largest diesel engines ever built. Engine powers up to 100,000 kW are available from a single engine. They are tall to allow for long strokes which improve engine efficiency. The large physical allow for long strokes which improve engine efficiency. The large physical size of the engine and components leads to slow rotational speed with speeds up to 300 r/min considered to be slow. For equivalent power output, the two-stroke diesel engine is significantly lighter than its comparable four-stroke relative. This is most apparent for large power requirements where the two-stroke engine produces much more power for the same weight.

Large, slow speed, two-stroke marine diesel engines offer the advantages of:

(1) Burning poorer quality, cheaper fuel;

(2) Providing large power from a single, less complicated machine comprising fewer individual cylinders and moving parts;

(3) Having a low rotational speed allowing them to be directly coupled to the propeller and removing the need for transmission machinery such as clutches and gearboxes etc;

(4) Being reversible and thus eliminating the need for reversing gear or controllable pitch propellers.

Merchant ships driven by slow speed diesel engine will usually have a single large main engine directly coupled to a single fixed pitch propeller. The thrust forces from the propeller will be transferred to the hull of the ship through a thrust bearing built into a thrust block, the thrust block may be built as part of the slow speed engine, and this system is supported by diesel generators providing the ship's electrical power.

Medium speed, four-stroke diesel engines

Medium speed engines operate in speed ranges from 300 r/min to 900 r/min. The majority of medium speed engines operate on the four-stroke cycle. They are most common as the propulsion engines in smaller ships such as Ro-Ro ships and passenger ships. They are used widely as the electrical power generation engines in most merchant cargo ships.

Four-stroke engines have more moving parts, are more complex and produce less power for equivalent weight compared to two-stroke slow speed engines. Medium speed engines do, however, offer several advantages which make them attractive for marine applications.

(1) The engines are compact that they are not long or high, which allows them to fit in engine rooms with low head space such as those in Ro-Ro ships fitted under the vehicle deck;

(2) Medium speed engines use less oil than slow speed engines;

(3) Recent developments have produced medium speed engines capable of burning low quality heavy fuel oil;

(4) Engines of considerable power, to 25,000 kW and more, have been developed, allowing a large power system to be achieved with compact engines and engine room. This makes them suitable for passenger ship applications where the smaller the space provided for engines and machinery the more space is available for paying passengers.

Most medium-speed diesel engines are non-reversible meaning that a controllable pitch propeller is usually employed to cater for astern thrust. Propulsion system compared to an equivalent ship with a matched slow speed propulsion system operating at optimum conditions, when used as the primary source of power for propulsion applications medium-speed engines can be used in a number of configurations.

Single propulsion engine

A ship's propeller operates most efficiently at low rotational speed especially in the case of the large diameter propellers used in cargo ships. The slow speed two-stroke engine can be directly coupled to the propeller as the maximum efficiency of each can be matched at a suitable rotational speed. In the case of the output speed of the medium speed engine must be reduced to one more suitable for the propeller. This is done using a reduction gearbox. To reduce the load on the engine during starting, it is necessary to uncouple the propeller shaft from the drive shaft. This is done via a clutch which is often incorporated as part of the gearbox. The output shaft of gearbox then drives the controllable pitch propeller.

The output shaft of the engine is coupled to the gearbox. The output shaft of the gearbox drives the Controllable Pitch Propeller (CPP) through a clutch arrangement. The oil supply to and from the propeller is fed into the propeller shaft through an oil distribution box. This box is attached to a collar running on a section of the propeller shafting, thrust forces maybe accommodated in a separate thrust block and bearing.

Many gearbox designs incorporate the clutch, thrust bearings and CPP oil distribution box into the same casing as the reduction gears, this design has the following advantages:

(1) The engine transmission package uses components that are known to be compatible and have been proven to work together reliably;

(2) The cost and complexity of installation is less than if separate, stand alone components were to be used;

(3) The entire installation is smaller in size, especially length, than the separate units;

(4) Negotiations and correspondence etc are simplified as only one supplier need be dealt with.

Multiple propulsion engines

Larger vessels and ships using medium-speed engines usually use two or more engines to provide power to the propeller. Multiple engine installations can have several configurations. The first two arrangements discussed in this section have engines driving a propeller through a transmission gearing system. Other propulsion arrangements using multiple engines are possible. A number of these possibilities are discussed later in the section.

Single propeller shaft with geared drive

Multiple engines can be arranged to drive a single propeller. This is usually done by using a multiple input reduction gear. All the engines are arranged around the gearbox, each engine is connected to the gearbox through a clutch allowing multiple stages of power output to the propeller. A single output from the gearbox drives the propeller through a thrust bearing and CPP oil distribution collar, if fitted.

Multiple propeller shafts

Some vessels are propelled by more than one propeller, for example some ferries, passenger ships, special purpose ships, offshore vessels and Ro-Ro vessels etc. The majority of multiple propeller applications are smaller vessels requiring added manoeuvrability. This is not always the case as some very large ships have been built with two propellers. These large ships have had two propellers directly coupled to slow speed engines. This effectively produces a ship with two engine rooms, one for each engine. In smaller vessels the engine configurations are usually extensions of the single or multiple engines, single shaft arrangements mentioned above. Medium-or high-speed engines are usually used in these cases. In vessels such as catamarans with propeller drives one drive system is mounted on each of the hulls. This creates two engine rooms. Two examples, the first of a catamaran, the second a twin screw ship.

High–speed diesel engines

The most common diesel engine throughout the world is the high-speed engine. The majority of these engines operate on the four-stroke cycle but a significant proportion utilize the two-stroke cycle. These engines have running speeds over 1,000 r/min and are ideally suited to driving land-based vehicles such as busses and trucks. the application of high-speed diesel engines as propulsion engines at sea id limited to smaller vessels such as tugs, ferries and barges etc. They are regularly used for electrical power generation in support of a medium-speed propulsion engine, on larger ships their use is limited to emergency power generation to small applications such as diesel driven emergency pumps and compressors.

The acceptance of high-speed engines in ships has grown in recent years with the development of larger horsepower engines, which has been assisted by co-operation between traditional medium- and slow-speed engine manufacturers with high-speed engine manufacturers, these manufacturers have begun to produce engines capable of supplying power in ranges that formerly fell between those of medium-and high-speed engines.

The propulsion layouts used with high-speed engines parallel those mentioned above for medium-speed engines.

The diesel-electric propulsion system described above for medium-speed engines is equally applicable to high-speed engines. The scale of system and applicability will be reduced.

NEW WORDS AND EXPRESSIONS IN TEXT

exclusively	[ɪkˈskluːsɪvlɪ]	*ad.*	无例外地，专有地
predominance	[prɪˋdɔmɪnəns]	*n.*	优势，突出优点
configuration	[kənˌfigjuˈreiʃən]	*n.*	构造，结构，外形
equivalent	[iˈkwivələnt]	*a.*	相等的，相当的
complicated	[ˈkɔmplikeitid]	*a.*	复杂的
clutch	[klʌtʃ]	*n.*	离合器
reversible	[riˈvəːsəbl]	*a.*	可逆的
Ro-Ro	[rəuˌrəu]	*a.*	滚装的（船）
application	[ˌæpliˈkeiʃən]	*n.*	应用，运用
vehicle	[ˈviːikl]	*n.*	交通工具，车辆
cater	[ˈkeitə]	*vi.*	满足（需要）
diameter	[daiˈæmitə]	*n.*	直径
gearbox	[ˈgiəbɔks]	*n.*	变速箱
collar	[ˈkɔlə]	*n.*	环，轴衬，法兰盘
accommodate	[əˈkɔmədeit]	*vt.*	调节，向……提供，容纳
		vi.	适应
reliably	[riˈlaiəbli]	*ad.*	可靠地
multiple	[ˈmʌltipl]	*a.*	多样的，多重的
ferry	[ˈferi]	*n.*	摆渡，渡船
manoeuvrability	[məˌnuːvrəˈbiliti]	*n.*	机动性，适航性
catamaran	[ˌkætəməˈræn]	*n.*	双体船，筏
screw	[skruː]	*n.*	螺丝钉，螺杆
flexibility	[ˌfleksəˈbiliti]	*n.*	弹性，挠性
grid	[grid]	*n.*	格子，栅格
pod	[pɔd]	*n.*	（包发动机或燃料的）外壳
land-based	[ˈlændbeɪst]	*a.*	基于岸上的
tug	[tʌg]	*n.*	拖船
barge	[bɑːdʒ]	*n.*	驳船，游艇
layout	[ˈleiˌaut]	*n.*	规划，设计，布局图
parallel	[ˈpærəlel]	*a.*	平行的，相同的
thrust bearing			推力轴承
thrust block			推力块
controllable pitch propeller (CPP)			可调螺距螺旋桨，调距桨

READING MATERIAL

Maintenance and Safety Aspects

When designing a new engine type, the maintenance and service aspects are of great importance. The safety aspects are of importance during the production, assembly, testing and installation of the engines at the licensees and the shipyards and, naturally, it is also of importance when the ship enters service.

This is also acknowledged by the licensees, the ship-owners as well as the relevant authorities, and issues relating to maintenance and safety are regularly brought into focus. In this respect, a working group has been established together with a major ship-owner for the purpose of evaluating and improving the safety aspects in service. In the following, examples are given to illustrate some improvements in this area:

Assembly of engine structure

The bedplate / frame box and cylinder frame / frame box assemblies have, in general, been designed using the "law of similarity", meaning that the forces applied, and thereby the dimensions of the bolts used in the joints, have been scaled in accordance with engine sizes. For the K90MC and K90MC-C engines, this meant that M64 bolts were applied in these locations. In terms of weight, the bolts, nuts and distance pieces for the assembly of bedplate and frame box was about 16.5 kg. As these components are carried and mounted by hand, it is easy to imagine that the working conditions are rather uncomfortable, especially when the components are to be lifted to high positions inside the crankcase, and thereby the safety conditions are affected. Therefore, it was decided to optimize this assembly in order to improve the working conditions. Detailed analysis, combined with tests carried out at one licensee, revealed that the assembly could be changed. First of all, the strength of the bolt could be utilized better and, secondly, the total assembly force was adjusted. Thus the bolt size was reduced from M64 to M48 for the K90MC and K90MC-C. The main target was to unify the bolt sizes used on all large bore engines. Also the distance pieces have been unified, which means that the working conditions during assembly of the engines have been improved and, at the same time, the production conditions have also been improved in terms of a reduced number of component variants. For the K90MC, the total weight of the bolt, nut and distance piece for assembling the bedplate and the frame box was almost halved, i.e. to 8.4 kg.

Engine galleries

The arrangement of the galleries is important with a view to providing optimum conditions for the general operation and overhaul work on the engines. For large bore engines, this is particularly relevant in order to achieve comfortable and safe working conditions. When designing the S80MC-C which is the engine with the longest stroke in the entire engine programmed, this issue was obvious. For this engine, the distance from the top of the cylinder frame, where the upper gallery is normally located, to the top of the cylinder cover was increased from 1.800 mm to 2.400 mm approximately. Because of this change, it was natural to rearrange the locations of the galleries. On the S80MC, the galleries are located as is normal for large bore engines, i.e. the uppermost gallery is located at the top of the cylinder frame with steps at each cylinder to gain access to the cylinder covers and exhaust valves. For the S80MC-C, an extra gallery is introduced, and the steps at each cylinder are omitted. The advantage is much better access to the fuel pump top cover and the components on the cylinder cover. The new uppermost gallery is accessible from ladders at both ends. Taking readings of exhaust gas temperatures is much easier, and it is not necessary to climb up and down the ladder for each cylinder. The working conditions during overhaul of exhaust valves, cylinder covers, pistons and cylinder liners are also improved very much, and good access is obtained. Furthermore, small platforms are located on the exhaust side of the cylinders. The platforms provide a safe working position instead of standing on pipes. Finally, the galleries are extended at the fore and aft ends of the engine. The extended galleries give direct and easy access to the exhaust receiver. It is not necessary to use a ladder at a high position when climbing inside the exhaust receiver. The rearrangement of the galleries was met positively by the licensees, ship-owners and classification societies. Consequently, this design will be extended to large bore engines where feasible.

Working conditions inside the crankcase

Safe working conditions inside the crankcase are also important, especially for large bore engines where the components are quite heavy, e.g. a main bearing cap for a K98MC weighs 2,100 kg. Finally, all surfaces inside the crankcase are oily, which makes the working conditions even more difficult. For that reason, initiatives have been taken to improve the working conditions. The number of steps and handles inside the crankcase has been changed and, in general, the distance between the handles is reduced to about 3.00 mm, thereby making climbing inside the crankcase easier. Further- more, steps have been introduced in the oil pan on the largest bore engines. The reason is that, for example on the S90MC-C, the height of the oil pan is more than 8.00 mm. On the K98MC/MC-C engines, the distance between the crosshead guides is more than 1.500 mm and, therefore, suitable holes have been made in the centre web plate to facilitate climbing from starboard side to port side also at the top of the crankcase. However, some licensees have claimed that the increased number of handles in the crankcase is too costly. Naturally, there is a general understanding of the importance of the safety aspects, and without jeopardizing safety; a design has been developed in which the handles have been replaced by standard ladders. As a result, the time for welding is reduced significantly. The ladders are easily mounted inside the crankcase and, with small modifications; the traditional platforms can be arranged on the ladders. In order to further improve the working conditions inside the crankcase, special platforms have been designed. The new platforms offer superior working conditions, such as during overhaul of main bearings, pistons, stuffing boxes, crosshead bearings, crankpin bearings, etc. With the new platforms, a floor is established from where the main part of the work can take place in a normal standing position, and even work at the high positions can be carried out rather conveniently. The platforms are easy to mount inside the engine. It only takes a few minutes to build the platforms, and with the improved working conditions, the total time for overhaul is reduced. The improved working conditions have been positively received by the ship-owners, and a large number of platforms have been ordered for existing engines in service. In order to further improve the working conditions inside the crankcase, special platforms have been designed. The new platforms offer superior working conditions, such as during overhaul of main bearings, pistons, stuffing boxes, crosshead bearings, crankpin bearings, etc.

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NEW WORDS AND EXPRESSIONS IN READING MATERIAL

shipyard	[ˈʃɪpjɑ:d]	*n.*	造船厂
acknowledged	[əkˈnɔlidʒid]	*a.*	公认的，认可的
illustrate	[ˈiləstreit]	*vt.*	举例说明，图解，阐明
bolt	[bəult]	*n.*	螺钉，螺栓
scale	[skeil]	*n.*	刻度，成比例
bedplate	[ˈbed,pleit]	*n.*	基座
assembly	[əˈsembli]	*n.*	总成，组装体
crankcase	[ˈkræŋkkeis]	*n.*	曲柄箱
frame	[freim]	*n.*	机架
unify	[ˈju:nifai]	*vt.*	统一，使成一体
variant	[ˈvɛəriənt]	*a.*	不同的
		n.	变量
feasible	[ˈfi:zəbl]	*a.*	可行的，切实可行的
initiative	[iˈniʃiətiv]	*n.*	想法，意图
jeopardize	[ˈdʒepədaɪz]	*v.*	危害
overhaul	[ˌəuvəˈhɔ:l]	*v.*	检查，大修
mount	[maunt]	*n.*	装配
		vt.	装上，设置，安放
crosshead guide			十字头滑块

LESSON TWO Working Principle of Diesel Engines

Four stroke cycle diesel engines

The events of each of the four stroke cycle diesel engine are suction, compression, expansion and exhaust. Starting with the piston at the top of the cylinder, the induction stroke is performed as the piston moves down. During this stroke the inlet valve remains open and a charge of air is drawn into the cylinder. The piston then returns to the top of the cylinder whilst both inlet and exhaust valves remain closed and the charge of air is compressed. The compression raises the temperature of the air and as the piston reaches the end of this stroke, a controlled amount of fuel is injected into the cylinder in the form of a fine spray. On coming into contact with the hot air the fuel ignites causing a rapid rise in pressure which drives the piston downwards on the expansion stroke. As the piston reaches the bottom of the cylinder for the second time the exhaust valve is opened and during the upward and fourth stroke the hot spent gases are expelled through it.

If the charge of air entering the cylinder during the induction stroke is drawn in by the piston movement only without being assisted in any way, then the engine is said to be naturally aspirated.

The power of any diesel engine is determined by the amount of fuel that can be burnt in each cylinder per cycle and the speed at which it can be run. The rotational speed is limited by the forces arising from the inertia of the moving parts. In the case of a naturally aspirated engine the amount of fuel that can be burnt is limited by the mass of air drawn into the cylinder during the induction stroke. Diesel fuel requires about 14.5 times its own mass of air for complete combustion. The time available for combustion in the diesel cycle is very short; if only the chemically correct amount of air were provided, the fuel would not have time to burn completely and, in practice, almost twice this quantity is found to be necessary.

The cylinder can be charged with a greater mass of air by supplying it under pressure. The air is pressurized in a compressor, sometimes termed a blower, and fed to the induction manifold of the engine. The process is called pressure charging or supercharging.

In some special cases the compressor is driven mechanically from the engine crankshaft. More usually, some of the energy present in the exhaust gas is utilized by passing it through a turbine which is directly coupled to a centrifugal compressor. The compressor and turbine together form a free running unit, separate from the engine, known as a turbocharger.

The pressure of the air in the inlet manifold to the cylinders of a turbocharged engine is termed the boost pressure. In engines having a high boost pressure the air leaving the compressor is hot and it is beneficial and sometime, necessary to cool it as this assists in increasing the mass of air filling the cylinders and in keeping the internal parts of the engine cool. The air is cooled by passing it through an intercooler. The quantity of air provided by turbocharger is so great that the amount of fuel that can be burnt in each cylinder per cycle (and hence the power) is not limited on this account but by the temperature which the exhaust valves, cylinder heads and pistons can withstand.