英汉对照石油科普丛书

石油产品应用

石 油 工 业 出 版 社

出版说明

英国石油公司出版的《Our Industry Petroleum》一书，迄今为止已重版（包括修订）了五次。这本书对于刚刚投身石油事业的工作者，对于希望概括了解石油工业结构、历史和各个生产部门情况的人士，起到了指南的作用。

我社以此为蓝本，按章（或几章）分册出版这套“英汉对照石油科普丛书”，旨在向自学英语的同志，特别是石油系统广大职工和有关院校的学生提供一套全面介绍石油基本知识的英语读物。这套丛书计划出十二个分册。每一分册约3～5万字，并尽可能配用与内容密切联系的插图。为便于读者自学，除采用英汉两种文字相互对照的形式外，还对英语中某些语言难点（包括复杂的句子结构、短语等）作了必要的注释。因此，凡具有相当于理工科大学二年级英语水平的读者，都可以毫无困难地阅读这套丛书。为了保证丛书的质量，每一分册都先由熟悉专业的同志提供通顺可诵的准确译文，然后统一请南京大学大学外语部的教师对译文作进一步校订，并加做必要的语法注释。但能否真正收到预期的效果，则要由读者作出评定了。我们衷心希望能得到广大读者的批评、指正。

石油部科技情报所的张淼同志，倡导并协助我社组织了“英汉对照石油科普丛书”的编译工作，在此再次表示感谢。

Contents 目　　录

FUELS AND LUBRICANTS FOR PETROL AND DIESEL VEHICLES

In the last seventy or so years, during which the whole concept of transport has undergone a radical revolution, petrol and diesel engines have achieved their notable dominance largely because two suitable liquid fuels, petrol and diesel fuel, have been widely and consistently available *(Petrol is known also as gasoline and motor spirit; [1]diesel fuel is known also as gas oil and, in the United Kingdom, as Derv.)

*These two systems, petrol and diesel, [2]convert the latent chemical energy of their fuels to useful power by hurning them inside the engine; for that reason, the generic term for both types of engine is ***internal-combustion*** engine. Gas turbines, which have so far been used to only a limited extent as power units for land transport, are also internal-combustion engines, *as is the rotary piston engine–the Wankel engine–though this, too, has so far failed to make a serious impact as a vehicle power unit. [3]Gaseous fuels are also suitable for use in internal-combustion engines, but practical difficulties relating to the storage of gases have discouraged their use for vehicular applications.

In essence, the mechanical designs of both petrol and diesel engines are very similar. * Both have pistons and cylinders connected to a flywheel by a crank-shaft,[4] which converts the reciprocating action of the piston to the rotary action needed to power the driving wheels of the vehicle,

Horizontal and vertical designs exist in both diesel and petrol engines, and both single-cylinder and multi-cylinder versions exist in both forms. The multi-cylinder versions may have their pistons in a row (in-line), in two rows (vee), in a circle (radial) or have two pistons in one cylinder (opposed pistons). A major variation in design, found in both petrol and diesel engines, is the *two-stroke*, in which combustion takes place at every complete cycle of the piston, *as distinct from the more conventional *four-stroke* engine,[5] in which combustion takes place* in every alternate cycle.[6]

The most significant difference between the petrol and the diesel engine is the way in which combustion is achieved. In the petrol engine a mixture of petrol and air is compressed in the cylinder and then ignited by an electric spark. In the diesel engine only air is compressed in the cylinder* and to a much higher pressure than in the petrol engine. [7] When the air is fully compressed diesel fuel is injected into the combustion chamber where it ignites spontaneously due to the heat that has been generated by compression of the air,

The higher pressures and temperatures of the diesel engine mean that a heavier and more costly engine is necessary for a given power output; nevertheless, because of the higher pressures and temperatures utilised, better efficiency is achieved. Consequently, if the greater weight and higher initial cost of the diesel engine can be tolerated, users gain a distinct benefit in the form of lower operating costs. Because of its robust construction, the diesel engine often lasts longer between major overhauls and gives less trouble with minor breakdowns, * though when breakdowns do occur specialised attention is usually necessary, even for relatively minor troubles. [8]

Petrol engines are usually chosen as the power unit for private cars, small vans, motor cycles and motor boats; the diesel engine, on the other hand, is preferred for most commercial-transport applications, comprising buses, taxis, trucks, tractors and rail traction.

FUEL FOR THE PETROL ENGINE

Fuel from the vehicle's tank is pumped to the carburettor, *at which point it is partly atomised, partly vaporised and is mixed with the air. *This mixture of fuel and air then flows to the combustion chamber, where it is pressurised and ignited. Petrol must volatilise, ignite easily and burn progressively to ensure smooth combustion and efficient engine performance. The principal fuel characteristics that influence engine performance are octane number and volatility.

OCTANE NUMBER

Normally the combustion of the fuel-air mixture is smooth and progressive as the flame-front advances evenly from the spark-plug across the combustion chamber. However, since the combustion pressure is high, the mixture may "explode" spontaneously, *giving rise to a metallic knocking sound ("knock") and to a loss of power. [10*] The higher the compression ratio of the engine, the greater this tendency is, [11] but knock can be avoided by using fuels with good knock resistance. The knock resistance of a fuel can be determined by a number of different methods, including an internationally accepted procedure employing a single-cylinder laboratory test-engine known as the CFR engine; CFR* stands for[12] Co-operative Fuels Research. The compression ratio of this engine is increased progressively until knock occurs in the fuel under test. *The engine is then run at the same compression ratio using a number of reference fuels of known knock resistance until one is found that knocks to the same extent as the test fuel.[13] The reference fuels are blends of normal heptane, which knocks very badly, and *iso*-octane, which has a very good knock resistance and is given the arbitrary rating of 100. The reference fuel is classified by the percentage of *iso*-octane in the blend; for example, a reference fuel comprising ninety per cent *iso*-octane and ten per cent normal heptane would have an octane rating of 90. If the knock level of the fuel being tested is matched by a reference fuel with an octane rating of 90, the fuel is then said to have a Research octane number (RON) of 90, * and similarly for other octane levels.[14]*Commercial fuels of the required octane number are produced by blending selected fuel components produced by a number of refinery techniques and by the addition of small amounts of tetra-ethyl-lead and/or tetra-methyl-lead, both of which have particularly good knock-depressant properties.[15] An octane rating scale above 100 is obtained by adding given amounts of tetra-ethyl-lead to iso-octane.

The octane number obtained with the CFR engine, *though it is useful for comparing fuels under standard conditions,[16] does not always accurately predict the anti-knock performance of the fuel in use on the road in multi-cylinder engines. Tests are therefore carried out on the road or on vehicle dynamometers to determine the actual road anti-knock performance of the fuel. Various techniques have been devised for correlating these results with the Research octane number determined by the CFR engine. One method favoured in Europe is the front-end octane approach in which only the portion of the fuel that vaporises below a given temperature is tested in the CFR engine. *At low engine speeds fuels with a Research octane number of the fraction distilled to 100°C of about eight less than the Research octane number obtained on the total volume of fuel usually give knock-free performance, provided the RON level also meets the requirements of the engine.[17] The CFR engine and the test procedure are slightly modified to give a better comparison than RON for knock behaviour in vehicle engines operating in the mid and upper speed ranges. With this method, which is known as the Motor

Method, a Motor octane number of 10 to 12 below the Research octane number usually ensures a satisfactory performance for road vehicles.

VOLATILITY

petrol must vaporise adequately to form a readily combustible mixture in the combustion chamber, but it must not be so volatile that it turns into a vapour in the fuel system.* If it does, stalling will result, owing to the phenomenon known as *vapour lock*.[18] This condition occurs when the under-bonnet temperature is particularly high,* as may be the case[19] in hill climbing, slow driving in dense city traffic or when caravans or boats are being towed. To avoid vapour lock, the volatility of the fuel is controlled* in terms of a minimum volume of vapour to a unit volume of liquid[20] at a temperature that is selected to be appropriate for the ambient temperatures and motoring conditions of the locality in which the fuel is sold.

Volatility also affects carburettor icing, a phenomenon that also leads to stalling; it is caused by the latent heat of vaporisation of the fuel in the carburettor. The chilling effect produced by vaporisation of the fuel freezes any moisture present in the air and causes ice to form on the carburettor and throttle butterfly valve. Carburettor icing is particularly likely to occur at temperatures of about 40°F and in conditions of high humidity. It can be minimised by the use of appropriate freezing-point depressants or surface-active additives,* which are usually incorporated in premium petrol where climatic conditions would otherwise lead to carburettor icing. [21]

FUEL FOR THE DIESEL ENGINE

Diesel fuel is drawn from the vehicle's tank by a lowpressure pump that feeds it to a high-pressure injection pump. A filter is usually placed between the low-pressure pump and the high-pressure pump to remove all traces of road dust and tank rust that would otherwise damage the precision components of the high-pressure pump. This pump forces the fuel through an injector, breaking it into a spray of fine droplets that ignite spontaneously in the hot compressed air of the combustion chamber.

The most important charactoristics of diesel fuel are its properties* in regard to[22] combustion and lowtemperature flow.

CETANE NUMBER

Unlike the petrol enging, in which spontaneous ignition must be avoided, the diesel engine is specifically designed to operate on the principle of spontaneous ignition; for this reason, it depends on fuel that ignites spontaneously and burns rapidly. This rapid burning and the resultant sharp rise of pressure in the cylinder give the diesel engine its characteristic sound. Diesel engines are designed and built to withstand the rapid combustion that* is characteristic of[23] this principle, and the performance of the fuel is rated by its ability to produce this typical rapid spontaneous combustion. As will be seen, this is almost the complete reverse of the approach used to evaluate combustion properties of petrol.

A single-cylinder variable-compression-ratio testengine is used for rating diesel fuel; it is known as the CFR Diesel Engine. The reference fuels employed are blends of normal cetane and heptamethyl nonane. The cetane number of the test fuel is derived from the percentage of cetane in the reference fuel* that has ignition properties similar to those of the fuel on test.[24] *The cetane number of a diesel fuel is exactly analogous to the octane number of a motor gasoline, both as regards its role as an indication of road performance and as regards its method of determination.[25]

An indication of the combustion properties of the diesel fuel may also be obtained from its physical characteristics. Diesel Index and Cetane Index are parameters which are used for this purpose,* the former being derived mathematically from the fuel's gravity and aniline point, and the latter from the gravity and volatility.[26] In general, a figure of 50 or above for either Diesel Index or Cetane Index indicates that the combustion characteristics or ignition quality (cetane number) of the fuel is satisfactory. Conversely, values of 40 or less indicate that the fuel is unlikely to burn satisfactorily in a diesel engine. This is particularly true in cold climates, where a combination of poor ignition quality and low temperatures may result in starting difficulties and excessive noise and white smoke formation. Cetane Index is rapidly* gaining favour over[27] Diesel Index since, in general, it has been shown to give a better prediction of cetane number.

LOW TEMPERATURE FLOW CHARACTERISTICS

The desire to attain high cetane number for good diesel combustion can lead indirectly to problems in another area of diesel fuel performance. High cetane numbers* are consistent with[28] fuels containing high proportions of paraffinic components which, at low temperatures, tend to crystallise from the fuel as wax. The temperature at which this crystallisation starts is called the CLOUD POINT, since the fuel assumes a hazy appearance due to the small wax crystals. On further cooling the crystallisation progresses until eventually the crystals link together in a lattice and prevent fuel flow. *The temperature 3 degC above that at which a fuel fails to flow in a standard test tube is called the POUR POINT.[29]

The presence of wax in a diesel fuel system is naturally a hazard since it clogs filters and fuel lines thereby restricting or preventing fuel flow to the engine. Most systems, however, will function. even though a small quantity of wax may be out of solution. The actual temperature at which a fuel system fails to operate can be predicted by the Cold Filter Plugging Point (CFPP) of the fuel, which is the temperature at which a fuel fails to pass through a fine mesh filter under controlled laboratory test conditions.*CFPP is rapidly gaining acceptance, particularly in Europe, as being the most relevant parameter controlling diesel fuel low temperature flow characteristics.[30]

LUBRICANTS FOR PETROL AND DIESEL ENGINES

Since the mechanical features of both types of engine, petrol and diesel, are broadly similar, most of the fundamental requirements of an engine lubricant *apply equally to both.[31]Oil is circulated