

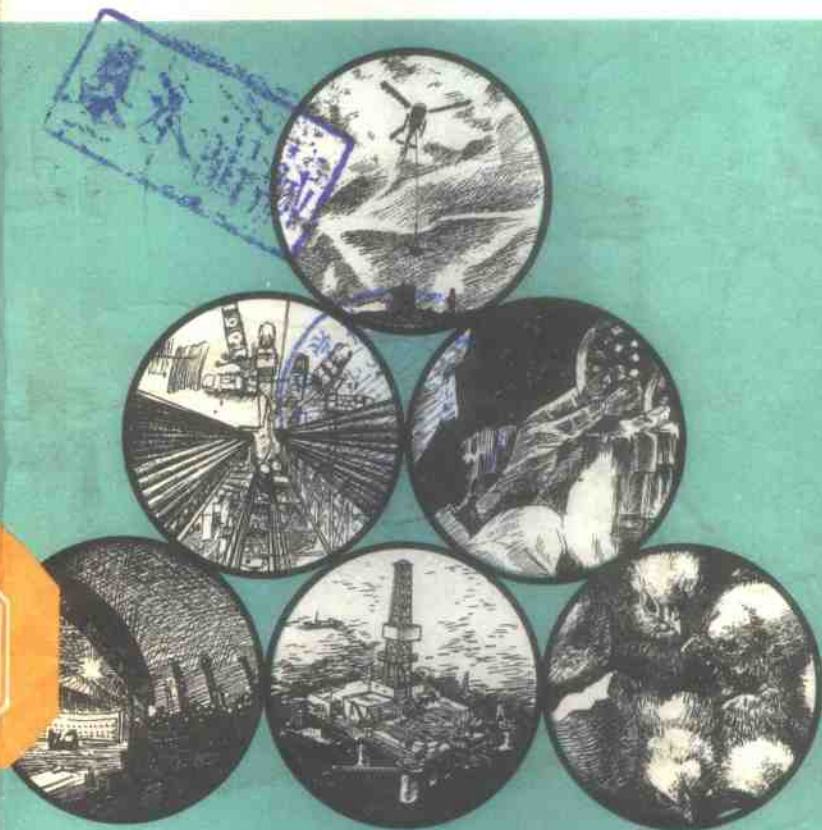
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英汉对照石油科普丛书

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# 石油及其产品



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石油工业出版社

英汉对照石油科普丛书

## 石油及其产品

顾惠达 译注 谭美华 校

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## 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）分册出版了这套“英汉对照石油科普丛书”，旨在为石油系统各院校的学生和自学英语的同志，提供有关石油基本知识方面的英语读物。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。为利于读者自学，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）做了必要的注释。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焱同志，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。

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## THE CHARACTER OF CRUDE OIL

### DEFINITION

The raw material of our industry, \*referred to as crude oil or petroleum<sup>1</sup>, is the naturally occurring rock oil which accumulates in underground oilfields in many parts of the world. The term crude oil is restricted to liquid mixtures of hydrocarbons and related compounds, which are capable of flowing up a well-pipe, either under the pressure existing in the reservoir, or with the mechanical assistance of bottom-hole pumps, or by gas lift.

\*Excluded from this definition are other forms of hydrocarbon accumulations<sup>2</sup>, such as natural gas and the associated relatively volatile liquid hydrocarbons, called gas condensates. The gas condensates can be completely distilled, whereas crude oils cannot, because they contain a proportion of very high molecular weight constituents, which are involatile in commercial practice, and are referred to as residual components, or the residue. At the other end of the scale, shale oil which can only be recovered from shale rock by strong heating is excluded \*as, also, are the highly viscous, semi-solid hydrocarbon deposits found in the form of bituminous tar sands, e. g. those at Athabasca in Alberta, and as pitch-lakes<sup>3</sup>,

e. g. in Trinidad.

Crude oil in world trade, after the release of associated gaseous components at atmospheric pressure, is a free-flowing liquid at, or slightly above, normal ambient temperatures, having a density within the nominal range 0.780 to 1.000kg/litre at 15°C.

### CRUDE OIL COMPOSITION

Crude oils are complex mixtures of a vast number of individual chemical compounds. At the outset, \*it must be emphasised that every separate accumulation of oil is a unique mixture<sup>4</sup>, not matched exactly in composition or properties by any other sample of crude oil<sup>4</sup>. This uniqueness even applies to the crude oils which are nominally found in a particular oilfield if, in fact, the field is made up of several unconnected zones in individual strata or locations.

This situation arises because, although crude oils consist of mixtures of the same families, or series of chemical compounds, the differences reflect variations in the relative proportions of each of such series in a particular crude oil.

The picture is even more complex, \*since within each series, each compound containing a given number of specific atoms in its molecule, can have these atoms arranged<sup>5</sup> in a predictable number of different, three-dimensional spatial positions; these different arrangements of the atoms describe the isomeric variations, or



isomers, of the basic compound which can exist. Each isomer has slightly different physical and chemical properties from its fellows while, at the same time, exhibiting the general properties of the series. \*For example, in the series of hydrocarbon compounds called alkanes (paraffins) the variations in the ways of arranging the carbon atoms, giving individual isomers, as the series ascends from molecules containing 4 to 40 carbon atoms, is as follows<sup>6</sup> (leaving out some intermediates):

<i>NO. carbon atoms</i>	<i>NO. isomers</i>	<i>NO. carbon atoms</i>	<i>NO. isomers</i>
$C_4$	2	$C_{34}$	35
$C_5$	3	$C_{35}$	355
$C_6$	5	$C_{36}$	4 347
$C_7$	9	$C_{37}$	36 797 588
$C_8$	18	$C_{38}$	62 491 178 805 831

\*When it is considered that petroleum contains mixtures of at least five identifiable series of hydrocarbons, each with members having up to more than 50 carbon atoms<sup>7</sup>, the scope for variability in this naturally occurring material is apparent.

## CHEMISTRY

Over the years since 1859, when the modern commercial exploitation of crude oil began, a very wide range of analytical techniques has been, and still is being applied, to elucidate the chemical composition of petroleum.

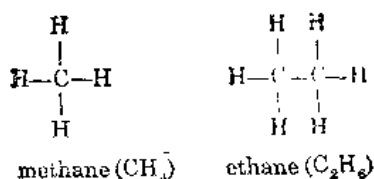
Some of this effort has been directed towards characterising individual molecular types, \*to gain insight into the origin of petroleum<sup>8</sup>, \*some towards improvements in product quality and refining technology<sup>9</sup>, and some to give additional information for the engineering design of processing plants. In another direction, the petroleum chemical side of the industry has evolved on the basis of the known constituents of crude oil, to manufacture a wide range of synthetic products, by extraction and transformation processes.

### **HYDROCARBON SERIES**

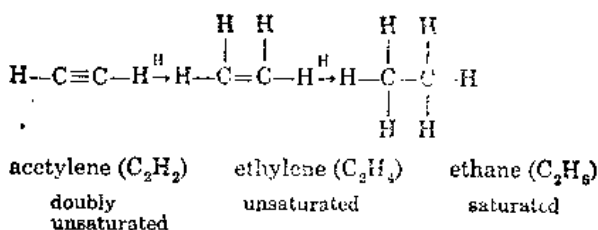
The bulk of the compounds present in petroleum are composed solely of the elements hydrogen (H) and carbon (C), \*termed hydrocarbons<sup>10</sup>. The carbon atom has four valency linkages available for attachment to

other atoms (depicted— $\overset{|}{\underset{|}{\text{C}}}$ —) and, in the simplest hydro-

carbon compound methane( $\text{CH}_4$ ), these are all attached to separate hydrogen atoms. A feature in the chemistry of carbon, however, is the stable nature of compounds containing large numbers of carbon atoms linked to each other, \*forming chain-and ring-like structures<sup>11</sup>. In the various series of hydrocarbons, methane can be considered as a building-block for the addition of a carbon atom to a chain or a ring, with the elimination of two atoms of hydrogen for each carbon atom introduced, e. g.



Where<sup>12</sup> the attachment is by one linkage from each carbon atom to the next, and the remaining linkages are attached to hydrogen atoms, 'as in ethane above'<sup>13</sup>, the hydrocarbon has no spare linkages and is termed saturated. Two carbon atoms can join to each other, however, by Sharing two and three of their Linkages, forming series of unsaturated compounds, which can be transformed to the saturated form by the chemical addition of hydrogen, e. g.



Unsaturated hydrocarbons are very rarely present in naturally occurring petroleum, but are present in the products from some refining processes, and are manufactured to form one class of raw material for the production of petroleum chemicals.

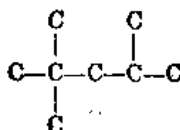
#### (a) ALKANE SERIES

The two alkane series (formerly called paraffins),

are composed of chains of linked carbon atoms,\* a distinction being made<sup>14</sup> between normal-alkanes containing only straight carbon to carbon chains, and their corresponding isomeric, branched-chain forms, called iso-alkanes. Both series have the general composition  $C_nH_{2n+2}$ , and the names of the individual members end with "ane", such as methane, ethane, propane, e. g. (showing only the carbon links);



normal-octane ( $C_8H_{18}$ )



iso-octane ( $C_8H_{18}$ )

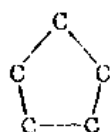
Alkanes represent a large proportion of the hydrocarbon present in many crude oils. The normal-alkanes series is the more abundant, with indications that all the individual members are present in petroleum in the range  $C_1$  to  $C_{78}$ . While<sup>15</sup>, theoretically, the branches in the iso-alkanes could be several or many carbon linkages long, \*it is characteristic of the iso-alkanes found in petroleum that they are predominantly those with single carbon atom (methyl) branches<sup>16</sup>.

An indication of the relationship between the number of carbon atoms in the molecule and the boiling points of the alkanes is given in Fig. 1, \*showing that

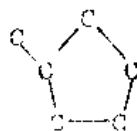
an iso-alkane has a lower boiling point than the corresponding normal-alkane<sup>17</sup>.

### (b) CYCLO ALKANE SERIES

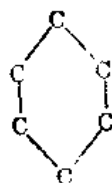
Two series of saturated hydrocarbons having carbon atoms linked in ring-like central structures predominate in petroleum, these are the cyclo-pentane series having five carbon atoms in the ring, and the cyclo-hexanes having a six-membered ring. The general formula for cyclo-alkanes (formerly called naphthenes), is  $C_n H_{2n}$ , and each series ascends by the addition of branches of carbon atoms to the outside of the ring, e. g.



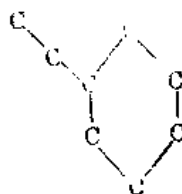
cyclo-pentane  
( $C_5H_{10}$ )



methyl-cyclo-pentane  
( $C_6H_{12}$ )



cyclo-hexane  
( $C_6H_{12}$ )



ethyl-cyclo-hexane  
( $C_8H_{16}$ )

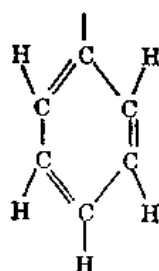
The relationship between boiling point and the number of carbon atoms per molecule of the cyclo-alkanes lies between n- and i-alkanes in Fig. 1. (見103頁)

Ring structures with lower and. higher numbers of carbon atoms in the ring do exist in minor proportions in crude oils.

Members of both the cyclo-pentane and cyclo-hexane series, \*other than<sup>18</sup> cyclo-pentane itself, can be made to release hydrogen atoms in certain refining processes, transforming the cyclo-alkanes into aromatics,described below.

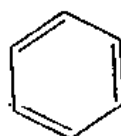
### (c) AROMATICS SERIES

The simplest member of the aromatics series is benzene, composed of a ring of six carbon atoms, with six associated hydrogen atoms, \*leaving three pairs of unsaturated carbon bonds between members in the ring<sup>19</sup>, e. g.



benzene  
( $C_6H_6$ )

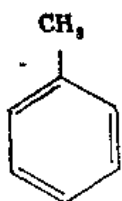
usually shown  
as



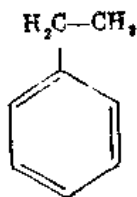
benzene  
( $C_6H_6$ )

Several series of aromatic compounds exist in petroleum, which are related to benzene in different ways.

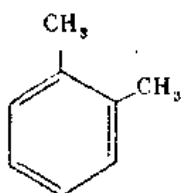
\*The progressive substitution by alkanes of the hydrogen atoms on the outside of the ring forms the alkyl benzene series, e. g<sup>20</sup>.



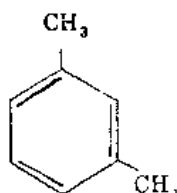
toluene  
( $C_6H_5, CH_3$ )



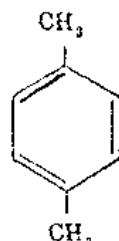
ethyl benzene  
( $C_6H_5, C_2H_5$ )



1,2- dimethyl  
benzene  
(ortho-xylene)

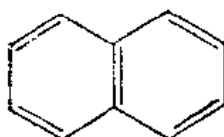


1,3- dimethyl  
benzene  
(meta-xylene)  
All  $C_6H_4, (CH_3)_2$

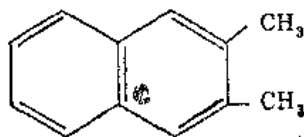


1,4- dimethyl  
benzene  
(para-xylene)

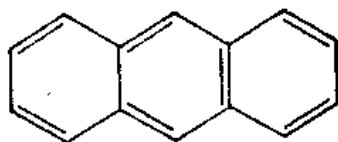
Compounds sharing two or more benzene rings also form series by substitution of the hydrogen atoms on the outside of ring, e. g.



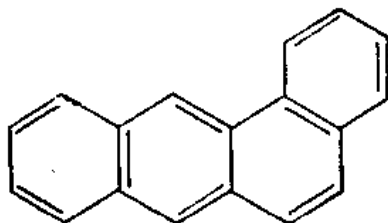
naphthalene  
( $C_{10}H_8$ )



2,3- dimethyl  
naphthalene  
( $C_{10}H_8, (CH_3)_2$ )



anthracene  
( $C_{14}H_{10}$ )



1,2- benzanthracene  
( $C_{18}H_{12}$ )

The boiling range/carbon number relationship of the aromatics series is shown on Fig. 1.

### ***NON-HYDROCARBON SERIES***

In addition to compounds containing only carbon and hydrogen, petroleum generally contains relatively small proportions of the elements sulphur, nitrogen, oxygen, vanadium and nickel, which are chemically attached to hydrocarbon-like chains and rings.

#### **(a) SULPHUR COMPOUNDS**

Crude oils vary considerably in sulphur content<sup>11</sup>, ranging from less than 0.1 per cent weight sulphur up to about 7 per cent weight sulphur<sup>12</sup>. These figures refer to sulphur atoms which are chemically attached to



carbon atoms in hydrocarbon-like structures, and exclude the gas hydrogen sulphide ( $\text{H}_2\text{S}$ ), which is associated with some crude oils within the reservoir; arrangements are normally made to remove hydrogen sulphide from crude oil along with the light hydrocarbon gases, during the gas separation stage of production.

The following series of sulphur compounds have been identified in crude oils, where R in the structural formula refers to alkane radicals such as ethyl ( $\text{C}_2\text{H}_5$ ), butyl ( $\text{C}_4\text{H}_9$ ), etc.:

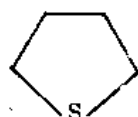
Alkane thiols

(formerly called mercaptans)  $\text{R}-\text{S}-\text{H}$

Thia alkanes

(formerly called sulphides)  $\text{R}-\text{S}-\text{R}$

Thia cyclo alkanes



thia cyclo-pentane

( $\text{C}_4\text{H}_8\text{S}$ )

Dithia alkanes

(formerly called disulphides)  $\text{R}-\text{S}-\text{S}-\text{R}$

Cyclic sulphides, e. g.