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NOMENCLATURE IN THE PETROLEUM INDUSTRY

Crude oils, complex mixtures of naturally occurring organic liquids, are difficult to characterize in detail. Thus, many of the definitions used by the exploration, production, and refining sectors of the petroleum industry to describe petroleum and its products often lack precision. Even the term petroleum is poorly defined. Although often used synonymously with crude oil, petroleum is also frequently used to include natural gas (see Gas, natural) and even solid hydrocarbons. Definitions of materials are commonly given in terms of the processes used to obtain them. Gasoline, for example, is the fraction of crude oil that distills between 15 and 200°C (60 and 392°F) (see Gasoline and other motor fuels). Further complications arise because different parts of the petroleum industry use terms in differing ways. For example, wax may refer to material made up predominantly of long-chain alkanes, or it may refer to esters of long-chain alcohols and acids (see Waxes). Even the term hydrocarbons (qv) is used loosely indicating all the compounds in crude oils, whether or not these include compounds of nitrogen, sulfur, and oxygen.

In nature petroleum occurs in subsurface accumulations, or reservoirs, called fields that may be made up of one or more pools. Petroleum compositions vary widely and range from hydrocarbon-rich gases called natural gas, through crude oil liquids, to high molecular weight solids known as reservoir bitumen, residual oil, or tar. Petroleum is generated from kerogen, the high molecular weight, insoluble organic material in source rocks. High subsurface temperatures convert the kerogen to a petroleum-like range of compounds called bitumen. Part of this bitumen moves out of the source rock, in the process of expulsion or primary migration, and moves through permeable rocks to accumulate in a reservoir (secondary migration). The petroleum engineering procedures for bringing this petroleum to the surface are called production.

Traditionally the unit of crude oil production has been the barrel (bbl), equal to 42 U.S. gallons, 5.61 ft^3, 158.8 L, or 0.159 m^3. Increasingly petroleum reserves are given in metric tons, but because one unit is a volume and the other a weight, there can be no unique conversion factor for a material having a range of densities. Fields of $>500 \times 10^6$ bbl (79.5×10^6 m^3) of recoverable oil ($>100 \times 10^6$ bbl (15.9×10^6 m^3) in the U.S.) are called giants. Oil density may be reported in any appropriate units, and although metric units are used it is more common to report densities as degrees API (°API) or API gravity, where API stands for American Petroleum Institute. The relationship between density and API gravity is an inverse one defined by the following relationship:

$$^{\circ}\text{API} = \left[141.5/\text{specific gravity at}60^{\circ}\text{F}\right] - 131.5$$

Water corresponds to an API gravity of 10; crude oils fall between 10 and 60°API. The most common crude oil values are in the 35–40° range.

Other terms relating to physical properties include viscosity; refractive index; pour point, ie, the lowest temperature at which the oil flows; flash point, ie, the temperature at which the oil ignites; and aniline point, ie, the minimum temperature at which equal volumes of oil and aniline are completely miscible. These are determined under defined conditions established by ASTM.

Table 1. Generalized Distillation Ranges for Products Obtained During Crude Oil Refining

Product	Temperature range, °C	Carbon number range
gasoline	30–210	5–12
naphtha	100–200	8–12
kerosene and jet fuel	150–250	11–13
diesel and fuel oils	160–400	13–17
atmospheric gas oil	220–345	
heavy fuel oils	315–540	20–45
atmospheric residue	≥ 450	30+
vacuum residue	≥ 615	60+

Natural gas production is generally given in cubic feet or cubic meters ($1000\ ft^3 = 1\ Mcf = 28.3\ m^3$). Reserves of a trillion cubic feet (Tcf) ($28.3 \times 10^{12}\ m^3$) or more form a giant gas field. Natural gas is called dry when methane is the dominant hydrocarbon, and wet if it contains more than 4 L/100 m^3 of natural gas liquids (>0.3 gal/1000 ft^3). When gas (or oil) has a bad odor owing to high concentrations of hydrogen sulfide and volatile sulfur compounds it is called sour. Sweet gas has no noticeable odor. For statistical purposes gas is commonly reported as an equivalent amount of oil based on an equivalent heating capacity. The conversion is normally made using $170\ m^3\ (6000 ft^3 = 1\ bbl)$ and leads to a barrel of oil equivalent (boe).

Crude oils contain a wide range of hydrocarbons including straight and branched chains, ring compounds, and aromatics, as well as more complex compounds that incorporate nitrogen, sulfur, and oxygen (often called the NSOs), and some nickel and vanadium. The straight-chain, normal alkanes, range from 1 to >100 carbon atoms. These are often called paraffins in the petroleum industry because of the useful adjective paraffinic. Branched hydrocarbon chains that are nominally built up from repeated isoprene units (2-methyl butane structure) are called isoprenoids or terpenoids, and the 19- and 20-carbon compounds, named pristane and phytane, respectively, are frequently present in high concentrations. Isoprenoids also lead formally to saturated multiring structures. Petroleum chemists use the obsolete word naphthenes for the compounds that organic chemists call alicyclics. A better term, cycloparaffin, is used herein, leading to the adjective cycloparaffinic rather than naphthenic. Some of the characteristic structures in this group can be directly related to molecules synthesized by organisms. Whereas these have been called chemical fossils, it is more usual to call them biological markers or biomarkers. Common examples include the steranes and hopanes.

Aromatic hydrocarbons form a minor but important group of compounds in crude oils and range from single-ring to multiring compounds. The latter are called polycyclic aromatics (PAHs). Small aromatic molecules are environmentally significant and BTEX is commonly used as an abbreviation for benzene–toluene–ethyl benzene–xylenes. Multiringed compounds containing both aromatic and saturated rings may be referred to in the older literature as naphtheno-aromatics. The highest molecular weight fraction of crude oils commonly contains ashphaltenes that are dark in color, NSO-rich, and very aromatic.

Most crude oil is refined to provide useful products and the dominant process is distillation (qv) (Table 1). Petroleum products produced by simple distillation without the use of pressure, cracking, or catalysts are called straight run. Residual material that has too high a molecular weight to distill forms a residuum, often called by such names as asphalt (qv). Naphtha (unrelated to naphthenes) is a distillate of petroleum having a boiling range lower than about 200 or 260°C (even occasionally up to 350°C). As a process intermediate, naphtha includes the components used to formulate gasoline and the lighter grades of fuel oils such as kerosene and diesel fuel oil. As a finished product, naphtha usually denotes a more specific type of narrow boiling range material. The terms naphtha and solvent may be used interchangeably. For example, Varnish Makers' & Painters' (VM&P) naphtha has a range of 95–150°C. The majority of streams within a refinery designated as naphthas are straight-run materials, however the term can also be used for some cracked distillates.

A number of other words that have traditionally been used in the petroleum industry are difficult to define precisely. These refer partly to specific boiling ranges, but also to certain intended uses. Thus, gasoline boils lower than naphtha, and kerosenes generally higher, but these terms are applied to products that are intended as fuels, rather than as solvents.

Gas oil is a product boiling slightly higher (235–425°C, or sometimes wider) than kerosene. The main feedstock to the catalytic cracking units (see Feedstocks), it received its name from use as an enriching agent in the production of city or manufactured gas. It is often used as diesel fuel.

Cylinder oil is a viscous oil used for lubricating the cylinders and valves of steam engines (see Lubrication and lubricants). It is prepared from cylinder stock. The product from cylinder stock, when filtered and processed, is bright stock.

Cycle stock (recycle stock) denotes any product that is recycled, that is, taken back to an earlier stage in the process. The term cycle stock is also used for the gas oil-like product of catalytic cracking.

The word distillate is occasionally used by petroleum chemists with a specialized meaning. Although anything that has been distilled is, of course, a distillate, the term distillate is sometimes used to denote distillate fuel oil as opposed to residual fuel oil.

In the petroleum industry the International Union of Pure and Applied Chemistry (IUPAC) system is in widespread use for naming organic compounds. Two points, however, regarding group names and the prefix, iso, call for comment.

1. Group Names

Although the IUPAC system is effective in denoting any hydrocarbon, no matter how complicated, the system does not always result in convenient terms for groups of compounds. Because hydrocarbons having the same number of carbon atoms are apt to have boiling points within a small range, it would be convenient to have words that would refer to C_4, C_5, C_6, ... saturates, and C_4, C_5, C_6, ... monounsaturates, etc. The IUPAC system, however, goes by the number of carbon atoms in the longest straight chain. Thus, for example, the hydrocarbon referred to by the older systematic name of isobutane, when named in the IUPAC system is 2-methylpropane. However, for saturated aliphatic hydrocarbons, names such as butanes, pentanes, hexanes, etc, are taken as names in the older system, and therefore used as group names.

The situation is different when naming the ethylenic hydrocarbons, because the IUPAC has provided names such as propene, butene, and pentene, which are different from the former names ending in -ylene. However, butenes/butylenes, pentenes/pentylenes, etc, are not truly synonymous pairs, because the IUPAC name goes by the longest-chain rule. Isobutylene, named 2-methylpropene in the IUPAC system, would be included under substituted propenes, but not under butenes. Similarly the three pentylenes derived from isopentane are methylbutenes and not pentenes. For example, if it is necessary to denote the group of five isomeric monounsaturated hydrocarbons C_5H_{10}, the term pentylenes denotes this group, whereas pentenes denotes a narrower group having only two members, the two straight-chain pentylenes.

2. The Prefix Iso

In names such as isobutane, isopentane, isobutyl alcohol, and isoamyl alcohol, the prefix iso has a precise meaning, ie, one methyl group attached to the next-to-terminal carbon atom and no other branch. This notation is also frequently used by petroleum chemists to have a much wider meaning, denoting nothing more than branched-chain. If both meanings persist, any individual use of the prefix becomes ambiguous. Herein, an effort is being made to use branched-chain or just branched consistently for the looser meaning of iso, so that

this prefix can be kept for denoting concisely what otherwise would require some circumlocution. An exception is made for the well-established name isooctane, which is 2,2,4-trimethylpentane [540-84-1].

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