MINISTRY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF
TECHNICAL AND VOCATIONAL EDUCATION

PE-01011

PRINCIPLE OF PETROLEUM ENGINEERING

A.G.T.I(First Year)

Petroleum Engineering

CONTENTS

Chapter(1)

Development and Composition of Petroleum

1.1 Productive Formations

The earth's crust is composed of essentially of three types of rocks: igneous, metamorphic, and sedimentary. Although oil and gas are found in all three kinds of rocks, they are mostly associated with sedimentary rock. Sedimentary rocks come from a variety of sources, but in general are laid down on the earth by the action of wind or water, or through chemical deposition (like leaching). These sedimentary materials can be classified as (1) rocks (sand stone, shale), (2) carbonates (certain limestones) and (3) dolomites.

Although sedimentary rocks are associated with oil, not all sedimentary rocks contain oil. In order for petroleum to be present, most scientists theorize that the remains of plants and animal life, as well as the presence of certain temperatures and pressures, were needed. So how did this environment occur?

Early life began in vast sea and inland lake that covered large portions of the present continents. As the abundant populations of the marine plant and animal life died, their remains were buried rapidly and preserved in the slit and mud that continuously filtered down to the ocean floor.

Rivers carried great volumes of mud and sands to be spread by currents and tides over the ever-changing seashore line. This joined the marine life remains that settled to the bottom of the sea and deltas and were repeatedly buried. The mud and seawater protected the material from further decay. As more and more layers of organic material, sand, slit, clay and lime accumulated and time passed, the weight of the overlying sediments exerted great pressure on the deeper sedimentary layers. With the increasing weight of the accumulating sediments, the sea floor slowly sank, forming and preserving thick sequences of mud, sand, and carbonates. These eventually formed into sedimentary rocks. This tremendous pressure along with the high temperature, bacterial action and chemical reactions-caused the formation of crude oil and natural gas.

1.2 Composition of Petroleum

Petroleum is a liquid commonly called "*crude oil*". However, both natural gas and crude oil are often called petroleum. Neither natural gas nor crude oil is a single chemical compound both are mixtures of numerous compounds called *hydrocarbons.*

The organic material from which petroleum originated was composed of compounds based on the element carbon. During the distillation process, which created petroleum, hydrogen and carbon combined in various molecular sizes to form a family of hydrocarbons.

Each hydrocarbon is named for the number of carbon and hydrogen atoms in its molecule. Hydrocarbons are named using conventional chemical standards that are based on the Latin language. For example, the prefix "meth" in the name methane indicates the molecule contains one carbon atom.

Figure 1-1 is a simplified portrayal of a molecule of methane. Table 1-1 shows the names, compositions, and molecular weights of the first 12 hydrocarbon family compounds arranged in order of increasing molecular weight.

Petroleum is a mixture of the hydrocarbons shown in Table 1-1 as well as heavier hydrocarbons.

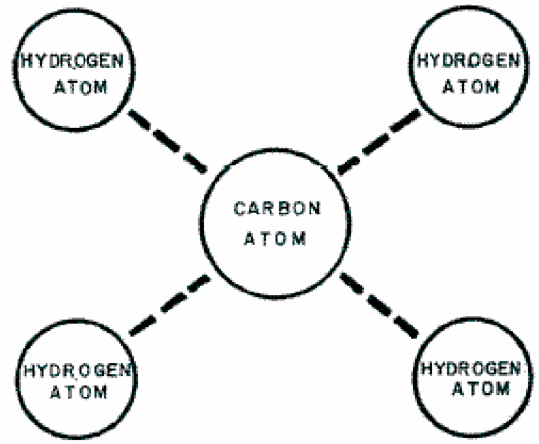

Figure1-1. A methane molecule is composed of four hydrogen atoms that are bonded to one carbon atom.

Table 1-1
Physical Constants of Hydrocarbons and Other Compounds

Hydrocarbons	Number carbon atoms	Molecular weight	Density (g/ml)	Boiling point (°F)	Viscosity (centipoises)
Methane	1	16.04	0.415	-258.7	
Ethane	2	30.07	0.561	-126.9	
Propane	3	44.09	0.585	-43.9	
Butane	4	58.12	0.600	31.1	
Pentane	5	72.17	0.626	97.2	
Hexane	6	86.17	0.660	156.2	0.401
Heptane	7	100.20	0.684	209.1	0.524
Octane	8	114.23	0.704	258.4	0.706
Nonane	9	128.25	0.718	303.4	0.711
Decane	0	142.28	0.730	345.2	0.920
Undecane	11	156.30	0.741	384.4	1.170
Dodecane	12	170.33	0.766	418.1	1.350
Other Compounds					
Carbon dioxide		44.01	1.287	-109.3	
Carbon monoxide		28.01	0.814	-310.0	
Hydrogen sulfide		34.08	1.002	-79.2	
Water		18.02	1.000	212.0	1.002

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1.3 States of Hydrocarbons

Hydrocarbons, like all other forms of matter, take various forms called "*states*". The state of a hydrocarbon is primarily dependent on pressure and temperature. Just as water can be in a solid, liquid, or gaseous state depending on pressure and temperature, so can hydrocarbon occur in different states.

At the pressures and temperatures beneath the earth's surface, the hydrocarbons methane through pentane take the form of gas; hexane and heavier hydrocarbons are liquids. At sea level atmospheric pressure and room temperature, methane through butane occurs as gas; pentane and heavier hydrocarbons occur as liquids.

1.4 Common Mixtures of Hydrocarbons

At the pressure and temperature conditions beneath the earth's surface, the petroleum product called produced gas is actually a mixture of methane, ethane, butane, propane, and some pentane. The mixture of pentane and heavier hydrocarbons is called crude oil.

Nature gas used by consumers is composed of methane with some ethane and butane. Liquefied petroleum gas (LPG) is principally butane or propane with some methane and ethane.

Motor fuel gasoline is composed of hexane through decane. Diesel fuel, home heating oil, and kerosene have octane, nonane, and decane as their principal components. Motor oil is a mixture of decane and heavier hydrocarbons. Road-paving asphalt is a mixture of the heaviest hydrocarbons, which are almost always in the solid state.

1.5 Energy Content of Hydrocarbon Mixtures

For use as an energy source, hydrocarbon mixtures are burned in a reaction called *oxidation*. The oxidation reaction converts hydrocarbons and oxygen into carbon dioxide, water, and other products while releasing energy in the form of heat.

The energy release occurs during oxidation when carbon and hydrogen combines with oxygen. Naturally, more energy is released when a great deal of carbon and hydrogen are involved in a reaction than when small amounts of carbon and hydrogen are involved.

1.6 Other Compounds Found in Petroleum

Petroleum deposits sometimes contain only hydrocarbons and a small amount of water. This type of petroleum deposit is valuable because little must be done to the hydrocarbons before they are usable as refinery feedstocks or as consumer fuel.

Hydrocarbon deposits often contain acid gases such as carbon dioxide and hydrogen sulfide. Gas containing hydrogen sulfide is called *sour* gas. Gas containing little or no hydrogen sulfide is called *sweet* gas.

Some liquid petroleum deposits contain sulfur compounds and are called *high-sulfur* crude.

Chapter(2)

Drilling Bits

CHAPTER 2

Drilling Bits

Drilling bit is the most important part in drilling. Rotary bits are tools which do the actual bearing or drilling of the hole into the formation. Numerous individual rotary bits designs are available from a number of manufactures. All are designed to give optimum performance in various formation types according to the ideas and experience of each company. The severity of drilling requires that precise control over steel quality and heat treatment be exercised.

Drilling bits will classify into four broad groups:

(1) Blade (or) Wing bits
(2) Disc Bits
(3) Rolling Cutter (roller bits)
(4) Insert matrix bits (or) Diamond bits

The bits of each group act on the rock in definite way causing the bind of deformation.

(2.1)Types of Bits

Before discussing about the drilling bits I want to express different types of bits. They are one of the main factors which to a considerable elements the bits are classified into three general types-

(1) Drag type
(2) Rolling cutter (roller bits)
(3) Diamond

(1) Drag Bits

Drag bits have no moving parts and drill by the shoveling action of their blades on the encountered formation. Their water courses are placed such that the drilling fluid is directed on the blades, keeping them clean. Bits of this type were once widely used for drilling soft, sticky formations, but in recent years have been largely replaced by rolling water types. The blades are manufactured from various alloy steels and are normally hard-faced with tungsten carbide.

This type of bits as shown in fig: (2.1).

(2) Rolling Cutter (roller bits)

There are many types of rolling cutter bits, design according to different kinds of formation. The first successful rolling cutter bit was designed by Howard R.Huges in 1909. In these type of bits, rolling cutter bits are most widely used all over the world. Because rolling bits are justified in many area where there long life and reduction in drilling cost.

Structurally the bits are classified as cone type bits and as cross-roller bits shown in fig: (2.2).

Row of teeth are cut into the rolling member, so that these bits are also referred to as toothed-wheel bits. The surface of bit teeth is covered with tungsten carbide, in order to obtain longer bit life. Hardness of steel used in rock bits in about six to seven (orthoclase feldspar or quartz). The tooth wheel rotate independently; as the drill string is rotated, the rolling cutter turn by virtue of their contact with the bottom of the hole. A recent adaptation for the drilling of very hard rock has been the substation of rounded tungsten carbide inserts in place of the teeth ordinarily cut on the rollers, and these lather bits are referred to as button bits shown in fig: (2.3). Depending on the design of their cutter, rolling cutter bit drill the rocks with crushing (rumbling) action, and chipping or combination of crushing chipping action. With respect to the size of the mud fluid discharge ports and their arrangement, the bits are generally classified as conventional or as jet bits.

(2.1) Jet Bits

Jet bits are rolling cutter bits which have been equipped with fluid nozzles. Each nozzles directs a high velocity fluid jet directly on the hole bottom which rapidly removes the cuttings. This allows each bits tooth to strike new formation rather than expend some of its energy in regrinding previously lessened chips. The pressure losses through these nozzles are considerable and require extra pump capacity.

Typical jet bit is shown in fig: (2.4).

(3) Diamond Bits

Diamond bits drill by a scraping, drag bit action of these stones which provide from a steel matrix. Their use is justified in many areas where their long life and the consequent reduction in trip time afford sufficient advantage to offset the higher bit cost. The actual cost of a diamond bit is the initial cost less, a salvage which is paid according to the weight of undamaged diamond remaining after the bit's use. This commonly ranges from 25 to 75 percent of the initial cost. Diamond bits are normally used in hard formations. There are two types of diamond bit and cone bit are shown in fig: (2.5) and (2.6)

(2.2) Influence of Factors on the Penetration Rate of Bit

Penetration rate of bit is influenced by the following factors;

(1) Types of bit
(2) Weight on the bit
(3) Properties of drilling fluid
(4) Hydrostatic pressure of drilling fluid
(5) Discharge flow rate
(6) Discharge pressure of the pump
(7) Depth of formation drilled
(8) Rotation of the bit.