

PETROLEUM

9.1 PETROLEUM

Petroleum, according to Mr. Pratt, literally rock oil, is the generic term for all natural hydrocarbons, gaseous, liquid and solid except coal and derived from petra (rock) and oleum (oil). Therefore, the world petroleum stands for the oil that is derived from the rocks of the crust where it remains, either in liquid or even in gaseous state. To many of us, the term petroleum signifies motor fuels and lubricants. Petroleum provides fuel for heating and lighting, lubricants for machinery and necessary raw materials for a number of manufacturing industries. Thus, petroleum, or 'black gold', as it is often referred to, has emerged as an industrial giant in the present century, or giant in diversity of products as well as in industrial stature. It is interesting to note that, although its rise to a position of industrial giant has been a recent phenomenon, petroleum has long been known to man. In about 400 B.C., the famous Greek historian Herodotus noted the trade in petroleum. The ancient Chinese, too, made use of petroleum for various medicinal purposes as did the people of ancient Mesopotamia and the Medieval Europe. But the large scale commercial utilization of petroleum started only on 27 August 1859, following the exploitation of it by Colonel Edwin L. Drake near Titusville, Pennsylvania. This incident marked the beginning of the great 'oil rush' and the commercial exploitation of petroleum really got an impetus.

9.2 IMPORTANCE AND USE OF PETROLEUM

No other commodity of the present day has so close relation with the econo-political affairs of the world than petroleum and its different by-products. Petroleum products also have the distinction of being the most important commodities in international trade today. However, the beginning remained modest for a number of years because of the relative simplicity of the oil distillation process and the unawareness of the people regarding the various by-products of it. Its utilization was then restricted to mere kerosene lamps. It is justified to say that the present importance of petroleum is a relatively recent phenomenon, dating back only to the early 20th-century, more precisely following the innovation of internal combustion engines.

The rapidly expanding production of petroleum and its evergrowing importance in the sphere of industrial world can simply be attributed to a number of factors : petroleum occurs in large quantities, it is easily obtained, it has the widest range of domestic as well as industrial uses and, lastly, it can be cheaply distributed via pipelines. In the recent years, the greatest use of petroleum has been in the production of power from gasoline and fuel which occupy the lion's share of global oil output. Vast quantities of gasoline are used everyday to drive the millions of automobiles and airplanes, it is also used in enormous quantities to propel the ocean vessels, to ply railway locomotives and to generate electricity to cater the demand of factories. It is, indeed, petroleum which has revolutionized the entire transportation system, be it on land, water or in the air by providing the most convenient

fuel base of the present-day world. Like fuel, lubricants, too, play an outstanding role in the modern industrial society, since lubrication is of utmost necessity to run the countless number of machines. As there is yet no good substitute for petroleum as a lubricant, the machine-age of the present-day may come to a dead end without petroleum. The various by-products of petroleum are equally important to us. It has been estimated roughly that power, heat, light and lubrication comprises about 90 per cent of its uses. The heavier grades of petroleum by-products like asphalt, bitumen, pitch or tar are used for the purposes like road-surfacing, roofing and water-proofing etc. Petroleum-wax and benzole are equally important to us.

In the present-day industrial society, petroleum itself has become the most dynamic raw material base for an enormous range of chemical industries. Petroleum fractions like naphtha, ethylene and benzene are used to produce varied grades of products like synthetic textiles, fertilizers, insecticides, resins, adhesives, detergents, plastics, synthetic rubber etc. It is clear from the above discussion, though it had a very simple beginning, petroleum has, today, penetrated deep into every sphere of our life, from the corners of household to the largest industrial undertaking. Thus, it has been rightly named the 'modern industrial giant.'

9.3 THE ORIGIN AND NATURE OF PETROLEUM

Geologists are of different opinions as to the mode of origin of petroleum in nature and, therefore, different theories have been put forward with a view to explain the problem, though it is assumed generally to be derived from organic material of marine origin. Some geologists are of opinion that with the compaction of oceanic sediments under pressure, heat was generated that converted the decaying matter into small globules of oil. The former theory argued that the origin of petroleum must be inorganic. That theory is now discarded.

Oil can be obtained from many different types of sedimentary rocks of different geological ages and is very widely distributed. The rocks having greater proportions of pore spaces and having simple structural formations contain more oil than the others. It is, therefore, sandstone which contains more oil than mudstone, and shale, which have very small proportions of pore spaces compared to their volume. Igneous rocks rarely contain oil, though it may sometimes occur as seepage flows within the cracks and fissures. It has been found that undisturbed gently folded strata are the major sources of petroleum, though it may also occur within fault trap, salt plug and stratigraphic trap. In all such cases, the oil bearing strata lies within two impervious layers which prevent oil or gas to be escaped.

Petroleum is an inflammable mixture of hydro-carbon with very complex chemical constitution. It also contains other minerals like sulphur compounds and nitrogenous substances. The colour of crude petroleum varies from amber-green to brownish black. On the basis of its respective chemical composition, petroleum can be classified into three principal grades :

- (i) Paraffin base oil contains a high proportion of the lighter hydrocarbons such as methane and is commercially the most important.
- (ii) Asphalt base oil comprises mainly of the heavier hydro-carbons and is of less commercial significance.
- (iii) Mixed base oil is an intermediate group with mixed properties of the lighter and heavier grades of oils.

9.4 MAJOR OIL PRODUCING REGIONS

Crude oil or petroleum is obtained from almost every continent and constitutes perhaps, the most important item of international trade. The following table shows the distribution of crude oil reserves in the world :

Crude oil reserves, 1990
(millions of barrels)

Area	Per cent of world total
North America	13
Mexico	8
United States	4
Canada	1
South America	6
Venezuela	4
Western Europe	3
Norway	2
Great Britain	1
Eastern Europe	12
CIS	11
Africa	8
Libya	3
Nigeria	2
Algeria	1
Middle East	<u>50</u>
Saudi Arabia	24
Kuwait	10
Iraq	6
Iran	5
Abu Dhabi	5
Far East	5
China	3
Indonesia	1
Sub Total	97
World Total	100

It is evident from the above table that about 50 per cent of the world's proved petroleum reserves are concentrated in lands encircling the Persian Gulf, namely Saudi Arabia, Kuwait, Iran, Iraq and Abu Dhabi. Oil bearing tracts cover an area of about 22 lakh square kilometres, of which only 20 per cent area is presently being used for oil exploration.

It is interesting to note that the major industrial nations in Western Europe, with the exception of Great Britain, which require oil most have very insignificant oil reserves within their territory. This is why, they have striven to gain control of the petroleum industry. Apart from the Middle Eastern countries which have overwhelming control over the global oil reserves, two other regions contribute significantly both in regard to reserves and production. These are the North America and the former USSR, respectively. The following table gives an estimate of the global oil production of the major countries :

Crude Oil

<i>Country</i>	<i>Proved Recoverable Reserve (million Tons)</i>
1. Africa	9,005
a. Algeria	1,800
b. Libya	3,150
c. Nigeria	2,400
2. Asia	95,137
a. China	52,300
b. Indonesia	726
c. India	810
d. Iran	12,700
e. Iraq	13,600
f. Kuwait	12,785
g. Saudi Arabia	35,650
3. N & Central America	
a. Canada	720
b. Mexico	6,079
c. USA	3,560
4. S. America	9,872
a. Venezuela	8,604
5. Europe	2,145
a. Norway	1,025
b. UK	535
6. Former USSR	8,000
a. Russian Federation	5,132
b. Kazakhstan	449
7. Oceania	204
a. Australia	155

World production of petroleum, 1991

(in million tonnes)

Country	Production
CIS	515.3
USA	370.5
Saudi Arabia	320.3
Iran	151.7
Iraq	100.3
China	139.3
Mexico	138.7
UK	87.0
Venezuela	112.0
UAE	111.9
Nigeria	86.5

9.5 NORTH AMERICA

A. The United States of America : The United States is one of the most important producers of petroleum in the world. The country was the pioneer in the field of oil exploration since the world's first commercial oil well was dug at Titusville, Pennsylvania on August 27, 1859. In the initial years of oil exploration, the United States accounted for about 90 per cent of the global output, but with the subsequent development of oil fields in Middle Eastern countries and elsewhere, the United States lost its overwhelming supremacy and her market share dropped substantially. At present, the United States contributes about 13 per cent of global output of crude oil or petroleum. Oil fields in the United States are scatteredly distributed all over the country although six major oil regions can easily be distinguished :

- (a) The Mid-Continent Region.
- (b) The Gulf-Coast Region.
- (c) The Rocky Mountain Region.
- (d) The Californian Region.
- (e) The Appalachian and Eastern Interior Region.
- (f) The Alaskan Region.

(a) **The Mid-Continent Region**—This field extends from Kansas city through Central and Western Texas, Southern Arkansas right up to Northern Louisiana. This is the largest and the most productive oil producing region in the United States. Oil exploration in the Mid-Continent Region dates back to 1890, when the first oil well of the belt started operation in the town of Neodesha, Kansas. Shortly within a span of 40 years, the region, more specifically the city of Oklahoma, became the heart of the American oil industry. Several grades of oil, ranging from the light paraffin based oils to the heavy asphaltic as well as mixed grades of oil, are produced in this region. Because of its interior location, oil is transported cheaply to the major consuming centres like Chicago, Houston, Los Angeles and the rest of the country.

(b) **The Gulf-Coast Province**— The Gulf-Coast province comprises of the coastal districts of Texas, Louisiana, Southern Mississippi and South-Western Alabama. Large scale commercial oil exploration started in 1901 following the discovery of the Spindletop oil field in South-Eastern Texas. The output rose to the peak in 1905 but since then it has been a story of decline. Some massive oil fields of the region are confined to the coastal districts of Texas and Louisiana. Oil is also recovered from the off-shore mines. The oil of the region is poor in quality because of its heavy asphaltic base. Minor deposits occur in Mississippi, Arkansas and Alabama.

(c) **The Rocky Mountain Region**— This region stretches extensively from Montana to New Mexico in the Eastern Rockies. The oil in this region occurs in few isolated deposits because of the structural complexities. Exploration of oil is, therefore, not only difficult but also more expensive. Many of the potentially rich oil bearing stratas remain beyond the reach of exploitation. The most important regions for oil production include the states like Wyoming and New Mexico.

(d) **The Californian Region**— California is another large oil producing region of the USA. Oil extraction from this region rose to prominence as early as 1910 and since then the region has maintained its reputation as being the leading oil producing province in the country. In the earlier days, oil exploration in the region had been hindered greatly because of its remote location from the major consuming centres of the East. In the early period, however, oil exploitation was restricted and very ill-developed. Several reasons were liable for that including low demand and inaccessible nature of the land. The major fields of the region lie at Los Angeles, Long Beach and Southern San Joaquin. The region yields both light and asphaltic oils.

(e) **The Appalachian and Eastern Interior Region**— The Appalachian region was the pioneer region in oil exploration in the country but has lost its prominence in the last few years and has become, perhaps, Ohio. Subsequent to this development, oil exploration started in Pennsylvania, produced very high grades of oil that contained very low proportions of impurities. Oil production from the region started in 1884 in North-Western Ohio. Subsequent to this development, oil exploration started in Pennsylvania, Virginia, Kentucky, Illinois, Indiana and Michigan. Output of these fields has declined greatly in the recent years. The chief importance of these fields lies in the fact that they are located very close to the major consuming centres.

(f) **The Alaskan Region**— More recent estimate shows that this region is greatly endowed with vast deposits of mineral oil that may either equal to or surpass the deposits of Kuwait. Production cost of oil in the region is very high because of transportation deadlock and cool tundra climate that hinder oil exploration in the region to a great extent. Bulk of the output of the region comes from the Prudhoe Bay region that alone accounts for about 17 per cent of the country's total output. Oil is piped from the region to Valdez for shipment to the mainland.

9.6 CANADA

Next to the United States, Canada is the most important producer of mineal oil in the continent of North America and accounts nearly 4 per cent of global oil output. The country emerged as an important oil producing nation following the discovery of oil at Leduc near Edmonton in 1947. The country is fortunate for having enormous deposits of oil which is consumed not within the country alone but is exported in substantial quantities to many other countries. The Alberta region alone accounts about 75 per cent of the country's output

and the rest is obtained from Saskatchewan. The major oil producing regions are located around Edmonton, Redwater, Pembina, Calgary and Turner Valley. Smaller deposits are found in British Columbia, Ontario and Manitoba. Oil is transported to the consuming centres via the well-integrated network of pipelines criss-crossing the country. In more recent years, oil has been struck in the Grand Banks off Newfoundland and in the Athabaska Bay region.

9.7 MEXICO

Oil exploration in Mexico started as early as 1901 when excellent grade of oil was mined on the coastal plain of Tampico and Tuxpam, which were essentially two backward agricultural districts. Following the discovery of oil in these regions the economic character changed almost overnight and the backward agro-economy was radically replaced by modern economic infrastructure. Within a span of only twenty years, Mexican output rose to the peak. The annual output was then about 30 million tonnes or nearly 30 per cent of the global output. Since that period, there has been a steady decline in the output which can be attributed to a number of factors, namely :

- (1) high sudden production and early intrusion of saline water with subsequent rapid exhaustion of the wells,
- (2) restriction imposed by the then Mexican government on the operations of the foreign oil companies,
- (3) high amount of government taxes,
- (4) nationalization of the oil industry in 1938 resulting in the rapid decline in the oil output,
- (5) slow rate of recovery in oil production under national control.

Mexican output has somewhat been stabilized in the years after the World War. Increasing domestic as well as global demand and higher oil prices have favoured a new burst of development in the last two decades. A few more rich oil reserves have been discovered in the Southern part of the country and the production is expected to be increased in the future.

9.8 SOUTH AMERICA

In South America, almost all the major countries, excepting Paraguay and Uruguay, produce oil. From the geological point of view, the conditions that favour the concentration of oil within the rock beds are not at all favourable. The extensive stretches of the Guinea shield in the north and the Eastern Plateau flats of Brazil are equally hostile for oil deposits. The vast stretches of the Andes are so greatly distorted that petroleum can occur in small isolated pools within the mountains. Debarring all such areas which are not physically hospitable for oil exploration, commercial exploitation has thus far become successful in the countries like Venezuela, Colombia, Ecuador, Peru, Bolivia, Argentina and a small area near Salvador or Baia in Brazil.

Venezuela

Venezuela is the most distinctive producer of oil in the world today. Oil exploration in Venezuela started in 1918 and by 1930 the country emerged as the second largest producer. It held its supremacy till 1960 when it was surpassed by the then Soviet Union and subsequently by a number of Middle Eastern countries.

The country has several fields in the two important regions, namely, the Gulf of Maracaibo and the Orinoco Basins. The Gulf of Maracaibo, the pioneer area for oil exploitation in the country, still plays the leading role in country's oil arena. Nearly 50 per cent of the Venezuelan output comes from this region. A number of factors favour oil production in the Maracaibo region : relatively shallow depth of the principal oil bearing strata, which have been very little disturbed by former tectonic movements; a large number of wells equally contribute to the output; easy transshipment of oil by tankers through the Gulf for export; integrated net work system of pipelines favouring easy movement of petroleum from the fields to refineries and to the centres of consumption; favourable location of the oilfields along the Gulf Coast. The Orinoco Basin, on the other hand, is equally favoured by both the physical and economic conditions unlike the Maracaibo region. Most of the oil output of the country enters the export market. The United States and the European countries are the principal importers of Venezuelan oil. Crude petroleum and refined products constitute nearly $\frac{9}{10}$ th of the export earnings and the various taxes are the chief source of governmental revenue.

Colombia

Colombian oil fields are located in four principal regions, namely : the middle Magdalena Valley; the extreme South-Western corner of the Maracaibo Basin; the lower and upper Magdalena Valley. Of these four regions, the middle Magdalena Valley and the Maracaibo Basin region contribute the majority of the country's output. Oil wells lie at relatively shallow depths and yield good quality of oil. Oil is piped through pipelines to the refineries lying along the Caribbean Sea coast. The bulk of the country's output is sent for export.

Peru

Peru started its journey as an oil producer in 1896, but her production did not gain any significance till 1909. Peruvian oil fields are located in Piura Province of northern part of the coastal desert. Significant deposits also occur along the coastal belts that yield medium to heavy grades of oil from the shallow continental shelves. The oldest oil wells are located at Zorritos near Tumbes, but the bulk of the recent output comes from the newly developed oilfields of Lobitos and Negritos near Talara. Two new fields have also been developed at Maquia and Ganso Azul to the east of the Andes that produce nearly 10 per cent of country's output.

The lack of other mineral resources especially in the desert regions has greatly discouraged oil exploitation in the country. Part of the crude oil output of the country is refined locally for domestic consumption and the remainder is sent to Iquitos for refining and transshipment down the river. Peru is also an important exporter of oil in the world market.

Argentina

Argentina ranks second amongst the South American countries, next to Venezuela, in oil production. Like the other countries of the continent, oil production started in Argentina in the earlier part of this century. In the outbreak the production was small, but within the last few decades the country has substantially steadied her production and has become a significant producer of oil. Right from the beginning the Comodoro Rivadavia fields, on the Patagonian coast, had been the most important area of the country. It still contributes the lion's share of the Argentine output. Prospective new fields have been built up near Neuquen in the south; near Mendoza in the west; and in the north-west at Oran and Tartagal. These fields continue northward into Bolivia. Argentina is self-sufficient in regard to oil

production. Oil fields are linked with Buenos Aires by pipelines where oil is refined for consumption.

Ecuador

Ecuador has few scattered deposits that yield small amount of oil. The principal region lies on the north side of the Gulf of Guayaquil that remained the most important region for long period. Ecuador had a very slow growth rate in the initial years that has stabilized to great extent in the recent times.

Bolivia

Bolivian oil fields are located in the remote eastern part of the country where oil is mined from the fields like Camiri, Rio Barnejo and Sanandita. Bolivia's reserve is expected to be very large. Oil is piped to Sucre and Cochabamba for refining.

Chile

In Chile, principal oil reserves can be found in the southern-most corner of the country at Punta Arenas and on Tierra del Fuego. Chilean output is small and usually meant for domestic consumption. Refineries and petrochemical industries are located at Valpariso and Concepcion. Other petroleum-producing regions of South America comprise a number of fields near Salvador and in Baia in Brazil. In all the oil-producing countries of South America, intensive exploration are now being carried out. It is, therefore, expected that these countries will contribute more in the future.

9.9 WESTERN EUROPE

The European countries are not among the leaders of global oil output though they are the most important consumers and importers of oil. Excluding the CIS, the European countries altogether contribute only 3 per cent of world output of oil. The geological structures of Western and Southern Europe are so distorted that it is seemingly improbable that any significant reserves underlie the region. The principal West European producers include : Germany, France, the Great Britain and the Netherlands. In Germany, the principal oilfields are situated in the western half of the country in Bavaria and Schoonebeck. The oil reserves are widely scattered and account for only 1 per cent of global output. Austria is another important West European producer of oil where the important reserves occur in Vienna basin. Austria is self-sufficient in oil production. The surplus output is sent for export. In France, production comes chiefly from the South-West region where the oilfields of Lacq and Parentis have been operating for a very long time. Oil has also been struck in the Paris Basin region but the output is small. Great Britain has emerged as the largest oil-producing nation of Western Europe in comparatively recent years. The bulk of Britain's output is obtained from the North Sea field which is equally shared with Norway. The country has enough oil to satisfy her own needs and accounts for nearly 3 per cent of the world total. The Netherlands has small deposits that occur chiefly near the eastern border of the country. Italy, in Southern Europe, is another notable producer of oil where the principal fields are located near Ragusa and Gela in Sicily and at Abruzzi in the East Central part of the country.

9.10 OIL IN THE MIDDLE EAST

The Middle Eastern countries, namely Iran, Iraq, Saudi Arabia, Bahrain and Kuwait, are the most important oil producing nations in the world, and it is quite probable that they will retain their supremacy in the years to come. Only in 1908, oil exploration began under the leadership of the famous Anglo-Iranian Oil Company at the high rugged, mountainous

terrain of the Masjid-i-Sulaiman area. The company invested a lot of money not only in drilling oil but also in modernizing the economic infrastructure of the country. Thus, in the Middle East, the early petroleum economy blended resources from two different regions : (a) the Middle East itself contributed the raw material and (b) the highly industrialized Western Countries provide the necessary knowledge to explore it. The US, Dutch and British Companies controlled exploration, drilling and production. Near about 40 per cent of the crude oil output from the Middle East flowed westward via pipeline to the Mediterranean ports for further shipment and refining; even by 1940 the Middle East, under the leadership of Iran, remained an insignificant producer of petroleum.

Middle Eastern producers of oil got a tremendous impetus in 1960 following the global rise in petroleum pumping. The region, as a whole, emerged as the second-largest producer of petroleum in 1960, moving ahead of Venezuela and the former Soviet Union. Exploration in the traditional areas of Iran, Iraq and Saudi Arabia, supplemented by extremely productive fields of Kuwait, provided a border base of operations in that region. In fact, per well productivity in the Middle East far exceeded the yield elsewhere. Kuwait soon outranked the other leading nations of the region because of the richness of her reserves. So 1960's gave birth to the world's most productive oil-producing region. In the seventies, the supreme authority of oil production had shifted from the multinational oil companies and the nations that heavily backed them to the primary producers of oil in the Middle East. Britain's Institute for Strategic Studies once commented rightly, "The thread of the burgeoning power and changing tactics of the Middle East oil producing countries seemed to overshadow almost all military threats to North America, Europe and Japan. US internal oil resources are nearing exhaustion. The reserves are expected to last not more than 15 to 20 years. For this important raw material to keep the wheels of industry and transport moving, it is expected that by 2005, USA will have to import nearly 90 per cent of its total needs of oil from foreign countries, about 40 per cent of it from the Middle East".

In the initial period of oil exploration, the Middle East region suffered greatly from the lack of technological skill. As a result, they had to depend solely on the foreign companies of the USA, the UK, France and the Netherlands. But in the recent years, the local governments have undertaken the charge of the oil fields and thereby have stabilized the oil production to a great extent. The strategic importance of the oilfields has greatly mounted up geo-political tensions in the region. Conflict between the Arabs and Israelies, the undefined nature of many of the desert boundaries and the conflicts between the rival sheikhdoms or neighbouring rival governments as in the Iraqi-Iranian War of 1980, and the more recent war between Iraq and Kuwait, make the oil industry of the Middle East rather insecure. As a result of massive bombing, pipelines have greatly been damaged, oil rights have been contested time and again. All these have tremendous bearing on the oil economy of the present world.

Nevertheless, radical transformation of the Middle East economy has also taken place following the exploration of oil in the recent years. Royalty and payment of taxes by foreign companies, that produce and market the oil, supply the bulk of the revenues of the governments of the Middle Eastern states and are making possible a variety of welfare projects to raise the standard of living of the people. Several Arab countries, having only moderate deposits of oil, have also been economically benefited through their control on transportation routes. For example, United Arab Emirates, with its Suez Canal, and Syria, Lebanon and Jordan, derive transit fees and taxes as the pipelines have criss-crossed their countries.

Middle East countries export oil to almost every corners of the earth but Western Europe constitutes the major market. Other significant buyers include Japan, Australia, India and African countries. Most of the oil is shipped to the market in crude form, though a rather negligible amount of it is refined at refineries located along the Persian Gulf Coast, at pipeline terminals on the Mediterranean coast or at the northern and southern entrances to the Red Sea. The Persian Gulf oil is extremely important to UK, mainly because of the fact that it supplies the bulk of the countries oil requirements and, perhaps more importantly, sales of oil and other petroleum products in world markets are a much-needed source of foreign exchange. The Middle Eastern oilfields are primarily concentrated in the south-western and northern portions of the Persian Gulf. The major oilfields of the Middle East are as follows :

- (i) **Iran** – Agha Jari, Haftkel, Masjid-i-Suleiman, Naft Safid, Lali, Nafti-i-Shah, Gachsaran, Ahwaz.
- (ii) **Iraq** – Kirkuk, Rumalia, Zubair, Ain Zaleh, Naft Khaneh.
- (iii) **Kuwait** – Burgan and Magwa-Ahmadi.
- (iv) **Saudi Arabia** – Ghawar, Abqaiq, Qatif and Dammam.
- v) **Baharein** – Baharein.
- (vi) **Quatar** – Dukhan.

Oil in Saudi Arabia

Saudi Arabia has the largest reserves of oil in the world. Oil exploration in Saudi Arabia began in 1938 at Dammam oilfield but the area around Dhahran has the most productive fields at present. The most productive Saudi Arabian fields are located at Abqaiq, Ain Dar, Ghawar and the offshore wells of Safaniya. ARAMCO leads oil exploration in Saudi Arabia. Ghawar field is by far the largest in the country and extends for about 200 km from north to south and 25 to 50 km from west to east. Saudi Arabia ranks second in output of oil and her production has risen from 26 million tonnes in 1950 to over 110 million tonnes in 1967, 320 million tonnes in 1991. So far, 38 oilfields have been discovered in the country but only 13 are now in production. It means that the country has tremendous potentiality for increasing her output in the future. The bulk of the Saudi Arabian output is sent via pipelines to the Persian Gulf Coast for export or for refining at Ras Tanura Bahrain. Oil is also piped to the Mediterranean port of Saida by the 1,600 km Trans-Arabian Pipeline. This saves the 4,800 km long tanker route through the Suez Canal or the much longer Cape of Good Hope route. From Saida, oil is exported either in crude or refined form to various countries of Europe.

Oil in Iran

Iran is the pioneer in oil exploration in the Middle East, since oil exploration started in Masjid-i-Sulaiman field as early as 1908. However, commercial exploration started a few years later. The most productive fields of the country are located in the south-west of the country near Masjid-i-Sulaiman, Naft-i-Shah, Lali, Agha Jari and Bahregan. Apart from Masjid-i-Sulaiman and the Haftkel fields, others are post Second World War creations. Majority of the oil is refined by the refineries at Abadan and Kermanshah. The Iranian oil exploration pattern had gone through a complete metamorphosis in last 50 years. The continuous tussle between the multinationals and the governments regarding the payment of royalty posed a great obstacle in the overall development of oil output. After the nationalization of oil sector by Iran government in 1951, however, accelerated the output

brief period; though subsequent political unrest, mass movement, revival of Pan-Islamism, removal of Shah, long war with Iraq greatly disrupted oil production. Several oil well became unproductive. Gradually normalcy restored and production started increasing. At present, Iran is producing around 150 million tonnes of oil, the bulk of which is exported to Japan and other western European countries.

Oil in Iraq

Iraq is an important contributor to Middle Eastern oil output though her production has greatly declined in the last few years, mostly as the result of Iraq's aggressive militant attitude towards the neighboring countries producing oil. Iraq has to pay severely in recent years for her hostile attitudes. The majority of her principal oil fields have either been destroyed or in need of massive repair to start production again. War in the last two decades have become so closely associated with Iraq that war and Iraq have turned to be synonymous. As a result of these, Iraqi oil economy has degraded to a very humble state. However, Kirkuk in the north is the most important oil field of the country which started production in 1927. Other oil fields are located around Basra and Mosul. It has been reported that Iraq has started production again, but it is needless to say that it would take quite a long time to achieve the stage of her previous glory.

Oil in Kuwait

Kuwait's aspirations to become the chief of the oil producing nations in the world has shattered greatly following her recent war with Iraq. Oil exploration in Kuwait started at a relatively recent date, compared to her famous neighbours. The country has also achieved a spectacular growth during the last few years in both oil output and exports. Kuwait is a very small country but it possesses about 13 per cent of the world's proven reserves. The country used to get huge royalties, amounting 50 per cent of the profits, from the operating companies in the country, which made the Sheikh of Kuwait perhaps the richest man in the world. The bulk of the Kuwait's output were obtained from the Burgan oilfields, which is reported to be damaged badly by the Iraqi missiles. Prior to this conflict, Kuwait was one of the world's leading producers and exporters of oil. But she has certainly lost her supremacy because of the destruction of her most productive oilfields. In 1991, she produced 84 million tonnes of oil.

Other Producers

Other important producers in the Middle East, however, include Bahrain, Qatar and United Arab Emirates. In comparison to the leading oil-producing countries of the region, these countries virtually produce rather insignificant amount of oil mostly because of their poor reserves. Nevertheless, UAE, especially Abu Dhabi, is a significant contributor to regional output. The country has considerable reserves of about 5 per cent. Oil is the only source of revenue of many of the countries of the region and, therefore, the regional economic development of the countries is solely depended on oil. The oil prospects of these countries have brightened greatly following the destruction of Iraqi and Kuwaiti oilfields.

9.11 PETROLEUM IN THE CIS

The CIS holds a pride place amongst the petroleum-producing nations in the world. According to the estimates made by Russian geologists in various periods of the economic development, almost half of the entire geographical area of the country has oil and gas fields. During a period of six years from 1959-65, the Russian geologists has discovered as many as 430 oilfields within her own geographical area. The process continued even during

the later years and thus the output surpassed many others during Soviet period. Though oil reserves are almost ubiquitous in nature in the CIS, certain principal areas are quite easily distinguishable. They are :

- (a) The Volga-Urals Province.
- (b) Crimean-Caucasian Province.
- (c) Dneiper-Donetz Province.
- (d) Ural-Emba Oil Province.
- (e) West Turkmen (Transcaspian) Province.
- (f) Central Asian Province.
- (g) Siberian Oil Province.

The greater number of oilfields amply indicate the vastness of Russian oil deposits.

(a) This province covers a vast territory that stretches to the White Sea coast embracing the Ukhata and Pechora areas; in the south, the region gradually merges with the Emba Oil Province. The bulk of the major reserves of the country lie in the Tatar, Bashkir and Udmurt provinces; Kuileyshev, Perm, Ulyanovsk, Saratov, Volgograd, Atstrakhan regions. Tatar Republic is by far the most important oil producing province of the region, with vast deposits of high quality petroleum.

(b) In this region the Devonian and Carboniferous strata contains the rich oil deposits. The oil producing regions, however, are located in a number of areas :

- (i) Azerbaijan oil area where oil is chiefly explored from under the sea floor.
- (ii) The Terek-Daghestan Area.
- (iii) The Grozny Area.
- (iv) The Kuban Area.

(c) This province includes Poltava, Cheringov, Mogilev, Gomel and other regions. The most important oil fields of the region are Radchenkovskoye and Glinsko-Rozbyshevskoye fields.

(d) The Ural Emba Province lies within the Caspian Depression where the oil-bearing stratas are found to occur within salt domes. The most important oil fields of the region include Makat, Dossor, and Koschagyl fields. In more recent years vast reserves of petroleum have been discovered in number of other areas of Western Kazakhstan along the eastern shores of the Caspian Sea.

(e) This oil province is located in Turkmen where oil is explored from two important areas namely, the Apsheron Peninsula and the south-eastern part of the Caucasus mountain. The presently operative fields are Cheleken, Kundag, and Nebidag oilfields. In Western Turkmenia a number of new fields have been explored in more recent times that include the Koturtape oilfield.

(f) This province covers a large territory in the Uzbek, Tajik and Kirghiz Republics. The principal deposits are found in the Ferghana, Bukhara Khiva and South Tajik areas.

(g) Oil fields of the West Siberian Plain are of recent developments and has about 38 individual oil fields. The oilfields of this province are concentrated in two main oil bearing areas :

- (i) Middle Ob oil bearing area comprising the oil fields of the UstBalyk, Megionskoye and Lokosovo.
- (ii) Western Siberian field of Shaim-Krasnolenisk area. In the Far East there are some oil fields on Sakhalin island.

The growth and development of thin oil fields in the years following the Communist or Socialist Revolution was simply spectacular when the relative backwardness of the country in regard to oil output during the pre-Revolutionary period was considered. In 1989, the former USSR produced about 607 million tonnes. After the fragmentation of USSR, the CIS has produced 51.5 million tonnes in 1991.

9.12 OIL IN AFRICA

The presence of massive crystalline rocks to the Southern parts of the continent has greatly reduced the scope for oil exploration in the continent, since the most significant oil deposits in the world are closely associated with the sedimentaries. Geological investigations have proved the fact that some regions have significant deposits of mineral oil. Most important is the Sahara desert region in the north, where the two north African countries, namely Algeria and Libya, are noted for their reserves. Egypt, in contrast, has moderate oil reserves. Nigeria has large reserves of oil in the Niger Delta region, while Gabon has only small quantities.

Libya

Libya is the most outstanding oil producer in Africa at present, where oil, after year long search for oil under different multinationals, was found in 1957. Since then, the country had hardly looked back and subsequently several new oil areas were discovered in the various parts of the country. Characteristically, Libyan oil fields are scattered in nature, but the major fields are located to the South of the Gulf of Sirte at Dahra, Beda and Zelton. Some fields are also to be found to the east and west of the country. Libyan oil industry is, however, not devoid of some basic problems such as hostile desert environments, deeper occurrence of the oil-bearing strata, high cost of exploration of oil etc., but the basic advantage of being located very close to the Vast European market has certainly overshadowed many of the problems. The bulk of the output, which is around 54 million tonnes a year, is exported mainly to Europe.

Algeria

Algeria enjoys a pride position amongst the OPEC countries since her output has risen in the recent years to a great extent. Unlike Libya, oil exploration in Algeria started in late 1950's. Today, the majority of the country's oil output come from three main regions : Hassi R'Mel, Hassi Massaoud, and Edjile. The oil is piped to the coast at La Skhirra in Tunisia and at Arzew and Bougie in Algeria for export. Algerian refineries are located at Algiers and at Hassi Massaoud.

Nigeria

Despite massive exploration work to find out oil, they achieved success about two decades later in 1960 when oil was struck in the lower Niger Delta. Most of the Nigerian oil fields are located in the Delta area and the offshore regions. Nigerian oil output, per annum, is around 80 million tonnes and the bulk of it is exported to European and American countries.

Egypt

When compared with its oil rich neighbours of the Middle East, the Egyptian deposits seem to be very insignificant. Nevertheless, the country has made some significant progress in regard to oil production in the recent years. Petroleum in commercial quantities was first discovered at Gamsah as early as in 1908. The bulk of her major oilfields are located in the Sinai Peninsula, the most important of which is the Gaza oilfields. The oilfields at Ras Gharib, Asl. Sudr, Ghardaka, Ras Matarma, Firam, Balaimpanies are notable for their output. Anglo-Egyptian oil companies carry out the exploration of oil. The oil refineries are located at Suez, Alexandria.

9.13 OIL IN ASIA

Though the gross output of oil of the major Asiatic producers is substantially low, when compared with the leading oil producers of the world, some of the Far Eastern countries are long been noted for their output which is certainly of great national importance when the present global crisis of petroleum is kept in mind.

China

Amongst the leading East and South-East Asian countries, China ranks first in petroleum production. Chinese output of oil has gone up by many times since liberation and she, in fact, aims at attaining self-sufficiency in regard to production of mineral oil. In the initial years of petroleum exploitation in the country, China was greatly assisted by the then Soviet Government in respect of technology, survey techniques and necessary drilling equipments. But following the withdrawal of Soviet assistance in 1960, China became self-sufficient in every aspects of petroleum exploration. At present, China is probably the sixth largest producer of petroleum in the world. Because of her complex geological framework, Chinese oil fields are rather dispersed in their locations and thereby four principal areas can be distinguished, which include :

- (a) Lenghu and Karamai fields of Sikiang Province, Saidam Basin, Yumen.
- (b) Nanching fields of Szechwan Province.
- (c) Yanchang of Shanxi Province.
- (d) Coastal areas.

In 1991, China produced about 138 million tonnes of petroleum. China exports a little oil to Japan, Hong Kong, North Korea and Thailand.

Indonesia

Apart from China, Indonesia is another important producer of petroleum and goes almost neck China in gross output. Indonesian oil mining industry flourished under the Dutch colonial leadership in the initial phase of development and later both the Dutch and US companies became highly operative. Several contracts have been signed between the Indonesian Government and the different oil companies operating in the area. The most important oil-producing region is Palembang district of Sumatra which raises about 65 per cent of the country's output. Borneo is also important and accounts for about 20 per cent of the national output. Being an important south-east Asian member of OPEC, Indonesia exports oil to a significant amount. The bulk of her export goes to Japan and other neighbouring countries.

Japan

Japan is not at all important so far as the petroleum exploration is concerned, as neither her reserves nor her present output of petroleum is large enough to distinguish Japan as a leading nation. Her domestic output of petroleum is far from satisfying her own demand and, therefore, Japan has emerged as the most outstanding buyer of petroleum and petroleum products that enter international trade. Her petroleum belt lies along the Japan Sea coast from Hokkaido on the north to Northern Honshu. Nearly all the Japanese output comes from two principal oil fields – the Akita and the Nigata of Honshu Island. In 1988, Japan produced about 15 million tonnes petroleum or only 10 per cent of her demand.

Oil in India

India accounts for only 0.6 per cent of the global oil production though her internal production of oil has increased by many times since Independence. India has a very long history of oil exploration since oil was first discovered in 1867 at Makum in North-East Assam, but because of lack of communications within the high mountainous tracts, oil exploration could not start before 1882 when oil was first drilled at Digboi in the Lakhimpur district of Upper Assam. Digboi covers an extensive area and is the most productive oil-producing field of India. The Surma Valley region is also notable for its oil deposits though the region yields lower grades of oil. The principal fields are located at Badarpur, Masimpur and Patharia. Naharkatiya is another important oilfield of Assam that yields very high grades of oil. In recent years, oil has been struck at several other places of Assam which include Rudrasagar, Lakwa, Galeki, Moran and Auguria.

Since formation, Oil and Natural Gas Commission has done a great job in carrying out exploration work in several parts of the country. Vast reserves of very high grade oil has been discovered in the Cambay Gulf Area which include some of the highly productive fields of present day, such as Ankleshwar, Kalol, Kosamba, Sanand, Dholka, Wavel, Balol and many others. With the opening of Bombay High region by ONGC in 1973, a new chapter had been added to the history of oil exploration in India and the State of Maharashtra has also been included in the oil map of India. Offshore oilfields are highly productive and country's output has substantially increased as a result of such explorations. ONGC has successfully explored oil from the Kaberi Delta region in 1987. As a result, this region has emerged as an important oil producer in the country. Oil wells are located at Bhubangiri, Kovilappal, Narimanam and several other places in the delta. India's internal demand for oil is steadily increasing day by day but her domestic production is much lower even to meet her demand. Thus, India has to import a huge amount of oil from various sources which require heavy outlay of valuable foreign exchange. Nevertheless, oil refining industry and petro-chemical industry both play very significant role in the development of national economy

International Trade

Because of very dispersed location of the major oilfields in different parts of the world, international trade in crude oil holds a very pride place. There are a large number of areas where the hope for oil does not seem to be real at all. Such areas include the countries of North-Western Europe, Australia, most of Africa, South America and Far Eastern Asia. Indonesia has, however, large reserves of mineral oil. The most important producers of mineral oil today are, therefore, very limited in numbers and they include the USA, the CIS, Middle and Near-East, North Africa, Venezuela and Indonesia.

Petroleum, these days, is traded in the crude form and is refined near the important centres of consumption. The bulk of the oil produced moves via the pipelines, which quite often runs uninterruptedly for thousands of kilometres to reach the consuming centres. Oil is also carried by specially designed ships called tankers. The great bulk of oil is thus moved from the surplus areas to deficit. The principal buyers of oil include the countries of Europe, Japan, Australia, and the USA. Today's export trade is overwhelmingly dominated by the OPEC countries, which stands for the Organisation of the Petroleum Exporting Countries of the world. It was founded at a conference in Baghdad in 1960. Originally comprised of five nations, namely Iran, Iraq, Kuwait, Saudi Arabia and Venezuela, the OPEC has present membership of thirteen countries, which, apart from the five principal parent countries, include Algeria, Qatar, Libya, Nigeria, United Arab Emirates, Ecuador, Gabon and Indonesia. The prime objective of the OPEC nations was to sought a plausible mechanism to deal with the multinational companies which had overwhelming superiority in controlling the research and exploration of oil in their countries. Initially, the multinational companies successfully resisted reforms desired by host countries, but following the growth of political tensions in the Middle East and rapid development of petroleum exploration in different parts of the world, the multinational firms were bound to grant more concessions to the members of the OPEC countries. Eventually, the host countries negotiated three-fourths of the crude price for themselves and thus the OPEC strategy in 1970's gradually become, "after cash must come control". Due to continuing dependence on the OPEC controlled supplies by major importing countries in the 1970's and 1980's, Middle East politics continued to influence prices throughout this period. In 1980, the oil price increased by 13 per cent creating a great imbalance in the economic infrastructure of many developing nations.

9.14 OIL CRISIS AND THE WORLD ECONOMY

Since 1973, shortage of energy has become a problem of major dimensions in many parts of the world. The countries of Western Europe and Japan, which do not have sufficient volume of domestic oil reserves and depend solely on imported oils, suffered the greatest economic set-back. The USA was much less influenced. The fuel supply problem was caused principally by two reasons :

Firstly, because of the continuing rapid growth in demand for energy, especially in the form of petroleum products, and (b) the absence of comparable increase in the global oil refining capacity.

It had been estimated that the consumption of oil in Western Europe rose by 7 times during the period from 1956 to 1973. The situation, however, worsened in late 1973 when the members of the OPEC cut-back their output by 5 per cent and subsequently increased the oil prices at least four times within a relatively short span of time, in retaliation for the US support of Israel during the Arab-Israeli War in December 1973. At that time, an embargo was also placed on oil shipments to the USA and the Netherlands by the Organisation of Arab Petroleum Exporting Countries (OAPEC). Subsequently, this ban was imposed upon some other countries like Portugal, Zimbabwe and South Africa. The price was also increased. Anyhow, the Arabian countries most successfully used their oil as a weapon to fight against the aggression of superpowers in their territories. As a result of these consequences, the economy of the developing and underdeveloped countries has greatly suffered. The problem will continue since petroleum is a non-renewable resource and its reserve is exhausting day by day.

NATURAL GAS

Introduction: Along with coal and petroleum, natural gas is a fossil fuel. Natural gas is mixture of hydrocarbon of paraffin series, may contains higher as amounts of methane – upto 85 percent.

Natural gas contains smaller amounts of impurities, including carbon dioxide (CO_2) and hydrogen sulfide (H_2S). They are often removed during the refining process and used as commercial by products.

Natural gas is generally but not always associated with petroleum and is the ideal fuel. It is most convenient and the most readily controllable of all fuels. It is also the cheapest source of energy for many purposes.

Natural gas has two modes of occurrence; it is found with petroleum. Gas from oil wells, known as “wet” gas, is rich in volatile gasoline. Free gas, often known as “dry” gas, is usually ready to go directly into pipelines. About 30% of all the gas produced in U.S.A. comes from oil wells.

Today 104 countries possesses natural gas reserves, but out of these only 30 countries produce significant amount of natural gas. *Russian Federation, U.S.A., Iran, Qatar, Canada, United Kingdom, Algeria, Netherlands, Indonesia, United Arab Emirates, Norway and Saudi Arabia* are leading countries in natural gas production.

In the world, natural gas reserves are 300 trillion cubic metres, but according to geological experts, there are about 4,285 trillion reservoirs still unproven. About 75 percent world's natural gas reserves are located around the Persian Gulf region. *Russian Federation, Turkmenistan, Iran and Qatar* have 47% natural gas reserves of the world.

HISTORY OF NATURAL GAS USE

Historical records show that natural gas was used for heating or burned as fuel in China as early as 250 A.D. In the 17th century, natural gas was used for heating and lighting in northern Italy. In the United States it was first discovered in *Fredonia, New York* in 1821.

Although the gas utility industry dates to the early 19th century, but mass marketing of its present form – natural gas – only goes back to the *Post-World War II era*.

Besides, natural gas, manufactured gas dominated until natural gas commercial use started and it was produced by heating coal.

Natural gas, with the development of a comprehensive pipeline network, started after World War II, first in the United States. Until, 1960, only United States used natural gas on a gigantic scale. In the past 50 years expansion of the natural gas industry can be discussed only in superlatives, production increased 2000 percent. It has been moving up on petroleum and coal. Today natural gas is transported through extensive network of pipelines or in liquefied form and is transported by ship.

Today use of natural gas as compressed form (CNG) in motor vehicles is increasing very rapidly.

EXTRACTION AND PROCESSING OF NATURAL GAS

Once Natural gas has been extracted from the ground, it is usually transported by pipeline to a refinery, where it is processed. Natural gas is processed in an extraction unit to remove the *non-hydro-carbon compounds*, especially *hydrogen-sulphide* and *carbon dioxide*.

After the impurities have been removed in the extraction unit, the natural gas is transported to a processing plant, where compounds such as *ethane*, *propane*, *butane* are separated and removed for different uses. For example, *ethane* and *propane*, are used *extensively in the petrochemical industry*.

After being processed, natural gas is transported through pipelines to communities and other markets.

Natural gas can also be shipped and stored as a liquid. It turns into liquid at -160°C (-256°F). Natural gas occupies 600 times less volume as a liquid than as gas. Liquefied Natural Gas (LPG) is transported primarily by ship.

USES OF NATURAL GAS

Natural gas is used both as a fuel and as a raw material in the manufacture of chemicals. As a residential fuel, it is burned in furnaces, water heaters, cooking stoves and clothes dryers. As an industrial fuel, it is burned in kilns, used to bake bricks and ceramic tiles and to produce cement. Natural gas is also used for generating steam in water boilers and as a source of heat in glass making.

Natural gas serves as a raw material for creating petrochemicals. In turn, petrochemicals (natural gas based) are used as a base product for making fertilizers, detergents, pharmaceuticals and numerous other goods.

Natural gas is being used in transportation and power generation.

WORLD NATURAL GAS RESERVES AND DISTRIBUTION

After petroleum and coal, natural gas ranks third, accounting for about 23% of world primary energy production. Natural gas discovered on all continents except Antarctica. Today 104 countries possess natural gas reserves but about 30 countries have significant gas reserves.

Proven natural gas reserves of the world are about 300 trillion cubic metres. Russian Federation, Turkmenistan, Iran and Qatar possess 47 percent world's natural gas reserves. Russian Federation possesses 55,000 billion cubic metres gas reserves and ranks first in the world. While ranking 2nd Iran possesses 33,500 billion cubic metres natural gas reserves. Turkmenistan possesses 26,200 billion cubic metres gas reserves and Qatar has 25,470 billion cubic metres gas reserves. Saudi Arabia, United Arab Emirates, United States of America, Algeria, Nigeria, Indonesia, Australia, Malaysia, Norway, Netherlands, Venezuela, Canada, Kazakhstan, Turkmenistan, Uzbekistan, Iraq, Kuwait, China, Egypt and Libya are some other countries, which possess significant amount of natural gas reserves.

TABLE-I: World Natural Gas Reserves – 2012

No.	Countries	Reserves	No.	Countries	Reserves
(1)	Russian Federation	55,000	(2)	Iran	33,500
(3)	Qatar	25,470	(4)	Saudi Arabia	8,200
(5)	United Arab Emirates	2,250	(6)	United States	9,000
(7)	Nigeria	5,246	(8)	Algeria	4,502
(9)	Venezuela	5,525	(10)	Iraq	3,600
(11)	Turkmenistan	26,200	(12)	Indonesia	3,001
(13)	China	3,100	(14)	Norway	2,313
(15)	Malaysia	2,350	(16)	World Total	300,000

Source: World Fact book – 2012

Reserves in billion cubic meters.

IMPORTANT NATURAL GAS PRODUCING COUNTRIES OF THE WORLD

According to 2012 information 104 countries possess natural gas reserves but 86 countries produce natural gas. Among natural gas producing countries following are important gas producing countries;

(1) Russian Federation

Russian Federation possesses largest natural gas in the world – about 18.3% of natural gas reserves of the world. Outranking all countries in the world, Russia produced 669.6 million cubic meters gas in 2012.

The *West Siberian, Tyumen Province* possesses more than 2/3 gas reserves of Russia and is outstanding in gas production. Russia exports gas to Germany, Italy, France, Turkey, Hungary, Czech Republic and Poland. It exports its one-fourth gas output to other countries.

(2) United States

United States ranking 5th in the world, have 9,000 billion cubic meter gas reserves. Its natural gas production during 2011 was 651.3 million cubic meters. U.S.A. is second largest gas producer in the world. In 1820, gas production began at commercial level. *Texas, New Mexico, Louisiana* and *Alaska* states possesses large reserves of gas.

(3) Canada

Canada is 3rd largest producer of natural gas in the world. During 2011, it produced 160.1 million cubic meter natural gas. Its natural gas reserves are 1,754 billion cubic meters and ranks at 20th position in the world. Most of Canadian gas reserves are in *Alberta province*. Canada is producing surplus gas and exports large quantities of gas to United States.

(4) United Kingdom

Production of natural gas began in 1967 in the *North Sea-off* coast. U.K. is 18th largest gas producer in the world. During 2011, it produced 47.4 million cubic meters natural gas. United Kingdom have 28 off shore gas reserves in the North Sea. Bulk of gas production is consumed for generating electricity.

(5) Algeria

In the continent of Africa Algeria possesses largest natural gas reserves. It has 4,502 billion cubic meters gas reserves and ranks 9th in the world. During 2011, Algeria produced 84.81 million cubic meters gas ranking 8th in the world. Algeria is one of the prominent country in *liquefied natural gas* exporting country after Indonesia. It possesses about 35% gas reserves of the Africa.

Algeria's gas reserves are located in *Hassi-R-Mel* field and *In-Salah* region in southeastern region.

(6) Netherland

Ranking at 23rd number in the world, Netherland possesses 1,416 billion cubic meter gas reserves, in the *North Sea*. During 2011, its natural gas production was 81 million cubic meters. Netherland is 10th largest natural gas producing nation in the world.

(7) Iran

Iran is 3rd largest natural gas producing country in the world and it produced about 146.1 million cubic meter natural gas in 2011. Iran possesses second largest gas reserves after Russia — 33,500 billion cubic meters. Iran meets its more than 50% energy requirements from natural gas and export large amounts of natural gas.

Masjid-I-Sulaiman, Naft-I-Shah, Lali, Algha Jari and Bahregan are main gas fields in Iran.

(8) Norway

Norway is another outstanding natural gas producer in *North Sea* region. It is 6th largest natural gas producer and produced about 103 million cubic meters gas in 2011. Norway possesses 2,288 billion cubic meters gas reserves in the *North Sea*.

(9) Indonesia

Indonesia has 3,001 billion cubic meters natural gas reserves and ranks 13th in the world. Its production of gas in 2011 was 82.8 million cubic meters.

The most important gas producing region is *Palembang* in *Sumatra Island*, while *Borneo* produces remaining gas production. *Indonesia outranks all countries in liquefied natural gas production, Japan is largest importer of natural gas from Indonesia.*

(10) Saudi Arabia

Saudi Arabia ranks 6th in natural gas reserves in the world and possesses 8,200 billion cubic meters gas reserves of the world. While in natural gas production, Saudi Arabia is 8th largest country in the world. During 2011, it produced 99.23 million cubic meters natural gas.

Saudi Arabian gas reserves lies in the *eastern oil region* and *off-shore in the Persian Gulf*.

Besides, Uzbekistan, Malaysia, Turkmenistan, China, U.A.E., Argentina, Mexico, Qatar, Australia, Egypt, Pakistan, India, Venezuela, Thailand, Nigeria, Ukraine, Kazakhstan, Germany, Qatar, Australia, Egypt, Pakistan, India, Venezuela, Thailand, Nigeria, Ukraine, Kazakhstan, Germany and Oman also produce large quantities of natural gas.

TABLE-II: Important Natural Gas Producing Countries – 2011

No.	Countries	Production	No.	Countries	Production
(1)	Russian Federation	669.6	(2)	U.S.A.	651.3
(3)	Canada	160.1	(4)	United Kingdom	47.43
(5)	Algeria	84.61	(6)	Netherlands	81.09
(7)	Iran	146.1	(8)	Norway	103.1
(9)	Indonesia	82.8	(10)	Saudi Arabia	99.23
(11)	Uzbekistan	60.11	(12)	Malaysia	66.5
(13)	Turkmenistan	59.5	(14)	China	102.7

World Total: 3,250.00 million cubic meters. Production in million cubic meters.

Source: World Fact book II, 2012



Types of Inexhaustible Resources

Introduction to types of inexhaustible resources:

Natural resources vary greatly in their location, quantity and quality. For instance a particular forest type may occur only in certain countries. Also the geographical area covered by forest and wood quality may differ widely in different countries. Some resources can be reused after being used once. A convenient classification of resources is based upon their exhaustibility and renewability. Basically resources can be categorised as inexhaustible and exhaustible.

Types of Inexhaustible Resources Available on Earth

Inexhaustible resources are available in unlimited quantities on the earth. While some exhaustible resources remain virtually unaffected by human impact many other may show some changes in their quantity though their quantity remained unchanged. Resources like solar energy, wind power, tide power, rainfall and even atomic energy cannot be exhausted sufficiently at global level due to human activities. Such resources may sometimes be locally affected by human activities for example pollution may change quality of air.

Types of Inexhaustible Natural Resources

The types of inexhaustible natural resources are solar radiation, air, water, precipitation and atomic power.

1) Air: Air is an inexhaustible natural resource. Air is essential for the survival of human being and also on entire biota existing on earth. In atmosphere 95% of the total air is present up to the height of above 20km above earth's surface. Air consists of a mixture of various gases in different proportions.

2) Water: The seas, oceans, river, streams, lakes, ponds, pools, polar ice caps, water vapour etc form the hydrosphere. Water is a basic natural resource. It is a valuable national asset. It forms main requirements of human being. Water is obtained from the three natural resources:

1) rain water

2) surface water

3) ground water

Summary

These resources are present in unlimited quantity in the nature and they are not likely to be exhausted by human activities. Some of the inexhaustible natural resources are solar radiation, air, water etc.

Inexhaustible Resources Definition

Introduction:

Rapid urbanization and advancement in technology has resulted in the overuse of natural resources and energy. Not many of these natural resources are unlimited. Drinking water, land and trees are soon becoming a limited resource. There are also some of the in-exhaustible resources. It is air, water, solar energy and geothermal energy. The word 'in-exhaustible resources' means resources which are unlimited in nature or which can never be exhausted on usage by human activities.

In other words, resources that will never run out are called as in-exhaustible resources.

Facts about Inexhaustible Resources:

Air is in abundance and is in-exhaustible, but yes the quality of the air is definitely deteriorating because of human activities and industrialization.

Solar energy is one of the most in-exhaustible resources found on earth. Besides this tides and geothermal energy is also considered as in-exhaustible resource. Those resources which can be replenished naturally by environment, are the ones known as in-exhaustible resources.

Geothermal energy is one of the in-exhaustible resources that has not gained much popularity due to lack of research carried out in these areas. Here power is being generated by extracting power from heat stored in earth. This seems to be the most cost effective, efficient, reliable, sustainable and environmental friendly for generation of power.

Facts about Resources and Definition.

Wind which is one more in-exhaustible resource can be used for the production of electricity through wind mills.

Water is one more in-exhaustible resource which is replenished by precipitation or rain. This should not be confused with drinking water which is an exhaustible resource.

Tidal energy is also a renewable resource or an in-exhaustible resource as there is tides always and gravitational forces of moon and earth will never cease to exist. However tides are totally unpredictable and electricity can be generated when only tides flow in or out. But yes, tides are more predictable than wind and solar energy.

In other words, resources that will never run out are called as in-exhaustible resources.

Examples of Inexhaustible Resources

Introduction to examples of inexhaustible resources:

"Inexhaustible resources are those resources which would never fall short of demand at world scale so long as the planetary system exists."

(definition given by O.S Owen)

The examples of inexhaustible resources are sunlight, water, wind etc.

Here we will discuss about these resources which we have used in more scientific ways to make our life more easier and to conserve the exhaustible resources.

Solar Energy of Inexhaustible Resources:

Sun is the main source of energy. We all know that plants use the sun energy in photosynthesis and we eat these plants, so indirectly we are also using the sun energy. This is the natural use of sun energy. But as the needs of human beings increased over time, they made us devise more ways of harnessing solar energy. In ancient times, food was cooked on fires of wood. Then came the coal, and then, LPG. LPG is the petroleum product and as we all know that petroleum is not a renewable source. So the need of new invention has risen, which can replace the petroleum products. The solar cooker, solar water heater, solar calculator etc are made which derive energy from sunrays. Solar batteries are used in space flights which continue to supply power to the satellite. The solar power cells setup in Haiti were the only source of energy that helped them in the earth quake.

Wind Energy of Inexhaustible Resources:

As the name clearly tells, energy obtained from the wind is known as wind energy. The wind energy is converted into electricity. It is done with the help of wind mills. When the fast moving wind strikes blades of wind mills, the blades rotate and then with the help of a belt system the energy is transmitted to a machine which helps in generating electricity. It is also used in grinding grains and lifting water. The windmills in Germany produced so much power during a storm that storing it became a difficult task.

Tidal Energy of Inexhaustible Resources:

The energy of tides is used in coastal areas. Rising tides possess mechanical energy. This energy when harnessed properly, becomes a great source of power generation. In France, power generation is done by tidal energy. An artists view of the tidal power plant in France:-

So these are the few inexhaustible resources. If these resources are used properly we can have a more simple life without harming nature.

Types of Exhaustible Resources

Introduction to types of exhaustible resources:

The stock of these resources are limited in nature. These resources natural resources are liable to be degraded in quantity and quality by the human activities. Some of the exhaustible natural resources are soil, forest, wild animals, fossil fuels (coal, petroleum), etc. For example, mineral deposit of fossil fuel are formed slowly over millions of years and if they are once used cannot be regenerated. Likewise, the formulation of soil takes thousands of years for its formation and is not renewable in the life span of many generation of human being.

Important Types of Exhaustible Resources:

1. **Soil:** soil is a main exhaustible natural resources which is essential for survival and development of human beings. Indeed we meet our basic requirements of food, clothing, and shelter mainly from the plants that grow in the soil or from animals that feed on such plants. Soil is a stratified mixture of organic and inorganic materials, both of which are decomposition product.
2. **Minerals:** Minerals from exhaustible natural resources, since, their new materials can only be extracted from earth's crust once. Mineral deposits are formed slowly over millions of years and ones used cannot be regenerated. However, even in the transformed state in which minerals are used, they are not lost to the planet and so ideally available for reuse. Our under ground reservoir of metals and minerals are limited.
3. **Energy:** Our country is an agricultural country. Majority of Indian population lives in villages. A large part of total used in rural India comes from fuel wood, agriculture waste, cow's dug etc., whereas most of the energy consumed by urban Indian population is derived from coal, petroleum, natural gases.

Types of Exhaustible Resources : Different Sources of Power Generation

TABLE: Different sources of power generation:

SOURCES	ELECTRICITY PRODUCTION
1. Thermal power	70,000
2. Hydel power	23,800
3. Nuclear power	2,700
4. Wind power	1,150
5. Biomass power	256

Types of exhaustible resources in Forests and Wildlife:

Examples of Exhaustible Natural Resource

Introduction to Examples of exhaustible natural resources:

Natural resource are found in nature and they are either exhaustible or non exhaustible. Natural resources cannot be man-made but some of them can be renewed. There are various kinds of natural resources like sunlight, air, wind, soil, water, flora and fauna (wildlife that cannot be domesticated), minerals and fossil fuels. Air, water, sunlight are some of the natural resources that are needed for continuous survival of life on the Earth. Oxygen is the most important in that.

Exhaustible Natural Resources –

Exhaustible natural resources cannot be renewed after using them. Minerals and fossil fuels are examples for exhaustible natural resources.

1. Minerals – Minerals are the natural solid substances formed by geological processes. Minerals have a crystalline structure with a well defined chemical composition. A mineral is different from a rock. Minerals consist of a chemical composition, an ordered atomic structure and specific physical properties. Precious stones like Gold and silver are minerals. Various stones like lime stone and mica are also minerals. These are found in various layers of the Earth. Some are on the outer crust of the Earth but some are found in inner crust also. So the act of mining is needed to extract them and it results in exploitation of nature.
2. Fossil fuels – Fossil fuels are formed by the organic decay of various plants and animals. This process takes many years to get transformed into fossil fuels. Oil, gases and coal come under the category of fossil fuels. Most of the energy in the world is generated by the fossil fuels. Energy from fossil fuel is used for generating electricity majorly but along with this it is used for heating, transport, etc. They are also extracted by mining. These are very cheap as they are from the nature but extreme usage of these cause ecological disbalance.
3. To some extent soil as it takes a very long time to replace soil or to renew it.

1. **FORESTS:** Forest is an uncultivated and uninhabited piece of land. Normally forest is dominated by trees. However, a forest is any land managed for the diverse purpose of forestry whether covered with trees, shrubs, climbers etc. Forests occupy a special place in the life and throughout of the people.
2. **WILDLIFE:** The native population of a community make its wildlife. The term wildlife means all those naturally occurring animals, plants and their species which are not cultivated.