1.1 ORIGIN, OCCURRENCE OF PETROLEUM(2)

The petroleum industry began with the successful drilling of the first commercial oil well in 1859, and the opening of the first refinery two years later to process the crude into kerosene. To those unfamiliar with the industry, petroleum refineries may appear to be complex and confusing places. Refining is the processing of one complex mixture of hydrocarbons into a number of other complex mixtures of hydrocarbons.

ORIGIN. Most theories concerning the origin of petroleum postulate a vegetable origin with a close relationship to coal. Theory holds that any organic matter may be converted into petroleum under suitable conditions. There is also general agreement that petroleum was formed from organic matter near shore and in marine deposits deficient in oxygen and associated with minerals converted by time and pressure into limestones, dolomites, sand stones,and similar rocks. The concentration of organic matter in the original deposits may not have been high, but petroleum gas and liquids have migrated and gathered in places favouring retention, e.g., sealed-off porous sandstones. Over long periods of time, carbohydrates and proteins are probably destroyed by bacterial action leaving the fatty oils which are more refractory to bacterial or chemical destruction.

Petroleum, the product of natural changes in organic materials over millennia, has accumulated beneath the earth's surface in almost unbelievable quantities and has been discovered by humans and used to meet our varied fuel wants. Because it is a mixture of thousands of organic substances, it has proved adaptable to our changing needs. It has been adapted, through changing patterns of processing or *refining,* to the manufacture of a variety of fuels and through chemical changes to the manufacture of a host of pure chemical substances, the petrochemicals.

HISTORICAL. In the United States, Indians used oil seepages in Pennsylvania as medicines, and worldwide, various bitumens were known in Biblical times. Moses' burning bush may well have been an accidentally ignited gas vent. Drake's crude oil well, completed in 1859, showed the world the existence of extensive underground reservoirs of material then mainly Useful as a source of kerosene for illuminating lamps. The useless gasoline, which at times had been towed out to sea and burned as a nuisance, gradually became the major product with demand exceeding the supply. Improved quality, as represented by antiknock value, was also desired. The available quantity was extended by converting less desirable fractions into gasoline, first by thermal, later by catalytic cracking processes. Quality improvement in gasoline was brought about by cracking, the tetraethyllead antiknock properties discovery, polymerization, alkylation, aromatization, and through the gradual awareness that transformations of many kinds were possible by the application of organic processes on a large scale.

Refining has always been pushed along reluctantly by economic factors. For years, many companies viewed refining as a necessary evil to be endured so that they could

make money from the more. vital production and sale of the crude oil which they produced. Only recently, most companies have come to realize that their purpose is to take a many-component raw material and convert it, at maximum profit, into materials to fulfill the needs of a complex and constantly shifting multiproduct market. In 1930, a company could market only gasoline, kerosene, heating fuel, gas oil, and residuum and show a profit. Today the market is far more complicated, and the marketing decisions are more difficult. Simple fractionation of crude oil Into fractions was once sufficient but such simple products would rarely be salable now. Quallty needs require upgrading, blending, and consistent quality control of the finished products, although the crudes refined may vary greatly in type and distillate content.

The United States is the largest consumer of petroleum products in the world and has the Kreatest refining capacityl (2,763,800 m3/ day), but is no longer self-sufficient in raw material. The petroleum industry in its design, operation, sales, and executive branches is the largest employer of chemical engineers. Refining processes have become extremely large and quite complicated. All the branches of this industry are so interrelated and technical that engineering training is required at every level. Needs for technical help are also being enlarged because: (1) sudden price increases for crude and changing markets have required extensive technical readjustment designed to make better use of an expensive and increasingly scarce commodity and (2) the industry has expanded into many other chemical fields- including supplying raw materials formerly supplied by other, smaller sources.

Chemical engineering and petroleum processing have in a very real sense grown up together. Studies on fluid flow, heat transfer, distillation, absorption, and the like were taken and applied to a wide variety of materials because of need in the petroleum processing field. Since refined products have physical properties which vary widely from those of water, theory has been refined to include these variables, thus expanding the scope of chemical and mechanical engineering science.

Early refineries used batch stills, small horizontal cylinders, with little or no differential distillation to separate the components, and a condenser. This equipment was originally developed for distilling alcohol. The still produced first gas, then gasoline, then a series of oils of increasing average boiling points and lower value, until a heavy lubricating oil, or asphalt (depending upon the type of crude charged) remained in the still. Modern units operates continuously. First a tubular heater supplies hot oil to an efficient distillation column which separates the material by boiling points into products similar to those obtained with the batch still, but more cleanly separated; then later units convert the less salable parts of the crude (so called bottom half of the barrel) into desired salable products. The processes used include various cracking units (which make small molecules from large ones), polymerization, reforming, hydrocracking, hydrotreating, isomerization, severe processing known as coking, and literally dozens of other processes designed to alter boiling point and molecular geometry.

EXPLORATION. At one time drilling for petroleum was a hit-or-miss affair and only one out of 100 wildcat wells struck oil. Geophysical and seismic work has become highly refined, and when combined with high-speed computers to evaluate the vast

amount of data used to locate sites, the chance of drilling success has greatly increased. Geologists and geophysicists studied the occurrence of oil and used scientific instruments to direct their recommendations until, by 1962, 1 out of 9 wells drilled produced either oil, gas, or both. Today's success rate is even better. Discoveries are now being made in previously explored and rejected areas of difficult geology, such as the Rocky Mountain over thrust area, and the success rate remains high.

Geologists recognized at an early date that petroleum accumulates in pools caught in the anticlinal folds of sedimentary rocks. The gradual accumulation of data from drilling cores has guided the test procedures. At scientifically selected sites, wells have been drilled deeper than 6500 m to reach gas or oil.

Scismic analysis can determine the presence of domes and deposits at a considerable depth below the surface. The top of the arch of an anticline or dome is compressed and has a greater density than the surrounding rocks. Figure shows the various strata surrounding oil-bearing rock or sand. Oil and salt also have lower densities than the surrounding rocks. Creating small seismic waves and measuring their reflected waves at intervals in space and time makes possible accurate gravimetric mapping. The finding of a new field is a most serious and expensive undertaking.

B. BASICS OF CRUDE OIL.

1. Crude oils are complex mixtures containing many different hydrocarbon compounds that vary in appearance and composition from one oil field to another. Crude oils range in consistency from water to tar-like solids, and in color from clear to black. An "average" crude oil contains about 84% carbon, 14% hydrogen, 1%-3% sulfur, and less than 1% each of nitrogen, oxygen, metals, and salts. Crude oils are generally classified as paraffinic, naphthenic, or aromatic, based on the predominant proportion of similar hydrocarbon molecules. Mixed-base crudes have varying amounts of each type of hydrocarbon. Refinery crude base stocks usually consist of mixtures of two or more different crude oils.

2. Relatively simple crude oil assays are used to classify crude oils as paraffinic, naphthenic, aromatic, or mixed. One assay method (United States Bureau of Mines) is based on distillation, and another method (UOP "K" factor) is based on gravity and boiling points. More comprehensive crude assays determine the value of the crude (i.e., its yield and quality of useful products) and processing parameters. Crude oils are usually grouped according to yield structure.

3) Crude oils are also defined in terms of API (American Petroleum Institute) gravity. The higher the API gravity, the lighter the crude. For example, light crude oils have high API gravities and low specific gravities. Crude oils with low carbon, high hydrogen, and high API gravity are usually rich in paraffins and tend to yield greater proportions of gasoline and light petroleum products; those with high carbon, low hydrogen, and low API gravities are usually rich in aromatics.

4) Crude oils that contain appreciable quantities of hydrogen sulfide or other reactive sulfur compounds are called "sour." Those with less sulfur are called "sweet." Some exceptions to this rule are West Texas crudes, which are always considered "sour"

regardless of their H_2S content, and Arabian high-sulfur crudes, which are not considered "sour" because their sulfur compounds are not highly reactive.

TABLE TYPICAL APPROXIMATE CHARACTERISTICS AND PROPERTIES AND GASOLINE POTENTIAL OF VARIOUS CRUDES (Representative average numbers)

Crude source	Paraffins (% vol)	Aromatics (% vol)	Naphthenes (% vol)	Sulfur (% wt)	API gravity (approx.)	Napht. yield (% vol)	Octane no (typical)
Nigerian -Light	37	9	54	0.2	36	28	60
Saudi -Light	63	19	18	2	34	22	40
Saudi -Heavy	60	15	25	2.1	28	23	35
Venezuela -Heavy	35	12	53	2.3	30	2	60
Venezuela -Light	52	14	34	1.5	24	18	50
USA -Midcont. Sweet	-	-	-	0.4	40	-	-
USA -W. Texas Sour	46	22	32	1.9	32	33	55
North Sea -Brent	50	16	34	0.4	37	31	50

Top petroleum-producing countries

#	Producing Nation for 2004	(×106bbl/d)	(×103/d)
1	**Saudi Arabia**	10.37	1,649
2	**Russia**	9.27	1,474
3	**United states 1**	8.69	1,382
4	**Iran (OPEC)**	4.09	650

5	**Mexico**	3.83	609
6	**China**	3.62	576
7	**Norway**	3.18	506
8	**Canada 1,3**	3.14	399
9	**Venezuela (OPEC) 1**	2.86	455
10	**United Arab Emirates (OPEC)**	2.76	439
11	**Kuwait (OPEC)**	2.51	299
12	**Nigeria (OPEC)**	2.51	299
13	**United Kingdom 1**	2.08	331
14	**Iraq (OPEC) 2**	2.03	323

[2] Though still a member, Iraq has not been included in production figures since 1998

[3] Canada has the world's second largest oil reserves when tar sands are included, and is the leading source of U.S. imports, averaging 1.7 MMbbl/d in April 2006.

World's Largest Refineries (Barrels/Day)

Name of Refinery	**Country**	**Barrels/day**
Paraguama Refining complex(CRP)- amuay and Cardon	**Venezuela**	**940,000**
SK Corporation	South Korea	817,000
Reliance 1	India	661,000
GS Caltex	South Korea	650,000
Exxon mobile	Singapore	605,000
Exxon mobile	Bay town,USA	557,000
S-oil	South Korea	520,000
Hovensa LLC	Virgin islands	495,000
Exxon mobile	Batonrouge, USA	493,500
Shell Eastern	Singapore	458,000
Citgo lake Charles	USA	425,000
Shell Pernis Refinery	Netherlands	416,000
Saudi Armco yanbu Refinery	Saudi Arabia	400,000
Exxon mobile	Beatmont TX,USA	348,500
Chevron Pascagoula	MS, USA	300,000

REFINERIES IN INDIA

1.Barauni Refinery in Eastern India was built in collaboration with the at a cost of **Rs.49.4 crores** and went on stream in **July, 1964**. By November, 1967, the initial capacity of **2 MMTPA** was expanded to **3 MMTPA** by 1969. The present capacity of this refineries is 6.00 MMTPA. A Catalytic Reformer Unit (CRU) was also added to the in 1997 for production of unleaded. Projects are also planned for meeting future fuel quality requirements.

2.Bongaigaon Refinery & Petrochemicals Limited (BRPL) has the unique distinction of being the first indigenous grass root Refinery in the country integrated with a Petrochemical complex at one location.At present, the Refinery is processing crude available from the oil fields of East India and Ravva crude oil from the Krishna-Godavari basin off the coast of Andhra Pradesh.The capacity of the Refinery was augmented in through expansion of the Refinery comprising of one Crude Distillation Unit (CDU-II) and one Delayed Coking Unit (DCU-II). A bottling plant of capacity 22000 MTPA was added to the complex and commissioned on March.

3.Chennai Petroleum Corporation Limited (CPCL), formerly known as Madras Refineries Limited (MRL) was formed as a joint venture in 1965 between the Government of India (GOI),AMOCO and National Iranian Oil Company (NIOC) having a share holding in the ratio 74%: 13%: 13% respectively. From the grassroots stage CPCL Refinery was set up with an installed capacity of 2.5 Million Tonnes Per Annum (MMTPA) in a record time of 27 months at a cost of Rs. 43 crore without any time or cost over run.In 1985, AMOCO disinvested in favour of GOI and the shareholding percentage of GOI and NIOC stood revised at 84.62% and 15.38% respectively. Later GOI disinvested 16.92% of the paid up capital in favor of Unit Trust of India, Mutual Funds, Insurance Companies and Banks on 19th May 1992, thereby reducing its holding to 67.7 %. The public issue of CPCL shares at a premium of Rs. 70 (Rs. 90 to FIIs) in 1994 was over subscribed to an extent of 27 times and added a large shareholder base of over 90000.As a part of the restructuring steps taken up by the Government of India, Indian Oil Corporation Limited (IOCL) acquired equity from GOI in 2000-01 Currently IOC holds 51.88% while NIOC continued its holding at 15.40%. In view of the CPCL become subsidiary of IOCL in 2001. The Manali Refinery has a capacity of 9.5 MMTPA and is one of the most complex refineries in India with Fuel, Lube, Wax and Petrochemical feedstocks production facilities.

4.The **Digboi Refinery** was set up at in 1901 by Assam Oil Company Limited. The Indian Oil Corporation Ltd. took over the refinery and marketing management of Assam Oil Company Ltd. with effect from and created a separate division. This division has both refinery and marketing operations. The refinery at Digboi had an installed capacity 0.50 MMTPA (million metric tonnes per annum). The refining capacity of the refinery was increased to 0.65 MMTPA by modernization of refinery in July, A new delayed Unit of 1,70,000 TPA capacity was commissioned in. A new Solvent Dewaxing Unit for maximizing production of wax was installed and commissioned in 2003.

5.The **Gujarat Refinery** was built with assistance at a cost of 26 crores and went on stream in October 1965. The refinery had an initial installed capacity of 2 MMTPA (Million Metric Tonnes Per Annum) and was designed to process crude from Ankleshwar, Kalol and Nawagam oilfields of Oil & Natural Gas Commission in Gujarat. In September 1967, the capacity of the refinery was expanded to 3 MMTPA. The capacity of the refinery was further increased to 4.3 MMTPA through debottlenecking measures and to 7.3 MMTPA in October 1978 by implementing an expansion project of Rs.56.07 crores. With the implementation of additional processing facilities the Refinery could achieve capacity of 9.5 MMTPA in 1989. The refining capacity was further expanded to 12.5 MMTPA with commissioning of 3.0 MMTPA CDU in September, 1999. The present refining capacity of this refinery is 13.70 MMTPA.

6.Guwahati Refinery is an oil refinery near Guwahati owned by the Indian oil Corporation.It was the first in the public sector and was set up in collaboration with Romania at the cost of 17.29 Crore. and commissioned on 1st January 1962 with a design capacity of 0.75 MMTPA. The present capacity of this Refinery is 1.00 MMTPA.A Hydrodesulfurization for improving the quality of has been installed and was commissioned in 2002. The refinery has also installed in 2003 Indmax Unit, a novel technology developed by its R&D Centre for upgrading heavy ends motor spirit and diesel oil.

7.The **Haldia Refinery** for processing 2.5 MMTPA of Middle East crude was commissioned in January, 1975 with two sectors - one for producing fuel products and the other for Lube base stocks. The fuel sector was built with collaboration and the Lube sector with Romanian collaboration. The refining capacity of the Refinery was increased to 2.75 MMTPA in 1989 through debottlenecking measures. The refining capacity was further expanded to 3.75 MMTPA with the commissioning of new crude distillation unit of 1.0 MMTPA in March, 1997. The present refining capacity of this Refinery is 6.00 MMTPA

8.The **Jamnagar Refinery** is a private sector petroleum Refinery owned by Reliance Industries Petrochemicals Limited in Jamnagar, India. The refinery was commissioned on July 14, 1999 with an installed capacity of 661,000 barrels per day. It is the largest greenfield refinery in the world and third largest Refinery in the world. The refinery is currently undergoing massive expansion that will double its capacity to 1.2 million barrels per day. This will enable it to serve both the local demand and also act as an export refinery.

9.Kochi Refineries Ltd (KRL), is an operator of oil refinery located at Kochi India, Kerala. The company, formerly known as Cochin Refineries Ltd., was set up in pursuance of a formation agreement dated April 27,1963 was formally registered on September 6, 1963 at Ernakulam. The company was established by the Government of India.Philips Petroleum was also the prime contractors for the construction of the refinery. They entrusted the work to Pacific Procon Limited. Construction work started in March 1964 and the first unit came operational in September 1966. The installed capacity of 2.5 MMTPA was increased to 3.3 in September 1973, and to 4.5 MMTPA in

November 1994. The capacity of the Oil Refinery was further increased to 7.5 MMTPA in December1995.

The **Mathura Refinery** with a capacity of 6.00 MMTPA was set up at a cost of Rs.253.92 crores. The Refinery was commissioned in January, excluding FCCU and Sulphur Recovery Units which were commissioned in Jan, 1983. The refining capacity of this refinery was expanded to 7.5 MMTPA in by debottlenecking and revamping. A DHDS Unit was commissioned in 1989 for production of HSD with low content of 0.25% wt. (max.). The present refining capacity of this Refinery is 8.00 MMTPA

10.The **Mumbai Refinery** in, , came into stream in 1954 under the ownership of. In March 1974 the Government of India acquired it along with. was formed on after the merger of these companies. The capacity of the Mumbai Refinery of Hindustan Petroleum was 3.5 MMTPA which was increased to 5.5 MMTPA during after the implementation of an expansion programme. The Refinery at Mumbai came into stream in January, under the ownership of Burmah-Shell Refineries Ltd. Following the Government's acquisition of the Burmah-Shell, name of the Refinery was changed to Bharat Refineries Limited on. In August, , the Company was given its permanent name, viz. Bharat Petroleum Corporation Ltd.) The installed capacity of 5.25 MMTPA was increased to 6 in 1985. The present refining capacity of the refinery is 6.9 MMTPA.

11.Mangalore Refinery and Petrochemicals Limited (MRPL), located at Katipalla, north from centre of Mangalore city, is a State of the art Grassroot Refinery at Mangalore and is a subsidiary of ONGC, set up in 1998.The refinery was established after displacing five villages of Bala, Kalavar, Kuthetoor, Katipalla, and Adyapadi.The refinery has a versatile design with high flexibility to process crudes of various API and with high degree of automation. MRPL has a design capacity to process 9.69 million metric tonnes per annum and is the only refinery in India to have two hydrocrackers producing premium diesel (high cetane). It is also the only refinery in India to have two CCRs producing unleaded Petrol of high octane.MRPL, which was a joint sector company, become a PSU subsequent on acquisition of its majority shares by ONGC.Before acquisition by ONGC in March 2003, MRPL was a joint venture oil refinery promoted by M/s Hindustan Petroleum Corporation Limited , a public sector company and M/s IRIL & associates AV Birla Group). MRPL was set up in 1988 with the initial processing capacity of 3.0 million metric tonnes per annum that was later expanded to the present capacity of 9.69 million metric tonnes per annum.The refinery was conceived to maximise middle distillates, with capability to process light to heavy and sour to sweet crudes with 24 to 46 API gravity. On 28 March 2003, ONGC acquired the total shareholding of A.V. Birla Group and further infused equity capital of Rs.600 crores thus making MRPL a majority-held subsidiary of ONGC. The lenders also agreed to the debt restructuring package (DRP) proposed by ONGC, which included, *inter alia*, conversion up to Rs 365 core of their loans into equity. Subsequently, ONGC has acquired equity allotted to the lenders pursuant to DRP raising ONGC’s holding in MRPL to 71.62 percent.

12.The **Mathura Refinery** with a capacity of 6.00 MMTPA was set up at a cost of Rs.253.92 crores. The Refinery was commissioned in January,1982. excluding FCCU and Sulphur Recovery Units which were commissioned in Jan, 1983. The refining capacity of this refinery was expanded to 7.5 MMTPA in 1989 by debottlenecking and revamping. A DHDS Unit was commissioned in 1989 for production of HSD with low sulphur content of 0.25% wt. (max.). The present refining capacity of this Refinery is 8.00 MMTPA

13.The **Mumbai Refinery** in Mumbai,Maharashtra,India. came into stream in 1954 under the ownership of Esso. In March 1974 the Government of India acquired it along with Lubes.Hindustan Petroleum was formed on 1974 after the merger of these companies. The capacity of the Mumbai Refinery of Hindustan Petroleum was 3.5 MMTPA which was increased to 5.5 MMTPA during 1986 after the implementation of an expansion programme

14.The Refinery at Mumbai came into stream in January,1955 under the ownership of Burmah-Shell Refineries Ltd. Following the Government's acquisition of the Burmah-Shell, name of the Refinery was changed to Bharat Refineries Limited on 1976. In August,1977, the Company was given its permanent name, viz. Bharat Petroleum Corporation Ltd.(BPCL). The installed capacity of 5.25 MMTPA was increased to 6 MMTPA in 1985. The present refining capacity of the refinery is 6.9 MMTPA

15.CPCL's second refinery is located at Cauvery Basin at **Nagapattinam**. The initial unit was set up in Nagapattinam with a capacity of 0.5 MMTPA in 1993 and later on its capacity was enhanced to 1.0 MMTPA.

16.Nestling in the sylvan environs of the Brahmaputra valley where the beautiful rendezvous of water and land throws up myriad colours, **Numaligarh Refinery Limited (NRL),** which was set up at Numaligarh in the district of Golaghat (Assam) in accordance with the provisions made in the historic Assam Accord signed on 15th August 1985, has been conceived as a vehicle for speedy industrial and economic development of the region.The 3 MMTPA Numaligarh Refinery Limited was dedicated to the nation by the erstwhile Hon'ble Prime Minister Shri A. B. Vajpayee on 9th July, 1999.NRL has been able to display creditable performance since commencement of commercial production in October, 2000. With its concern, commitment and contribution to socio-economic development of the state combined with a track record of continuous growth, NRL has been conferred the status of Mini Ratna PSU.The present authorized capital of the company is Rs. 1000 crores and paid up capital is Rs. 735.63 crores. The shareholding pattern as on 31-03-2006 is given below:Bharat Petroleum Corporation Limited : 62.96% Govt. of Assam : 12.35% Oil India Limited : 12.35% Oil Industry Development Board : 12.34% Total : 100.00%. Product Range : Product range includes LPG, Naphtha, Motor Spirit (MS), Aviation Turbine Fuel (ATF)Superior Kerosene Oil (SKO)High Speed Diesel (HSD), Raw Petroleum Coke (RPC) Calcined Petroleum Coke (CPC) & Sulphur. Retail Segment : Strategic decision was taken to enter into the Retail Distribution segment. Permission was received from Govt. of India to market MS & HSD through a chain of 510 Retail Outlets in a phased manner. Hitherto, scores of retail

outlets, aptly christened 'Energy Stations' have already been commissioned in the North East and other parts of India and the process continues. Commitment to the community: NRL is conscious of the fact that the ongoing process of economic reforms is irreversible and the challenge of change on all facets of business and environment is inevitable. So is the fact that the real purpose of business is human well being. This dictum remains the driving force of all our social commitments. In keeping with this ideology, the company has both spawned and sponsored a succession of social initiatives which entail such diverse activities as providing relief to upgrading skill and productivity of the beneficiaries.

17.Panipat Refinery is an oil refinery that was set up in 1998. It is located in Baholi village, panipat in Haryana. Panipat is the seventh refinery belonging to Indian oil corporation Limited.. The cost of the refinery's construction was Rs 9024 Crore. It has a capacity of twelve MMTPA.

18.Tatipaka Refinery is a mini oil refinery of ONGC with capacity of about 0.1 MMTPA with an approved cost of Rs.29.9 crore. It was commissioned in September, 2001 at Tatipaka in the East Godavari District of Andrapredesh.

19.Visakh Refinery is one of the two refineries of HPCL, the other being Mumbai Refinery. In 1957, Visakh Refinery went on stream under the ownership of M/s Caltex India Ltd. In May, 1978, M/s Caltex Oil Refinery (India) was amalgamated with Hindustan Petroleum Corporation Ltd. The installed capacity of 1.5 MMTPA was increased to 4.5 MMTPA in 1985 and 7.5 MMTPA in 1999, through an expansion programme

PRODUCTION STATISTICS: The free world's consumption of petroleum in 1982 was 2.69 X I0^9 m^3, down from the 1979 peak of 3.04 X 10^9 m^3. Total world consumption was estimated at 5.59 X 10^9 m^3/ year. U.S. oil fields produce approximately 14 percent of the world's petroleum as shown in Table. Most of the free-world fields, except those of OPEC (Organisation of Petroleum Exporting Countries), are currently producing at maximum rates. No industry publishes more extensive statistical data than does the petroleum industry through the API (American Petroleum Institute) and other data-collecting agencies. Table show the quantities of refined products currently produced in the United States. Table show. the petroleum industry expenditures for new plants and equipment. It is felt that gasoline consumption in the United States has now peaked, so the major new growth will be consumption of diesel fuel and kerosene-based jet fuels until these last two will exceed gasoline.OPEC now provides 50 percent of the total free-world oil production. By 1990, this should be somewhat less as new fields are found in other locations, and as OPEC reaches productive maturity.