

PETROLEUM — ITS PRESENT AND FUTURE

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"Time is a threefold present — the present as we experience it;
the past as present memory; and the future as present expectations"

— St. Augustine

ABSTRACT

World's "published proved" reserve of oil by the end of 1984 was known to be of the order of 95,000 million tonnes. Of this, 57% lies buried in the middle eastern countries. At the present rate of growth in consumption and production of oil the existing reserves can be expected to last at least up to 2019 AD. In recent years, however, both production and consumption of oil indicate a negative growth rate. New resources are being discovered both onshore and offshore. Mostly the latter are adding to the reserve pool of the oil almost every year. With the present trend of development and better management of the available resources, the oil reserves are expected to last well into the next century.

The present ratio between production and consumption of oil in India is about 1:1.3. Analysing the present trend of increase in production and consumption, it has been estimated that India can become self-sufficient in oil within the next few years. The existing onshore and offshore reserves in the country will at least last for the next 25 years. New discoveries, added to the attainment of self sufficiency, reduction in production as well as in consumption and efforts to supplement the fossil fuels by non-conventional and renewable sources of energy will optimistically take us well within the twentyfirst century.

Key-words: Petroleum, onshore, offshore, trend.

INTRODUCTION

Petroleum hydrocarbons, oil, or fossil fuels, are the most important sources of primary energy for mankind. The contribution of oil and natural gas, as the sources of primary energy, is about 60% of the total for all the sources put together. Hence, more than two-third of this contribution comes from the oil alone (BP 1984).

Due to their limited availability and non-renewability, the reserves of fossil fuel are dwindling all over the world. Though new discoveries are made from time to time, largely in offshore areas, the prospect does not appear to be very bright. We may have to enter the twentyfirst century with very little reserve of fossil fuel.

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Various predictions and forecasts have been made about the future of oil in the world. Far from giving a clear picture, the situation which emerges is quite confusing due to the diversity of opinion at present ranging on the subject.

We have, therefore, made an attempt to analyse the picture in the global context with particular reference to India. Our sources of data are the yearly statistical reviews published by the British Petroleum (1978, 1979, 1980, 1981, 1982 & 1984). Oil and Gas Journal (1979, 1980, 1981, 1982, 1983, 1984) and Petroleum Asia Journal (1982a, b & 1983).

DISCUSSION

A. World & Middle East

World's "published proved" reserve of oil at the end of 1984 was 95,020 million tonnes (MT) of which 54,180 MT or 57% come from the middle east (ME) countries, indeed a very significant part of the total. Because of their strong influence on the world oil market, we thought that a comparison of ME countries with the global oil scenario will be worthwhile to depict a picture of oil — its present and future.

Figure 1 (i) shows the production of oil both in the ME countries and in the world from 1968 to 1983. The increase is gradual throughout with a decline from 1974 to 1975 and from 1979 onwards. Global oil prices shot up fivefold from 1973 to 1974 with marginal rise till 1978 after which it almost doubled in 1979 and trebled in 1980. However, from 1981 to 1983, there is a clear decline. Fluctuations in both the curves of production in Fig. 1 (i) are mostly due to price rise. Instead of calculating on the present decreasing pattern we thought that a more 'realistic' picture could be obtained if a 'trend analysis' (applying the linear-least square regression method) is used for the entire period (1968 to 1983). This analysis showed that the global oil production in 2000 AD will be 4079 MT of which the ME countries will account for 1043 MT (Table I).

Figure 1 (ii) shows the global marine transport of oil and the share of the ME countries from 1968-1983. Two oil tanker routes, originating in the ME countries extend into the Arabian Sea leading to various destinations and thus transporting about 50-60% of the total global marine transport of oil and its products (Sen Gupta and Kureishy, 1981). After 1981, however, the total transport has been gradually decreasing [Fig. 1 (iii)]. Like production, the transport also reached a peak in 1973-1974 after which it declined twice, once in 1975 and then again from 1979 onwards (Table I). The values work out as 1824 and 929 MT for the marine transport for the world and the ME countries respectively in the year 2000 AD.

Figure 1 (iii) shows the share of the ME countries in the global production and transport of oil from 1968 through 1983. Though the share in the

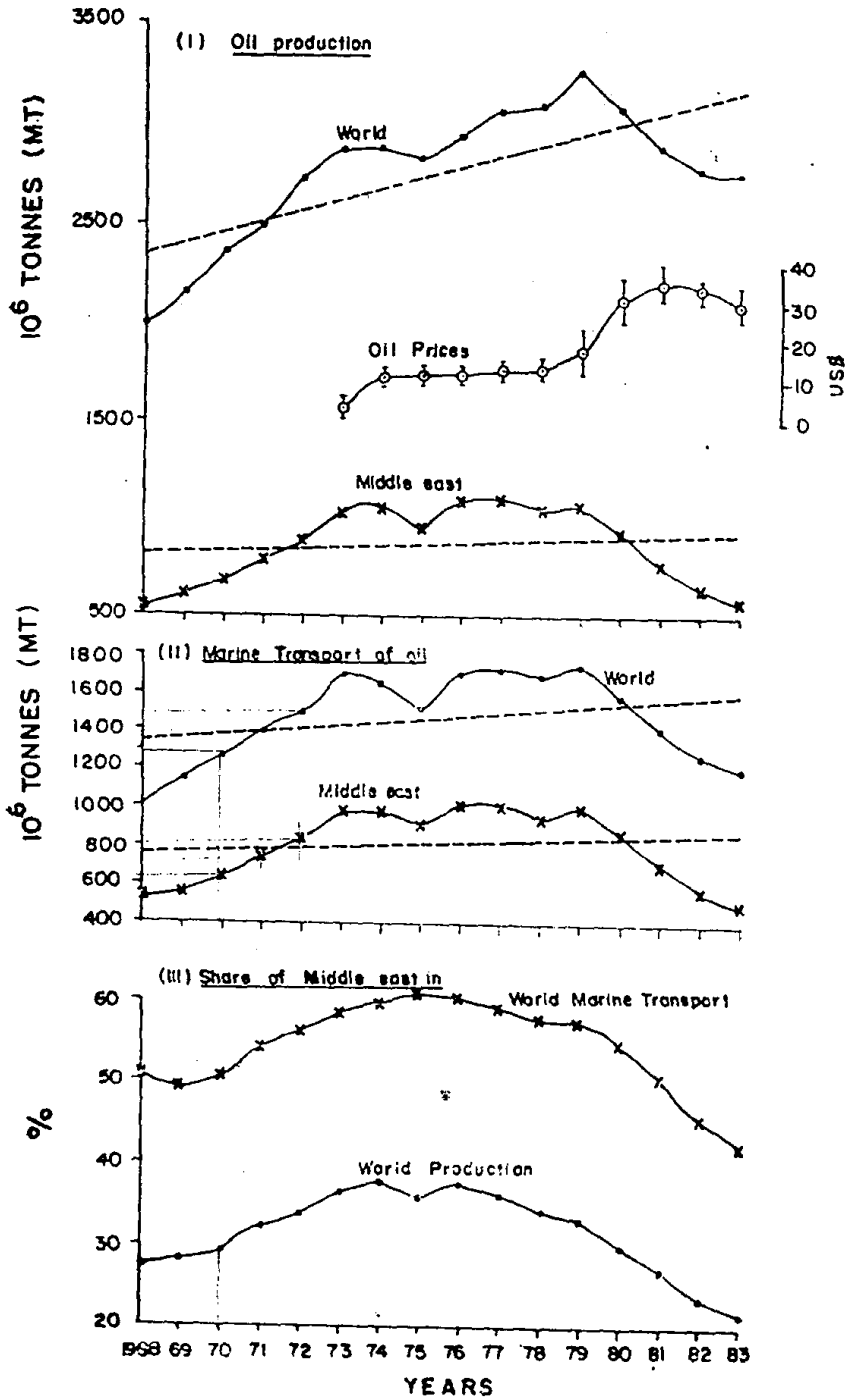


Fig. 1. (i) Oil production in the world and the Middle East countries and fluctuations in oil prices; (ii) Marine transport of oil in the world and the Middle East countries. Broken lines in (i) and (ii) are best fit for the equations of trend analysis. (iii) Percentage share of Middle East countries in World production and World marine transport from 1968 to 1983.

production ranged from a maximum of 37.7% in 1974 to a minimum of 21.4% in 1983, the corresponding share in transport is higher by about two-thirds of the share in production. It ranged from a maximum of 60.9% in 1975 to a minimum of 42.5% in 1983. These figures clearly indicate two aspects. Firstly, the major part of the oil from the ME countries is transported by the sea routes (90-95% of the total production); and secondly, though globally both production and marine transport of oil are showing fluctuating trends (decreasing at present), the shares of ME countries in both these are indicating a steady decline since 1976. The reason for this might be the discovery of more and more new sources of oil, offshore and onshore, and/or the marketing policies of the OPEC (Organisation of Petroleum Exporting Countries).

Table I. Prediction at entering the third millenium AD for production and transport of oil, based on present trend of growth.

Subject	Reference (Fig. no.)	Trend Equation	Prediction for 2000 AD- MT
World Oil Production	1 (i)	$Y = 54.31x + 2341.57$	4079
Middle East Oil Production	1 (i)	$Y = 6.84x + 823.9$	1043
World Marine Transport	1 (ii)	$Y = 14.32x + 1365.8$	1824
Middle East Marine Transport	1 (ii)	$Y = 4.86x + 773.25$	929
World Consumption	3 (i)	$Y = 76.33x + 1847.03$	4519

Plotting the annual growth rates of production and marine transport of oil [Figs. 2 (i) & 2 (ii)] we observe a highly fluctuating trend in both. Global growth rate of oil production varied from a minimum of -6.0% in 1980-81 to a maximum of 9.8% in 1969-70. Similar figures for ME production showed a minimum of -17.3% in 1981-82 and a maximum of 17.1% in 1972-73. The minimum in both the cases occurred during the biennium 1980-82, probably indicative of the present trend of decreased production and consumption. The years have been grouped for comparison with the sharp price rises which occurred during the periods 1968-1973; 1974-78; and 1979-1983 (Table II). The average annual growth rate for global production was 7.6% during 1968-1973. This was reduced to 1.6% during the period 1974-1978 and registered a negative growth of -2.2% for the duration 1979-1983. The corresponding figures for the ME countries were, sharply measuring to 13.6% during the first interval, which was drastically reduced to 0.4% during the second and then to a low of -10.8% during the third period. These negative growth rates, perhaps provide evidence that the future global supply of oil is going to last longer than once anticipated.

The trend in the growth rate of marine transport of oil [Fig. 2 (ii)] is exactly what one would expect, i.e. very similar to that of production. The

reduction in the average annual growth rate is, however, very significant. For the global value, it came down from 10.7% in 1968–1973 to 0.2% subsequently for the period 1974–1978 reaching a negative growth of -6.4% during the period 1979–1983. This is very similar to what we noticed in the production. The corresponding figures for the transport from the ME countries are 13.8%, -0.1% and -11.7% for the three intervals. The high negative values for the production and transport for the ME countries are quite significant. The reasons are: a) a world-wide recession in the oil industry, b) stagnation in the world super-tanker transport, c) stringent laws to regulate the danger of oil spills in coastal and nearshore waters, d) new discoveries of oil, and e) for alternate sources of energy from renewable resources.

Man's search for oil, both in onshore and offshore regions, has been constantly on the increase. Examining the data available (Oil & Gas Journal, 1979 to 1984), it has been observed that from only one country in 1951 the

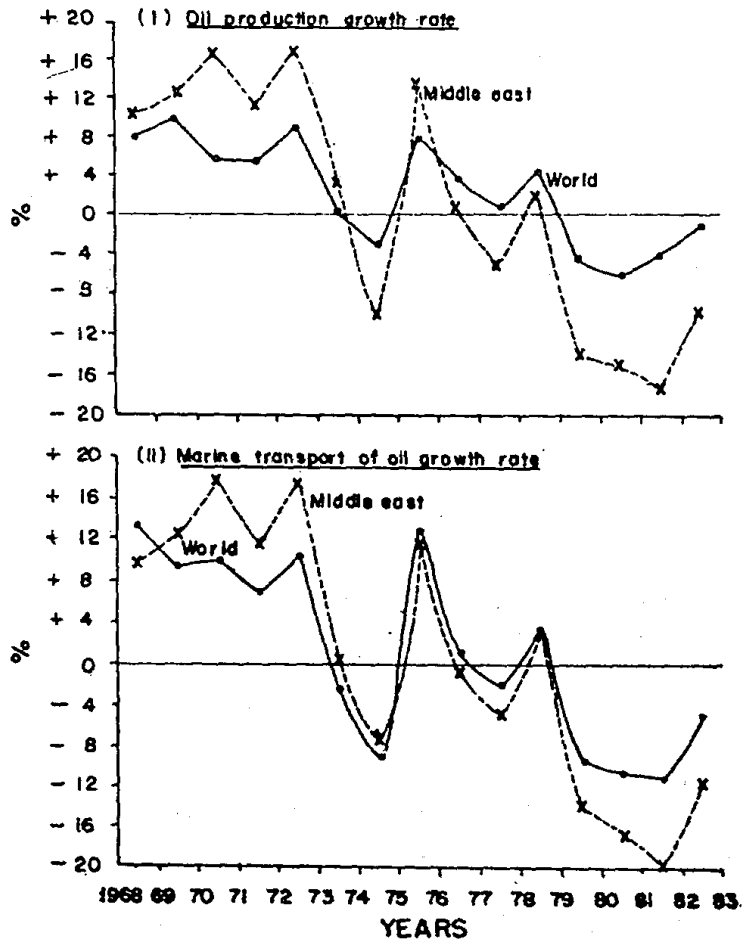


Fig. 2. (i) Growth rates of oil production in the world and in the Middle East countries; (ii) Growth rates of marine transport of oil in the world and in the Middle East countries from 1968–1983.

Table II. Average annual growth rate (%) of Production, Marine Transport and Consumption of oil from 1968 to 1983.

Period	Production		Marine Transport		World Consumption
	World	Middle East	World	Middle East	
1968-1973	7.6	13.6	10.7	13.8	7.8
1974-1978	1.6	0.4	0.2	-0.1	2.0
1979-1983	-2.2	-10.8	-6.4	-11.7	-1.9

number of offshore exploring countries increased to 38 in 1984. The total number of offshore oil fields were 12 in 1960, 109 in 1970 and 284 in 1980. At the end of 1984, the total number of active offshore oil fields is 313. This means that the 1970s had been a decade of intensive offshore exploration and exploitation. Global oil production increased from 1764.4 MT in 1968 to 3225.2 MT in 1979 registering an average annual growth rate of 7.5%. Offshore production increased from 227.4 MT to 573.5 MT, recording an average annual growth rate of 13.8% during the same interval. Table III presents a comparison of total and offshore productions from 1978 to 1984.

Table III. Comparison of total oil production and offshore oil production from 1978 to 1984.

Year	Oil producing countries	Offshore oil producing countries	Total production (TP) MT	Offshore production (OP) MT	OP/TP %	Growth %	
						TP	OP
1978	58	34	3094.1	562.7	18.2	—	—
1979	59	35	3225.2	573.5	17.8	+4.2	+1.9
1980	59	35	3079.4	645.2	20.9	-4.5	+12.5
1981	60	36	2890.3	671.1	23.2	-6.1	+4.0
1982	61	37	2750.6	659.2	24.0	-4.8	-1.8
1983	65	36	2755.5	636.9	23.1	+0.2	-3.4
1984	67	38	2693.7	718.1	26.7	-2.3	+12.7

During this period, while the total number of oil producing countries increased from 58 to 67, offshore oil producers grew from 34 to 38. The share of offshore oil in total oil production increased from 18.2% in 1978 to 26.7% in 1984. The average annual growth of total oil production during this period had been -2.2% compared to +4.3% for offshore. The progressive increase in the oil price made it possible to enter into costly and risky ventures of offshore exploration for oil. Onshore reserves almost everywhere are believed to have been largely explored and discovered. But the offshore reserves are still unknown though intensive search is going on in a large number of countries. According to 1979 figures, the discovered offshore oil reserves form only about half of what is known onshore (BP 1979).

The world oil consumption shows a trend similar to that of production [Fig. 3 (i)]. Consumption, like the production, increased steeply from

1965 to 1973, decreased from 1973 to 1975, increased again upto 1979 and thereafter has been decreasing progressively. The trend analysis indicates a global oil consumption of 4519 MT by the year 2000 AD (Table I). The percentage growth rate in oil consumption [Fig. 3 (ii)] shows a similar trend as production in recent years. From 1980 onwards, though the total production and consumption are decreasing, the growth rates in both these sectors showed an increasing trend. The percentage annual growths in both these are very similar. The average annual growth rate in consumption, during 1968-1973,

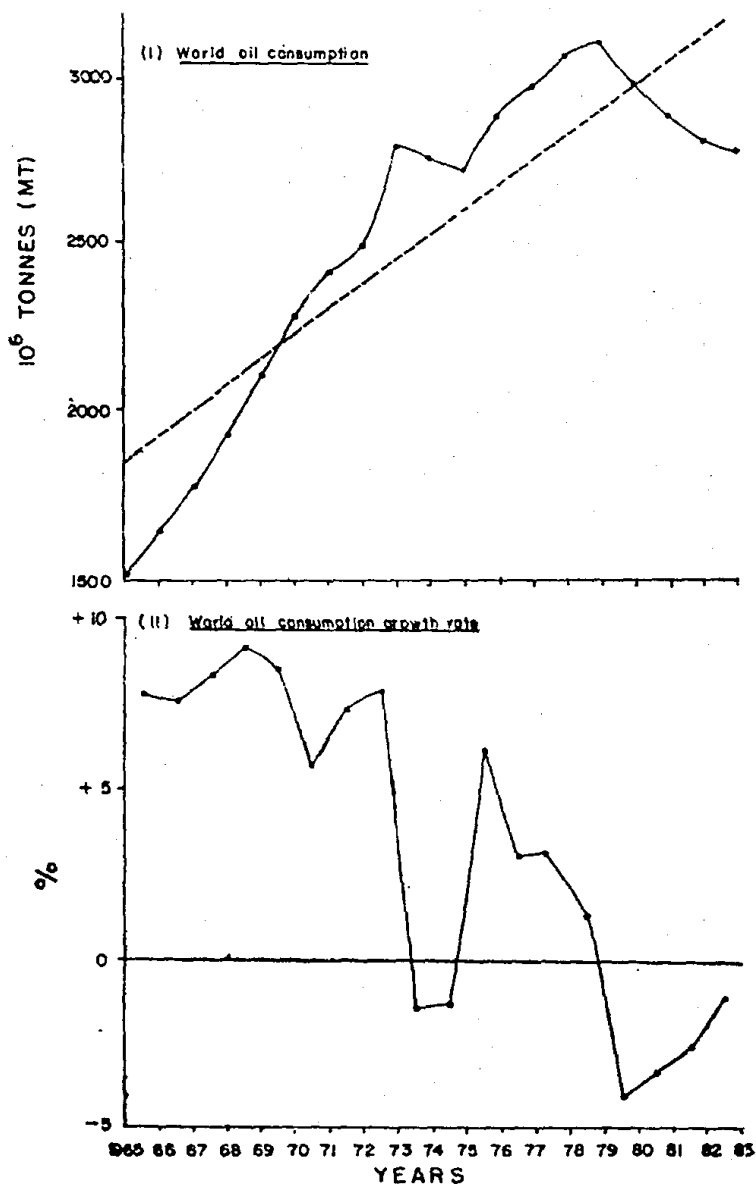


Fig. 3. (i) World oil consumption; (ii) Growth rate of world oil consumption from 1965-1983. Broken lines in (i) is the best fit for the equation of trend analysis.

was 7.8% as compared to 7.6% in production (Table II). The consumption decreased to 2.0% during the period 1974–1978 which compares well with the average annual production growth rate of 1.6%. Thereafter, during the period 1979–1983, both these showed a negative growth rate of almost of the same order (about -2%). Such a decrease in consumption may, presumably, be as a result of an apprehension that the global oil reserves will not cross over into the twentyfirst century AD, or it may be due to a much greater emphasis given to other sources of energy, e.g. nuclear, thermal etc.

B. India

India can be considered a typical example of a developing nation having oil reserves of its own, where production is unable to keep pace with the increasing demand. Figure 4 (i) shows the production and consumption of oil in India from 1970–71 to 1983–84. Production increased from 6.8 MT in 1970–71 to 11.8 MT in 1979–80, declining to 10.5 MT in 1980–81 and again increased to 26 MT in 1983–84. During the same interval the consumption also increased from 17.9 MT in 1970–71 to 35 MT in 1983–84. In other words during the last 13 years production increased by about fourfold, while consumption almost doubled. The ratio between production and consumption, however, decreased from 1:2 in 1981–82 to 1:1.3 in 1983–84.

Studying the growth rates of consumption and production [Fig. 4 (ii)] it can be seen that the maximum average annual growth rate for production of 54.3% was recorded during the period 1980–81 to 1981–82 and the minimum of -11% was recorded just a year earlier. A significant increase of 21.3% in production was recorded between 1976–77 and 1977–78 because of the commercial exploitation of the offshore reserves of the Bombay High oilfield. The rate of production at Bombay High increased from 3.3 MT in 1978–79 to about 20 MT in 1983–84. These were 28.4% and 76.9% of the total production for these two years. An attempt was made to examine the growth rates of the production and consumption by grouping the data as pre-Bombay High period (1970–77) and post-Bombay High period (1977–84). The production increased from an annual average of 4.6% to 18.2%, while the consumption increased only marginally from 5.2% to 5.5% during the two intervals.

Assuming that the reserves at the end of the year divided by the production in that year can be expressed as number of years supply remaining in that year, we made an attempt to calculate the length of oil reserves in India. Table IV indicates that the existing reserve in India will last for at least another 24 years from 1982–83. This would mean that upto 2006 AD, there is no cause of any concern. Of course, such a forecast presupposes that growth rates of production and consumption will not vary much from the base year and that the resources will continue to remain as of present. Moreover, if the ongoing intensive search for oil, both in onshore and offshore

areas, continue to yield results, it is almost certain that the length of oil reserves in India will continue to last far beyond the predicted date.

From the available geological and geophysical data, it has been estimated that the continental shelf around India upto a depth of 200 m, with an area of 452,000 km², can have a potential oil reserve of 1 billion tonnes approximately (R.R. Nair — personal communication). The proven reserves, as of now, is 510 MT which includes both onshore and offshore deposits. This

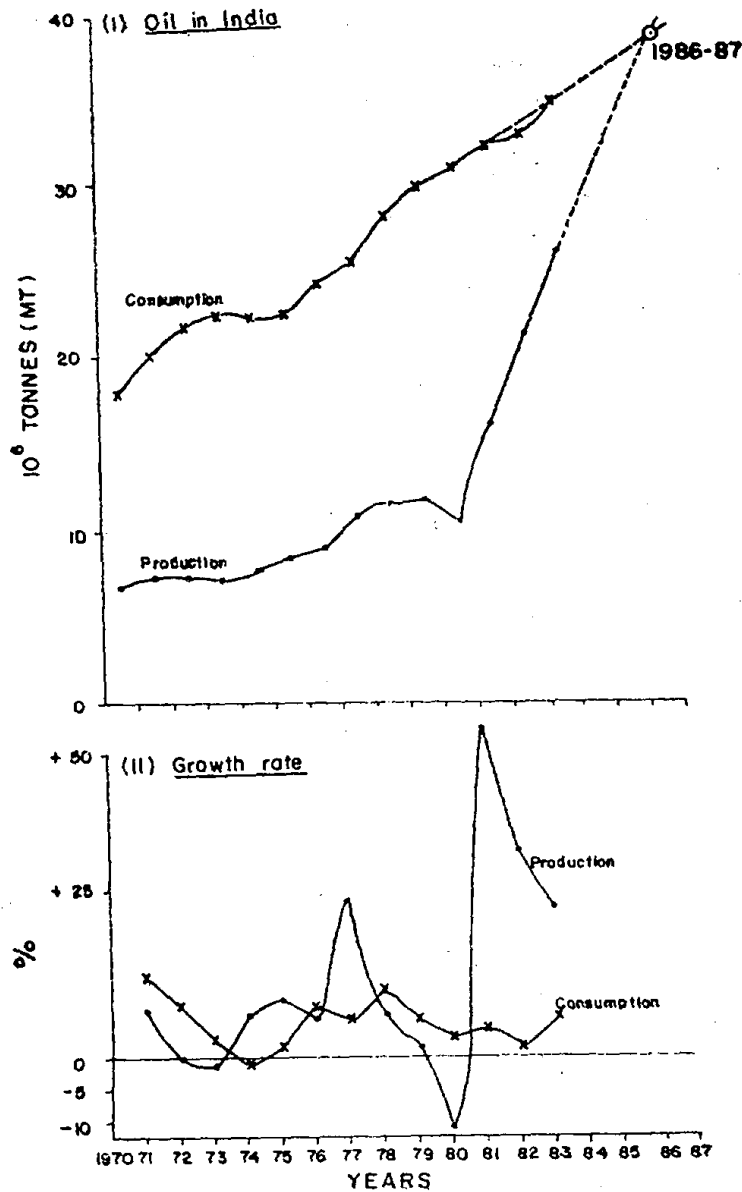


Fig. 4. Production and consumption of oil and their growth rates in India from 1970-1984.

is roughly about 50% of the anticipated reserve. Recent investigations on the deposits of oil and natural gas in the Godavari and Kaveri basins, off Andaman islands and off Pondicherry coast are indeed very promising. These indicate that our potential in oil resources is very promising and we can look towards the 21st century with considerable optimism.

Thus, an attempt can be made to work out the period when India can gain self-sufficiency in oil. Trend analysis, using the available data for all the previous years, does not indicate this clearly as it assumes proportional growth in both production and consumption all through. However, if we consider the trend from 1981 onwards, when the rise in production was over 50% as compared to the previous year, it can be observed (Fig. 4) that the increase in production is several times greater than that of consumption. Assuming that this pattern will be maintained during the coming years, one can extrapolate both the production and the consumption curves from 1981. The two lines intersect at a point which indicates the period as 1986-87 and the volume as 38.8 MT for both production and consumption (Fig. 4). This figure appears to be well within the capability. In other words, India can be expected to be

Table IV. "Published, proved" Reserves, Production and Remaining Supply of Oil in India from 1970 to 1983.

Year	Reserves (MT)	Production (MT)	Supply remaining* (years)
1970-71	128	6.8	18.8
1971-72	114	7.3	15.6
1972-73	125	7.3	17.1
1973-74	127	7.2	17.6
1974-75	144	7.7	16.2
1975-76	144	8.4	17.1
1976-77	275	8.9	30.9
1977-78	303	10.7	28.0
1978-79	347	11.6	29.9
1979-80	354	11.8	30.0
1980-81	366	10.5	34.8
1981-82	468	16.2	28.9
1982-83	510	21.2	24.1
1983-84	—	26.02	—

*Reserves at the end of the year divided by the production in that year is expressed as number of years supply remaining in that year.

self-sufficient in oil within 2-5 years from now. This is based on the present growth and extrapolation in production and the reduced rate in consumption as of now. One can, thus, conclude that India will be free from oil import by the year 1990 and will face the last decade of the present century with a much greater confidence.

The most spectacular progress India has made in recent years has been in the development of domestic resources of crude oil. Considered at one time grossly deficient in this natural resource till new reserves were discovered in Upper Assam in the fifties and in Gujarat a few years later. With these discoveries and with the commercial exploitation of the offshore reserves at Bombay High, India to day can meet more than three-fourths of its petroleum requirements from within the country. With the steady rate of growth and with a bit of luck India can be expected to become self-reliant in oil in a few years.

CONCLUDING REMARKS

A U.S. Government study (Barney, 1980) on the long-range energy forecast shows a decline in the world oil production concomitant with an increasing demand. Future production will, of course, be influenced by known reserves, new discoveries, improved production techniques, levels of demand, and OPEC production policies. During the next decade, the study states that governmentally imposed production ceilings could alter the supply position, but the most important longrange constraint on the potential production will be the estimated level of recoverable resources.

Recoverable worldwide conventional petroleum resources have been placed at approximately 272,000 MT (range: 160,000 — 423,000 MT) or just about three times the present "published proved" reserves. Recovery rate, which is the ratio of recoverable oil to oil in-place, is an extremely important parameter and this is highly sensitive to technological developments. The current world recovery rate, estimated at 25-30%, is expected to increase to 40% by the turn of the century. With an estimated new discovery of 1400-2700 MT per year, the production profile would lead to a ceiling of 4100-5200 MT per year and reaching a peak by about 1990.

As indicated in Table V, if the production rate remains constant, the world reserves of oil would last for about 35 years, and the total resources for about 105 years. This, of course, will not be a very correct description of

Table V. World Oil Reserves ("Published Proved")
Production and Remaining Supply from end
1978 to end 1981.

Period	Reserves (MT)	Production (MT)	Supply remaining (years)
End 1978	88.1 x 10 ⁶	3094.1	28.5
" 1979	88.0 x 10 ⁶	3225.2	27.3
" 1980	88.9 x 10 ⁶	3079.4	28.9
" 1981	92.1 x 10 ⁶	2890.3	31.9
" 1982	92.0 x 10 ⁶	2750.6	33.4
" 1983	92.0 x 10 ⁶	2755.5	33.4
" 1984	95.0 x 10 ⁶	2693.7	35.3

the declining pattern in petroleum production. The overall production would decline with time from the anticipated peak in the 1990s and the time involved would be longer than a century.

The estimated oil reserve in deep offshore and in known polar regions is about 70,000 MT. But the density of drilling per square kilometre varies from a high of 0.38/km² in industrial countries of 0.0012/km² in developing countries.

However, as far as the petroleum hydrocarbons are concerned, the reserves and the potential resources are, in general, fairly well in agreement and the total remaining resource constitute only about 5.4% of the total recoverable energy source.

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