NOTES

110 MILLION TONNES OF HYDROCARBONS PER YEAR BY 2000 A.D.

Abstract: The authors have analysed the present status of the country's oil and natural gas reserve estimates and production profile since 1978. A scenario projecting a yearly production target of 65 million tonnes of oil and 50 billion cubic meters of gas amounting to 110 million tonnes of oil and oil equivalent of gas by the year 2000 A.D. has been presented. These targets can be achieved if a national commitment is made and actions taken accordingly. Oil and Natural Gas Commission (ONGC) and Oil India Limited (OIL) have done exceedingly well in the past. In the present situation they have to be more transparent in their operations, receptive to national and international perceptions and prescriptions to accelerate oil/gas exploration and production programmes. The internationally acknowledged new technologies have to be introduced to augment exploration and production efforts. Ways and means have to be devised to attract risk capital and development capital from within and outside the country.

Introduction

Oil and natural gas production in the country amounted to 34.09 million tonnes (MMT) of oil and 16.988 billion cubic meters (BnCuMts) of gas during the terminal year of the 7th plan period (1989-90). Since then there has been a fall in production of oil and the total production in 1992-93 was only 26,95 MMT. The natural gas production has gradually increased reaching a figure of 18060 million cubic metres (MnCuMts) (16.25 MMT oil equivalent of gas (OEG)). The country imported 29.25 MMT of crude oil and 11.28 MMT of petroleum products during the same year 1992-93 amounting to a total value of Rs. 17,045 crores. The import bill for the year 1993-94 has been reported to be 6.4 billion dollars (about Rs. 20,000 crores).

Back in 1982, ONGC had prepared a paln to make India self-sufficient in indigenous oil and gas production by 1990. ONGC's share was targated at 60 MMT of oil. Such a paln could not be realised and it is obvious that something went wrong somewhere at some point of time either in conceptualization or in execution of the plan. It is not known whether a critical apprisal was ever made of the 1982 plans and their failure.

In 1988, S. Ramanathan of ONGC stated that by 1990 ONGC's opening balance of recoverable oil would be 443 MMT and gave a figure of 775 MMT as balance of recoverable oil resources by the end of the 9th plan. Ramanathan proposed an indigenous production of 62.5 MMT of oil and 53.5 MMT of OEG by the year 2004-2005.

R.C. Fuloria of Oil India Limited, in a paper in 1989, stated that the conservative prognosticated hydrocarbon resources of India are around 20 billion tonnes and with the increased exploration efforts this could easily be raised to 50 billion tonnes. He says that only 5 bilion tonnes of hydrocarbons have been discovered so far. The balance recoverable reserves are of the order or 700 MMT of oil and 700 BnCuMts of gas. He expects that the recoverable reserves will increse over the period to nearly 1250 MMT of oil and 1250 BnCuMts of gas by the yaer 2005. These reserves, according to him, could provide 70 MMT of oil and 40 BnCuMts of gas (36 MMT of OGC) by the year 2000 A.D.

As per statistics released by the Ministry of Petroleum and Natural Gas of Government of India (1993), crude oil and natural gas recoverable reserves and cumulative production are given in the following table I and shown in Fig. 1.

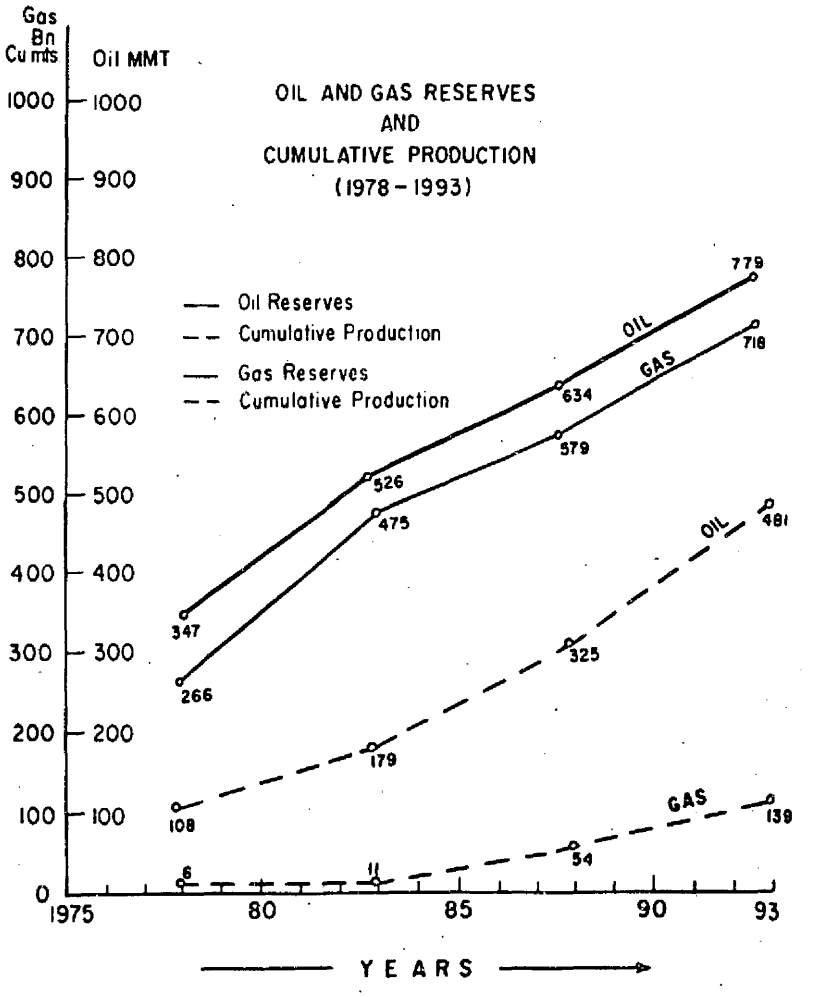

Fig.1. Oil and Gas reserves and cumulative production (1978-1993).

Table - I.

Year	Crude oil reserves (MMT)	Cumulative production (MMT)	Total (MMT)	Gas reserves (BnCuMts)	Cumulative production (BnCuMts)	Total (BuCuMts)
1978	347	108	455	266	6	272
				(239)	(5.6)	(244.6)
1983	526	179	705	475	11.15	486.15
				(431)	(10)	(441)
1988	638	325	963	579.5	53.8	633.3
				(521)	(48.4)	(569.14)
1993	779	481	1260	718	138.7	856.7
				(646)	(124.8)	(771)

(Figures in brackets are oil equivalent of gas in MMT)
(7.441 Barrels of crude oil and 1111 Cu.metres of gas have been taken as equal to 1 metric ton of oil)

Assuming an average oil recovery of 33.3 percent and gas recovery of 50 percent, the inplace reserves of hydrocarbons of India calculated for the same years as in Table I are given below and also plotted in Fig. 2.

Table - II.
INPLACE RESERVES OF INDIA
(MMT of Oil and OEG)

1978	445 X 3	+	244.6 X 2	=	1854
1983	705 X 3	+	441 X 2	=	2997
1988	963 X 3	+	569.4 X 2	=	4028
1993	1260 X 3	+	771 X 2	=	5322

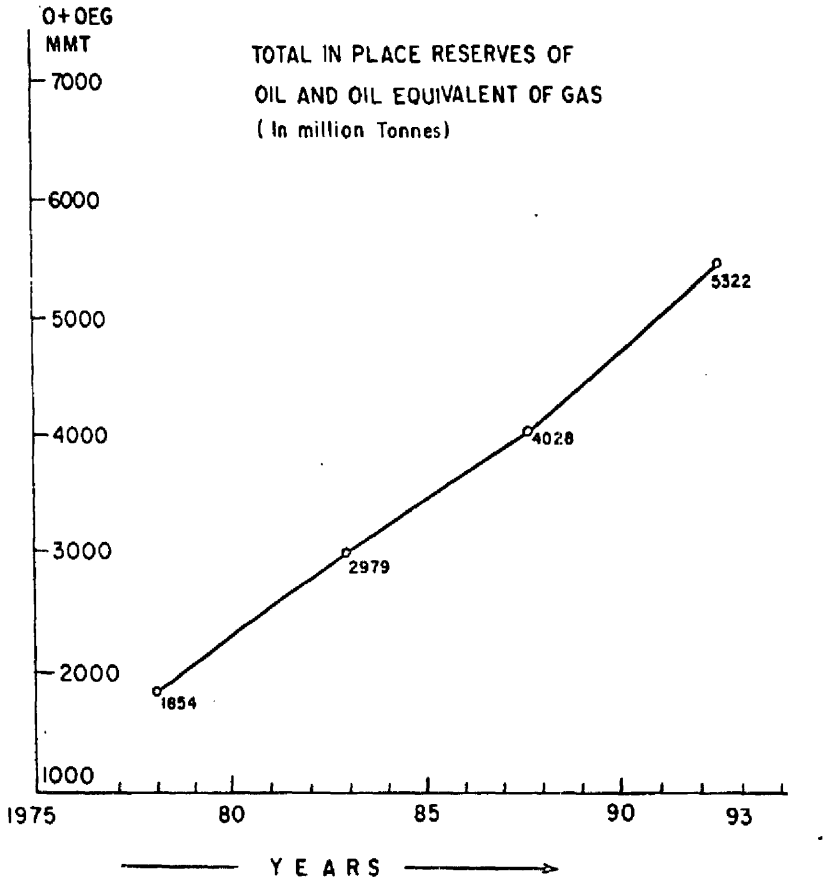

Fig.2. Total inplace reserves of Oil and Oil equivalent of Gas (in million Tonnes).

The prognosticated resources of hydrocarbons worked out by the ONGC as in January 1992 are of the order of 18280 MMT (Oil and OEG). The total resources for onshore basins amounts to 6810 MMT and for the offshore basins 11470 MMT (Oil & OEG). Category-wise total resources for category I basins have been estimated as 15350 MMT, for category II, 1180 MMT and category III, 1710 MMT (Oil & OEG). Category IV basins and deep water resources (more than 200m isobath) have not been taken into account.

Looking at the figures of prognosticated resources and in-place reserves as of 1993 there are still about 13000 MMT of hydrocarbons to be explored and converted into in-place reserves.

The yearly production of oil and natural gas is shown in figure 3. Whereas production both of oil and gas steadily increased from 1981 upto 1990, oil production has decreased over the last 3 years (1991-93). There has been slight fall in gas production between 1992 and 1993.

Hydrocarbon recoverable reserves over the years from 1978 to 1993 have increased steadily from 347 MMT to 779 MMT of oil and from 266 BnCuMts to 718 BnCuMts of gas. With greater exploration efforts and drilling, both the reserves and production of oil and natural gas can be substantially increased.

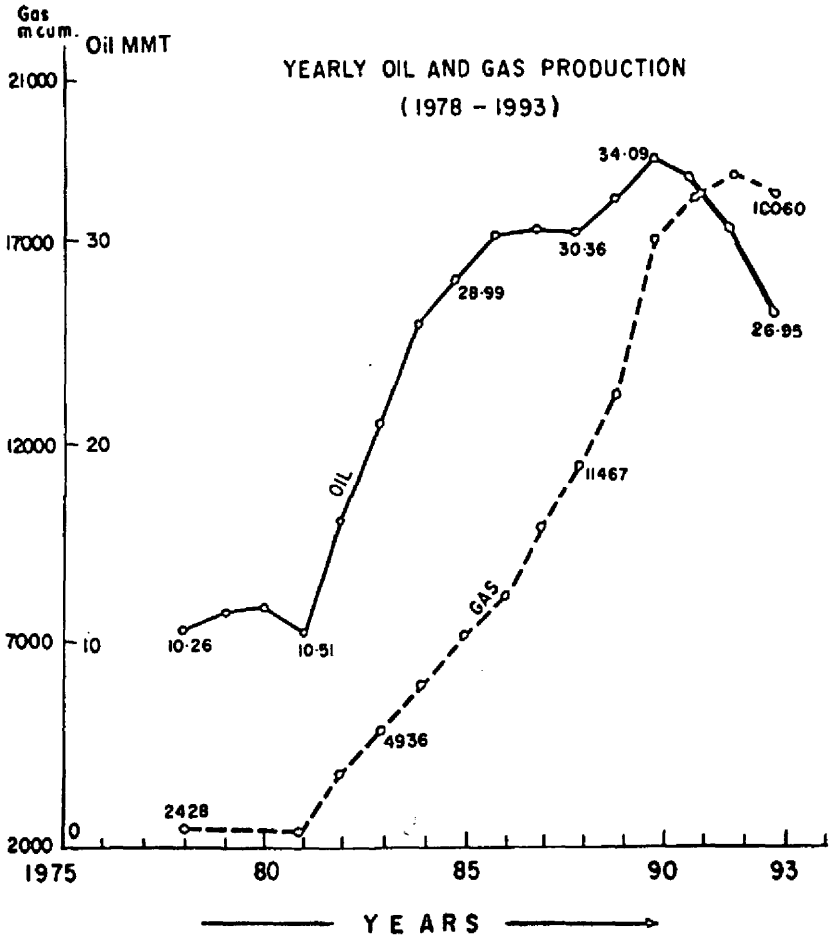

Fig.3. Yearly Oil and Gas production (1978-1993).

Production of 110 MMT of oil and oil equivalent of gas by 2000 A.D.

An oil explorationist, a reservoir or production engineer or any one connected with oil industry has to be an optimist and at the same time a pragmatist. An eminent reservoir and

production engineer of international repute Sastry Karra has given valuable suggestions, in a personal communication, that production of oil can be systematically increased if serious efforts are made towards accretion of reserves and use of modern production technologies. He states that oil in the ground has never been as valuable as oil on production, since the discount rates applied are always higher than the anticipated real price increases. This maxim has been accepted without question by the international oil companies. He says that a drop in reserve to production (R/P) ratio even to 11 years may sound alarming from a strategic view point but makes eminent economic sense.

We feel that even if the present rate of reserve accretion of oil and gas is maintained, a production of 65 MMT of oil and 50 BnCuMts of gas per year by 2000 A.D. can be assured by lowering the R/P ratio for oil to 15 years and gas to 18 years. The table III gives figures for oil and gas recoverable reserves, production figures and R/P ratios from 1978 upto 1993. The projected figures from 1994 to 2000 A.D. have also been given in the same table. The oil and gas reserves have been extrapolated from 1994 to 2000 A.D. as per the general trends for the last 15 years (Fig. 4). The R/P ratios have been gradually brought down from the present figures of 28.9 to 15 for oil and from 39,8 to 18 for gas production. The production figures both for oil and gas have been obtained, arriving at a figure of 65 MMT of oil and 50 BnCuMts of gas by 2000 A.D. The R/P ratio figures would certainly be higher if, over and above the extrapolated reserves for the period during these years, oil and gas productuion could also be suitably increased with greater reserve accretion.

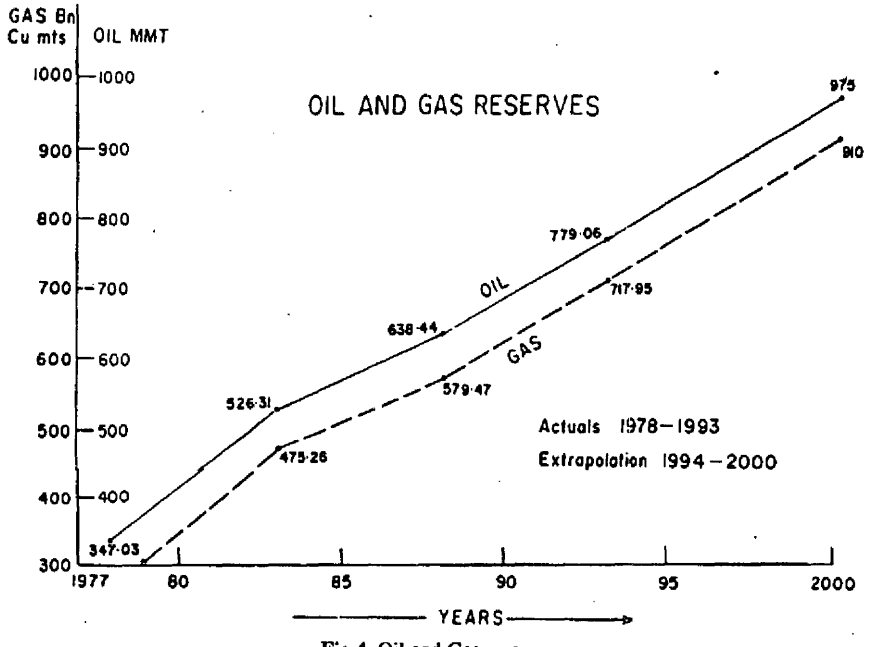

Fig.4. Oil and Gas reserves.

Addition of Reserves: Addition of reserves have to come from new discoveries in old oil field areas or by opening up new basins, upgrading existing reserves by additional drilling and deployment of enhanced oil recovery (EOR) techniques on a continuing basis.

According to the statistics available, 172 on-shore and 69 off-shore exploratory wells were drilled during 1992-93. The number of development wells during the same period were 196 on-shore and 31 off-shore. These numbers will have to be increased. It may be necessary

Table- III
OIL AND GAS RESERVES - PRODUCTION AND R/P RATIO
Actuals: 1978 to 1993 Projected: 1994 to 2000

Year	Oil Reserves	Production	R/P	Gas Reserves	Production	R/P
	(MMT)	(MMT)		(BnCuMts)	(BnCuMts)	
1978	347	10.76	32	265.86	2.428	109
1983	526.31	21.06	25	475.26	4.936	96
1984	510.8	26.02	19.6	478.25	5.961	80
1985	499.5	28.99	17.2	478.63	7.241	66
1986	558.01	30.17	18.5	497.05	8.134	61
1987	581.43	30.48	19	540.81	9.853	55
1988	638.44	30.36	21	579.47	11.467	50.5
1989	726.22	32.04	22.7	647.55	13.217	49
1990	738.8	34.09	21.7	686.47	16.988	40
1991	806.15	33.02	24.4	729.79	17.998	40.5
1992	801.05	30.35	26.4	735.47	18.646	39
1993	779.06	26.95	28.9	717.95	18.060	39.8
1994	810	32.4	25	680	19.429	35
1995	835	38	22	750	23.438	32
1996	860	43	20	800	28.571	28
1997	880	48.9	18	825	43.375	24
1998	924	54	17	860	39.000	22
1999	945	59	16	880	44.000	20
2000	975	65	15	910	50.000	18

to drill about 100 off-shore and 200 on-shore exploration wells per year to increase accretion of reserves and several hundred development, infill and outpost wells per year to increase production. It is important to increase exploratory efforts in mature basins. The unit capital cost required for increasing productivity from old fields is a fraction of unit capital required for new field development. The two ways of increasing production and recovery efficiences are repairing of sick wells and infill drilling. Technology is now available to complete wells that achieve a 10% flow efficiency.

It is conceivable that upto 10 MMT per year of additional hydrocarbons can be coaxed out of the producing fields. However, there are limits to such reserves and productivity additions. It is therefore necessary that with the work-over operations and infill drilling, proper reservior management must be practised and adequate pressure maintenance facilities made available.

Increassed oil production will also result in increased natural gas production. Project planning must allow for conservation of gas and avoid flaring that has been going on so far. It is a sad story that the total amount of 42.386 BnCuMts of gas, equivalent to 38.15 MMT of oil has been flared over a period of 1970-71 to 1992-93.

The over all world petroleum reservoir distribution is such that the number increases considerably as the size of the fields grow smaller and smaller. Giant oil fields like Bombay High are few but smaller fields should be many more yet to be discovered. And therin lies the future of petroleum industry in India.

Fast Tract Development

Besides Bombay High there are a number of fields such as Neelam, Mukta, Panna, Heera, Ratna, Tapti and other smaller fields which require immediate attention to go on optimal production. Neelam, Mukta and Gandhar have good potentialities and the three

together should be able to produce 6 to 10 MMT of oil and OEG per year. The other smaller and marginal fields put together could possibly produce another 8 to 10 MMT of oil and OEG by 2000 A.D.

Bombay High field is super-giant with several million tonnes of oil-in-place. It has made substantial contribution to oil production in the country. With proper reservoir management and sound production practices, it has a good potential of increase in annual production in the years to come. There is wealth of data available from a large number of wells over long years of its production history. This field appears to be an ideal candidate for detailed study of the effect of infill drilling on recovery efficiency prior to taking up enhanced oil recovery techniques. The increased production should pay for the infill wells and also capital requirement for any EOR schemes.

The A.B.Das Gupta report of the Bombay High Review committee (1990) should have provided valuable insight into the reservoir performance. The report has highlighted the fact that reservior monitoring and management are very essential from the time the production starts. Such an approach to reservoir monitoring must be applicable to all the oil/gas fields. It will be a good practice if technical aspects of such important reports are made public so that scientific discussions could be held to generate new ideas and new potentialities.

East Coast Deltas

The East Coast, fringed by major deltas of Bengal, Mahanadi, Godavari, Krishna, and Cauvery, has not yet yielded desired quantities of hydrocarbons. The style and tempo of exploration in Krishna, Godavari and Cauvery on-shore and off-shore areas have to be reoriented and accelerated. New concepts have to be deployed for exploration in all the East Coast delta basins. "Delta modelling", a neglected aspect, has to be developed. An autonomous research institute to assist the oil companies seems to be an answer to discover and produce more oil/gas from all the 5 deltas of the East Coast. Mahanadi off-shore basin is a prospective area and deserves application of new scientific concepts. Bengal basin poses a challenge. 'Dynamic basin modelling' has to be taken up immediately to study hydrocarbon formation, migration and accumulation potentialities of the region.

Risk and Development Capital

It is only now that India has appreciated the role of foreign and domestic (private) risk capital for development of oil industry. There are two countries in the region, Malaysia and Indonesia, which successfully rely on foreign risk capital for most of their exploration programmes. This is done with full participation and control of their state-owned oil companies. Up to 80% of the profits from the operations accrue to the treasuries of the countries directly or indirectly. A large number of international oil companies participate in exploration and development activities in these countries.

India has not been on the priority list of major oil companies for oil exploration. The international risk capital for exploration is currently going to South America (Colombia), North Sea, Libya, Nigeria, Australia, China, South China Sea and Russia with continuing steady activity in Malaysia and Indonesia. Development capital is now finding a new home in the erstwhile Soviet Union and Eastern Europe. There are, in addition, massive rehabilitation efforts in Kuwait and other OPEC Countries.

India has offered a number of blocks and small - medium oil/gas fields to international and Indian private oil companies for exploration and development. The former had earlier drilled a few wells off-shore but did not discover any commerical hydrocarbons. The discouraging results may be, because only a small number of wells were drilled or the blocks were not promising. It is only now that Indian private oil companies have entered the field independently and in development work. This is indeed a welcome change and together

with ONGC and OIL these companies should be able to find more hydrocarbons and increase the annual production.

International strategists predict that oil demand in the developing countries will more than double over the next 20-30 years. India should have a rolling perspective plan for oil and natural gas for the next 2 to 3 decades to meet the future challenges.

Directorate General of Hydrocarbons

The Government of India has recently set up Directorate General of Hydrocarbons (DGH) under the administrative control of the Ministry of Petroleum and Natural Gas to promote sound management of the Indian petroleum and natural gas resources. The Directorate-General is to review the exploration programmes of Indian and foreign companies including ONGC and OIL and to re-assess the hydrocarbon reserves estimated by the operating companies. This is expected to provide a technical body to regulate and over-see the upstream activities in the petroleum and natural gas sector and to advise the Government in these areas. Hopefully DGH should be able to periodically re-assess the total hydrocarbon potentialities of the country, provide sound advice on exploration strategies and ensure optimal production practices with scientific characterization and surveillance of the hydrocarbon reservoirs.

Conclusions

Abundant opportunities exist in India for developing a dynamic oil industry that can show substantial growth each year for the next decade or two. The most critical parameter is the availability of capital - both risk and development capital. Maximising the capital input will be the policy makers' challenge whereas the responsibility for efficient employment of this capital will rest with the two state oil companies and the new entrants, foreign as well as private Indian companies.

It is not only feasible but imperative that India produces 65 million tons of oil and 50 billion cubic meters of gas per year by 2000 A.D. It is possible to do so by maintaining the present rate of reserve accretion and reducing the R/P ratio to a reasonably safe level. Situations such as recent drop in oil production and a long recovery period must be avoided at every cost.

Serious and sustained efforts should be continued to convert prognosticated reserves of hydrocarbons to inplace reserves in category I and II sedimentary basins of the country and to upgrade the status of basins of other categories. Aggressive efforts are needed to increase the annual reserve accretion levels.

Latest techniques of data acquisition, processing and interpretation should be employed both in exploration and production practices. Reservoir characterization and surveillance are essential to optimise production from the known fields.

Every possible effort needs to be made towards self-sufficiency in oil and natural gas to meet the growing demands and future challenges.

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