Oil and gas exploration in deep water: An overview

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There has been increasing interest in deep water oil and gas exploration. What is deep water exploration and why is the international industry so keen on it? What have been the implications to the oilfield service sector in view of increasing deep water oil and gas exploration activities in many parts of the world? This article reviews recent developments in deep water exploration, with emphasis on the Indian scenario. ONGC has already drilled two wells and there are a number of large structures in deep water in excess of 400 m water depth. It is likely that in the coming years, deep water drilling in the Indian offshore would result in discovery of oil and gas.

WITH continuing advances in exploration and production technologies, the minimum water depth from which hydrocarbons were produced rapidly increased from 60 m in 1960 to nearly 2000 m as of today. Now, the depth at which a deep water field starts is being redefined.

As seen in Figure 1 the oil industry has made rapid progress in pushing the depth of sub-sea production. Within the next five years it is expected to exceed 2500 m (ref. 1). Various organizations have evolved their own definition of deep water ranging up to 500 m and even beyond. For example, in offshore Brazil, Petrobras classifies 'deep water' as 400–1000 m and beyond 1000 m as 'ultra deep'. In the North Sea, 200 m seems to have become the techno-economic limit for fixed platforms; only 3 fields, Draugen (270 m), Gulfaks (217 m) and Troll (330 m) all in the Norwegian sector, use fixed platforms in waters beyond this depth. The Troll A platform is the largest structure ever moved by man.

Why explore in deep water?

As oil from shallow waters is increasingly depleted, deep water reserves are becoming important to oil companies and more so to individual nations. Of the 700 sedimentary basins around the world, 240 are deep water offshore zones, and exploration has begun in half of them[2]. Therefore, there is considerable scope for the discovery of giant fields, an event that has become a rarity in onshore and shelfal offshore areas.

A number of factors contribute to the increase in global deep water activity. (i) Depletion of shallow water reserves, in some regions deep water is the only option. (ii) Greater potential for large finds compared with shallow waters; for example, in India, there has been disappointing potential in the east coast shelf and there is optimism that the deep waters may be more prospective. (iii) Future growth in hydrocarbon demand. (iv) Improved technology and management practices which have reduced development costs. (v) Host governments have evolved favourable fiscal policies towards deep water exploration.

Oil and gas review – Impact on future deep water developments

Future deep water developments are being reviewed in view of a sharp drop last year in the international oil prices though, of late, there has been a significant recovery. The relevant aspects of the industry are highlighted below:

- Likely slow recovery of oil prices over the next 3 to 4 years as the oil supply decreases and demand increases. This is based on an assumption of economic recovery in various Asian countries in the year 2000 and beyond.
- Despite relatively lower prices in the near term, deep water exploration and development initiatives are generally expected to be sustained worldwide, with offshore West Africa emerging as a major future source of oil production. Technology and resource

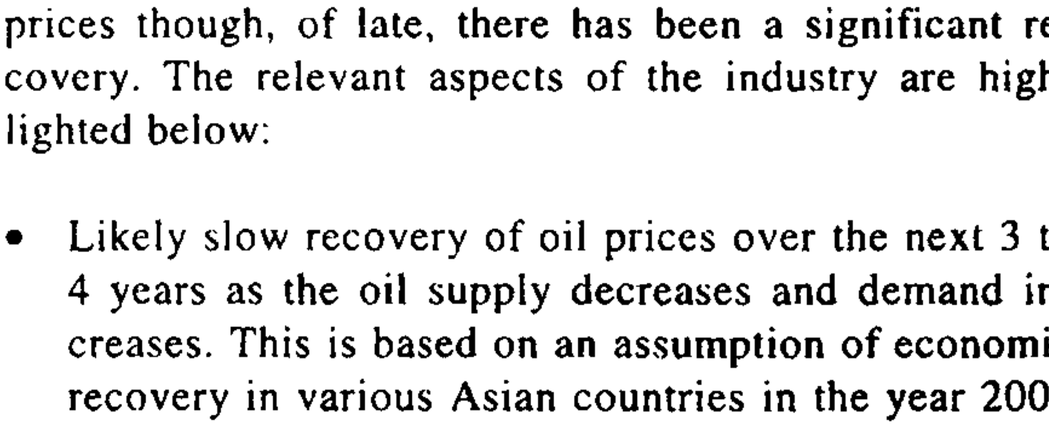

Figure 1. Offshore fields – Maximum depth by year on-stream.

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availability can sustain large increments in oil production capability at prices ranging between $18 and $22 per barrel. The current price environment will, however, slow the pace of development in some highly prospective areas, including especially the Caspian Basin region[3].

- Economic development in Asia is crucial to long-term growth in oil markets. The projected evolution of oil demand will strengthen economic ties between the Middle East and Asian markets.
- Though Oil Producing and Exporting Countries' (OPEC's) share of world oil supply is projected to increase significantly over the next two decades, competitive forces are expected to remain strong enough to forestall efforts to escalate real oil prices significantly. These competitive forces operate within OPEC, between OPEC and non-OPEC sources of supply, and between oil and other sources of energy (particularly natural gas).

The emerging deep water market

It is estimated that worldwide, in the next 2–3 years, no less than 50 deep water fields would be developed. Review of currently proposed offshore field developments shows that some 44% of these reserves are in depths greater than 300 m. In the Gulf of Mexico and Brazil however, deep water accounts for 90% of oil and gas reserves being considered for development. Offshore Brazil, Petrobras expects to boost its current 1 million b/d production to 1.5 million. Of this, 60% will come from water depths greater than 400 m.

At the end of 1996 production from all deep water fields (>300 m) was about 1 million b/d worldwide. Exxon has projected that this would triple to 3 million b/d by the year 2000, accounting for 10% of offshore production.

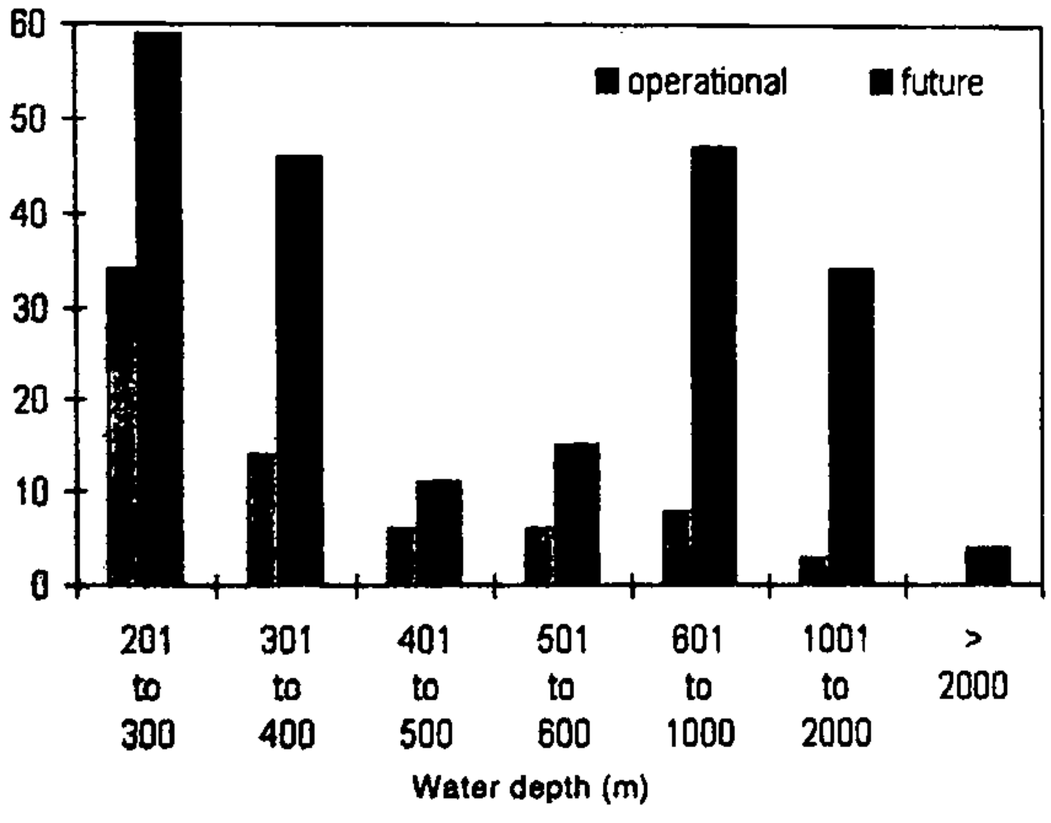

Figure 2. Existing and future schemes against water depth.

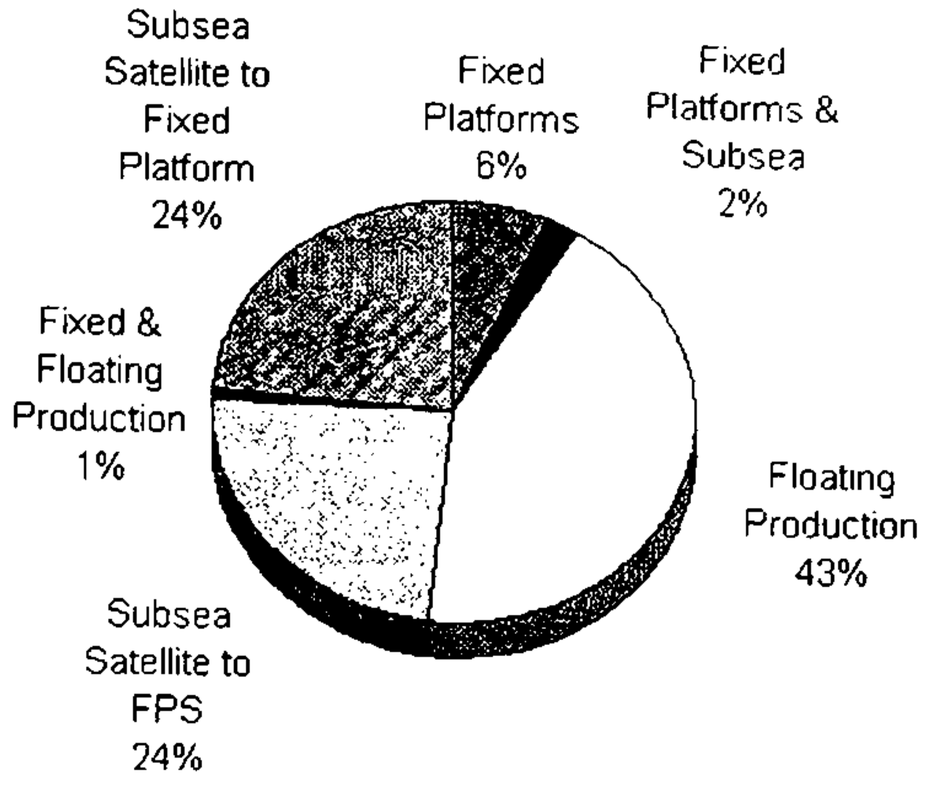

Figure 3. Pie diagram showing various options for development schemes.

Most of the 95 planned field developments are predominantly oilfields (~87) including a number of large ones with daily production rates in excess of 100,000 b/d. However, about 50% are small, and are likely to produce less than 20,000 b/d.

Development schemes for 139 deep water discoveries (out of 216 future deep water fields) show that floating production systems (FPS) are involved in 68%. The other largest category is that of sub-sea satellites tied back to fixed platforms.

Beyond 600 m there are no instances of fixed platforms; however, it is common for sub-sea satellites to be tied back up the slope to platforms in shallower waters. Figure 2 shows the existing and future schemes against water depth with about 100 projects in deep and ultradeep waters (> 300 m, L&T internal report).

Figure 3 shows various options considered for the development schemes and indicates that floating production facility is the most preferred option (L&T internal report).

The Indian scenario

In the 1970s and 1980s, India focused on traditional onshore oil exploration and the reserve accretion was 18 to 30 million tonnes a year. A move to offshore exploration resulted in the discovery of the Bombay High field and reserve accretion yielded a ten-fold increase. Will the shift from shallow to deep water lead to similar boost in India's reserves?

The Bombay High field in shallow waters off the western coast continues to provide the bulk of India's oil production. India's oil production has slowed to below 30 million tonnes a year while annual demand, running at more than 60 mmt, has been rising at about 8%. Because of the stagnating production, the Government

has begun to de-regulate the oil industry by inviting participation from both Indian and international companies. There is a clear need for exploring deep water potential off the country's eastern and western coasts. In recent years, ONGC has been extensively acquiring seismic data for this purpose.

ONGC estimates that an investment of at least $10 billion is required for deep water exploration in Indian deep waters ranging in depth from 200 to 600 m. Between 20 and 35% of hydrocarbon potential in India could be found in deep waters beyond 200 m. Based on the Directorate General of Hydrocarbon (DGH) data, which are not very exhaustive at the moment, the Government's estimates of deep water reserves range from 5 to 9 billion tonnes of oil and oil equivalent gas.

Based on the interpretation of seismic data, ONGC has already identified prospective western and eastern offshore areas and has selected four locations for drilling, covering about 1.4 million m^2 in the Arabian Sea and Bay of Bengal. ONGC has upgraded one of its drill ships, *Sagar Vijay* at Cochin shipyard for deep water drilling.

Drilling in the first two locations in Cauvery and KG offshore basins has proved to be disappointing as no oil and gas was found. ONGC now has invited leading deep water firms along with public sector firms like GAIL and IOC for joint ventures to bring in technology, financing and sharing of risk. The Gas Authority of India Ltd (GAIL) has expressed interest in this project, particularly in areas like the Andaman Islands where large gas reserves could exist.

The new exploration policy (NELP) announced in 1999 has thrown open a large number of onshore and offshore blocks. The deep water acreage has been kept separate with a reduced royalty schedule for deep water production. The policy envisions a level playing ground for national and global firms. It is no longer mandatory to offer a 30% ownership to national oil firms in joint ventures. However, there is concern that due to a low oil price environment and massive restructuring of the international energy industry, the interest in NELP acreage may be lukewarm. Most of the large players have evinced more interest in India's deep water acreage.

The Government has also initiated steps to find new oil and gas sources; under NELP, an area of 1.4 mm km^2 in water depth of 200–2000 m has been marked out for hydrocarbons. Seismic data in deep water areas along both the coasts have been acquired through a collaborative effort between DGH and geophysical service companies.

A number of oil companies have purchased seismic data and are looking closely at deep water prospects. $1.8 billion has been committed by ONGC for the next 5 years for its programme. Active cooperation is being sought from Petrobras as the Brazilians have established successful and cost-effective programmes in deep water oil and gas production.

Summary

Deep water oil and gas developments world over are growing strongly with major activities underway in North America, Brazil and Europe. Industry surveys suggest that 95 schemes are under various phases of development in water depths greater that 300 m with combined reserves of about 2.3 billion tonnes oil equivalent. It is likely that by end of the year 2002, 134 fields are likely to come onstream. These developments will require a capital expenditure of about $71 billion over the period, rising from some $10.7 billion in 1998, to nearly $19 billion in 2002. Small finds may provide an opportunity for small independent oil companies to enter deep water development through accessing proprietary technology from contractors for viable development schemes. Many service companies have developed technological expertise for deep water production. The current trend is towards larger all-in-one capabilities which will encompass design, engineering, construction and structure emplacement into one organization.

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