AN OVERVIEW OF OFFSHORE TECHNOLOGIES AND THEIR SUITABILITY FOR HYDROCARBON EXPLORATION AND PRODUCTION IN THE BAY OF BENGAL

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ABSTRACT

Offshore Exploration and Production (E&P) activities are extremely expensive, involving very high capital investments and associated risk factors, and advanced technologies. It is necessary to have a sound understanding of the technologies and economic aspects of offshore E&P. The paper highlights why Bangladesh must embark on a vigorous exploration initiative for hydrocarbons in the mostly unexplored Bay of Bengal. It aims to briefly introduce the technologies and discuss their possible applications in the Bay of Bengal. Finally, it discusses the status and possible utilization of the Sangu facilities, which is the sole offshore gas field in the country. There are many types of technologies involved in offshore E&P. However, this paper will limit its scope to drilling rigs and platforms. There are different types of drilling rigs, suitable for shallow, medium, and deep waters. Each has its application limits, advantages, and disadvantages. It is very important to select the most suitable one to carry out its functions in a safe and economic manner. Offshore platforms are permanent structures that allow different activities in the offshore settings like drilling, producing, processing, storing, and supplying oil and gas. The crucial factors for a successful platform setup and operation are selection of the platform type given the water depth and weather conditions, designing the suitable production method, selection of related equipment and supplying method.

Keywords: Offshore, Oil, Gas, Hydrocarbon, Exploration, Production, Structure, Drilling Rigs, Platforms, Sangu gas field

1. INTRODUCTION

Energy security is the primary condition for sustainable economic growth. The economy of Bangladesh heavily depends on oil and natural gas. As the local production is declining, the country is becoming increasingly dependent on imports, which is not a sustainable option. Therefore, Bangladesh must undertake vigorous exploration for new reserves. Until now, about 30 TCF of recoverable gas is discovered, of which about 19 TCF is already extracted. No significant discovery is made over last 2 decades, while the country along with the vast sea area remains mostly unexplored [3,5,14]. The vast sea must be explored in a systematic and scientific manner. This will require advanced technology, large capital, and a lot of expertise. This paper briefly presents an overview of the technologies for offshore E&P, discusses their suitability to the Bay of Bengal, and the fate of Sangu gas field and its facilities.

2. HYDROCARBON POTENTIAL OF THE BAY OF BENGAL

The land and sea areas of Bangladesh lie within the geological feature known as the Bengal Basin, shown in Fig.1 [4]. It is bounded to the west and north by the Precambrian Indian Shield and to the east by the Indo-Burman orogen. It extends to a significant distance into the Bay of Bengal.

![Figure 1. Index map of Bangladesh [4](image)](image)
offshore and offshore blocks of Bangladesh [12]. There are 26 blocks in the sea.

Figure 2: Bangladesh PSC Block Map [12]

The offshore part of the Bengal basin is believed to have all the favorable conditions for hydrocarbon generation, migration and accumulation. Discovery of 27 onshore and 1 offshore gas fields support this idea. Moreover, significant gas discoveries in the neighboring areas like the Mahanadi Basin of India and the Rakhaian Basin of Myanmar (Fig.3) provide strong indication of hydrocarbon discovery in the Bay of Bengal [6].

Figure 3: Block A-1, and Block A-3 of Myanmar where three reservoirs are identified [15]

3. OFFSHORE TECHNOLOGIES

From survey ships to high performance computers, offshore E&P involves a vast array of very sophisticated and advanced technologies. However, for this paper the discussion is limited to the two types of offshore equipment used for drilling and production of oil and gas. These are collectively called offshore structures.

Offshore structures allow activities such as drilling wells, producing from them, processing, storing, and exporting oil and gas. Moveable structures are towed to the required location and removed once the work is completed. These are primarily used for drilling. Barges, Submersibles, Semisubmersibles, Jack-ups, Floaters, and Drill ships are examples of moveable structures. Fixed Platforms are firmly fixed to the ground (ocean floor) and operate for the duration of the exploration and production period. Template (jacket) Platforms, Floating Production Systems, Tension Leg Platforms, Seastar Platforms, Subsea Systems, Spar Platforms, and Compliant Tower Platforms are examples of this type.

3.1 Moveable Structures or Rigs

Fig.4 shows some common movable structures, along with their operating depths. These are primarily used for drilling, but some can be used as production platforms as well.

Figure 4: Common Movable Structure [13]

3.1.1 Barges

Barges are large floating platforms are transported from one place to another by tugboats. Drilling barges are best suited for calm, shallow waters (less than 20 ft to 150ft [9, 13]), but not suitable for large open water scenarios [11].

The lower hull of the barge is sunk to rest on the ocean floor after being floated to the site. The lower hull's substantial surface area serves as a sturdy platform and prevents the rig from sinking into the soft mud [9]. Barges offers the flexibility for variety of conditions for shallow water cases [8].
3.1.2 Submersibles

These are suitable for shallow water (up to 50 ft deep). They have two hulls stacked on top of one another. The lower hull of the rig rests on the lake or sea bottom. The actual drilling platform is in the upper hull, along with the crew accommodations. The lower hull functions similarly to the outer hull of a submarine. As the platform is moved from one location to another, air is pumped into the lower hull, making the entire system buoyant. The air is let out of the lower hull when the rig is over the drill site, and it sinks to the bottom of the lake or the sea [9,11].

3.1.3 Jack-ups

Once transported to the drilling site by towing, three or four "legs" of a Jack-up rig are lowered to touch the ocean floor, allowing the working platform to rest above the water line. The rig's legs can be jacked up or down to desired elevation. These are more suitable for relatively shallow waters because the legs cannot be extended beyond 500 ft. Since their working platform is elevated above the water's surface, often safer to operate than drilling barges [9,11,13].

3.1.4 Floaters

Floating production storage and offloading (FPSO) structures are not fixed to the ocean floor. These rigs can drill in deeper water than Jack-ups or platforms. They deploy dynamic positioning, motion compensators to isolate the riser and drill string from wave motion. There are broadly two types of floaters, namely Semi-submersibles, and Drill ships. These are able to operate in a wide range- from 200m to 3,000m [7].

3.1.5 Semi-submersibles

These rigs are the most popular type and combine the advantages of submersible rigs with the ability to drill in deep water. While some semis are self-propelled, the majority need to be towed [9,11].

Large anchors, each weighing more than 10 tons, are typically used to hold semis in place. The platform is made robust and secure enough to be employed in turbulent offshore waters through anchors and the submerged portion. Dynamic positioning is used to stabilize semis. It is risky in shallow waters because the lower hull may collide with the surface blowout preventer unit. It is possible to reach depths of up to 6,000 feet (1,800m) using semi-submersible drilling rigs.

Advantages of the Semisubmersible are wide range of payload capacity, fully integrated system installed, maximum adaptability, support for distant wells, simple to redeploy [7].

3.1.6 Drill ships

These are specially designed ships to carry out drilling operations at deep-sea locations. In addition to the equipment of a large ocean ship, a drilling platform, derrick, and drilling apparatus are mounted on the center of the deck over a “moonpool.” The Moonpool is a reinforced hole in the bottom of the ship extending right through the ship down through the hull, which allows for the drill string to be raised and lowered by extending down into the water. It deploys dynamic positioning for smooth drilling operation. Drillship can operate at depths greater than 1800m [1,9,11].

3.2 Fixed Structures or Platforms

Fig.5 shows some common fixed structures or platforms. These are either moored at a certain location by cables or stand on their own rigid legs. These are used for long duration. They hold production facilities, living quarters, storage, pumping and compression stations, and a drilling rig. Thus, they provide for further development of the reservoir.

3.2.1 Template Platform

These are fixed to the sea floor by steel tubular, or “Jackets.” They host production equipment, living quarters, and a drilling rig. These are common in the Persian Gulf, the Gulf of Mexico, offshore Nigeria and Californian [10].

3.2.2 Tension Leg Platform (TLP)

The platform's tall, flexible legs extend up from the seafloor and are joined there. These legs have limited vertical mobility but allow for substantial side to side movement (up to 20 feet). Tension leg platforms can work at 7,000 feet of depth [11].

3.2.3 Sea Star Platforms

Sea star platforms are small tension leg platforms with a floating rig. Because of their flexibility, which allows for side-to-side movement, the platform can withstand the force of the ocean and wind without the
legs breaking off. These platforms are frequently used for shallower deep-water reservoirs where it would be more cost-effective to build a smaller platform. They can operate in depths of up to 3,500 feet [11].

3.2.4 Spar platforms

These are the largest offshore structures, built like large cylinders that float vertically and anchored to the sea floor. The first Spar platform was put into place (1996) which worked in water depths of 1,930 feet, and its cylinder was 770 feet long and 70 feet in diameter. Spars can be categorized as, Original Spar Design, Truss Spars, Cell Spars [7,11].

3.2.5 Compliant Tower Platforms

These are made up of slender trusses attached to the ocean floor foundation. Unlike the relatively inflexible legs of a fixed platform, the legs of this tower are flexible, allowing it to function in much deeper water because wind and sea pressure can be absorbed to a large extent. Despite its flexibility, the system is strong enough to withstand hurricane conditions [11].

4. EXPLORATION AND PRODUCTION IN THE BAY OF BENGAL

Despite the optimism of the geologists, exploration in the Bay of Bengal has been sporadic, with very limited success. Since the early 70’s until now, only about 28 exploration wells were drilled in the bay. Sangu was the only discovered gas field which went into production phase. Drilling in other potential offshore locations in Moheshkhali and Kutubdia did not yield any commercial reservoir. Some PSC blocks were relinquished without drilling any well. Information regarding the kind of technologies i.e., type of drilling rigs and methods used, are not available.

Because E&P for hydrocarbon involves very high investments and high risks, international companies may be reluctant to commit due to lack of data and history. It is yet to be proven as prolific as the Persian Gulf, Gulf of Mexico, and so on. Moreover, overly restrictive PSC clauses may also turn away international companies. Given the weather, depth, and sea current in the bay, Jack-up and Semi-submersible drilling rigs should be appropriate. If any major discoveries are made, production platforms like the one at Sangu, with legs fixed to the ocean floor, may be used. The decision, however, must be made after meticulous study of the sea condition and economy.

5. SANGU GAS FIELD

The Sangu field was discovered in 1996 [3] and was shut down in 2013 due to an unexpected low reservoir pressure after having produced about ~487 BCF of gas. Sangu facilities include the platform in the Bay of Bengal, onshore gas process plant located at Fouzdarhat, a 50 km 20-inch seabed pipeline. The block and all the facilities have been relinquished to the Government. It is necessary to find a good way to utilize these otherwise assets worth millions of dollars will be simply wasted.

The platform may be used to import LNG (liquefied natural gas), regasify and supply through the existing pipeline. Unlike the two operational FSRU’s (floating, storage, regasification unit) in the country, it has the advantage to be functional even during peak monsoon season without interruption.

Large quantities of LNG may be bought from the spot market when prices are low; however, lack of LNG storage facility makes that idea impractical. This problem may be solved by using the abandoned Sangu gas field as a huge storage of natural gas.

The platform may also be used to establish maritime, oceanographic, and meteorological research facilities. Moreover, it can be very useful in the process of surveying the bay, as mentioned before.

6. CONCLUSION

Based on the characteristics of the total Bengal basin and available geological and geophysical indications, as well as the reserve discoveries in the Mahanadi and Rakaine basins, the offshore blocks of the Bay of Bengal have the potential to be a significant source of hydrocarbon.

Based on the climate and water depth, Jack -up and semi-submersible rigs may be suitable; however, further research and economic analysis are required before specifying.

There are several options to use the Sangu facility. It may be used in connection with LNG import and storage, or as a facility for scientific research.

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8. REFERENCES


