An MPSO – Mono-column floater with Production, Storage and Offloading – for Gulf of Mexico operation

There are basically three types of floating production units operating in Gulf of Mexico (GoM): SPARs, TLPs, and SS (semi-submersibles), but no one of these concepts has storage capacity. Since the beginning of 2002, the MMS (Minerals Management Service) a Department of Interior Division that regulates the oil exploration in US, reached the decision to accept the use of FPSO, the worldwide most popular floating unit concept, in the Central and Western deepwater areas of Gulf of Mexico. FPSO concepts based on ship-shape vessels are being used in several locations all over the world, but the motions are sensitive to the wave height. Only the roll motion can be reduced by changing the weight distribution and using some hull appliances, such as enlarged bilge keels, but the heave and pitch motions are yet very difficult to mitigate.

So, the FPSO is convenient for flexible risers, but the high accelerations associated with ultra-deep water and high internal pressure make almost impossible the use of SCR’s (Steel Catenary Risers).

Technical aspects of the monobr design

The MonoBR unit is a mono-column floating structure, with production plant, storage capacity and exportation through offloading operation.

The MPSO has the motion response similar to the SPAR buoys, but with shallower draft and with a very good area for the production decks and a high deck payload.

The mono-column hull accepts several construction strategies and the modules hookup can be achieved along the finishing quay.
The high reserve of stability in intact and damaged conditions contributes positively for a low risk operation.

Finally, the best operational characteristic is to allow the production flow and exportation or importation of oil and gas through Steel Catenary Risers (SCR's).

**Project premises**

The Petrobras R&D Center (Cenpes) and Petrobras America Inc. are developing a unit to operate in the ultra deep waters in a Central Area of Gulf of Mexico.

The project shall comply with ABS, MMS & USCG Requirements & Rules.

The main characteristics of the system are:

- **Water Depth**: 7500ft (2,500m)
- **Production Capacity**
  - 120,000 bblpd
  - 21MM scfd
- **Production Water Treatment**
  - 75,000 bpd
- **Vessel Storage Capacity**
  - 800,000 bbl
- **1 Offloading (Retrievable Hose Reel)**
  - Shuttle-Tanker: 500,000bbl (within 10h)
- **6 ESP (Electrical Submersible Pump)**
- **4 Production Risers (OD 8'' SCR)**
- **2 Production Risers (OD 10'' SCR)**
- **1 Gas Export Pipeline (OD 8'' SCR)**

**Table: Main Dimensions**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Diameter</td>
<td>120 m</td>
</tr>
<tr>
<td>Waterline Diameter</td>
<td>88 m</td>
</tr>
<tr>
<td>Depth</td>
<td>58 m</td>
</tr>
<tr>
<td>Main Draft</td>
<td>39.5 m</td>
</tr>
<tr>
<td>Air gap at main draft</td>
<td>17.5 m</td>
</tr>
<tr>
<td>Displacement at main draft</td>
<td>262,000 tons</td>
</tr>
<tr>
<td>$GM_{h}$</td>
<td>3.1 to 7.9 m</td>
</tr>
<tr>
<td>Hull Steel Weight</td>
<td>37,000 tons</td>
</tr>
</tbody>
</table>
**Stability and motion**

The unit has double hull at sides and bottom, with a tank plan as follows:

- 24 ballast tanks (16 external, 8 internal)
- 08 cargo tanks
- 02 slop tanks
- 02 potable water tanks
- 02 diesel tanks

The MPSO tolerates more severe damages than conventionally required and has the capacity to compensate associated heel, restoring the even-keel position by ballasting operation only.

Numerical analysis and model tests indicated good motion responses, even in the harsh environmental conditions of GoM.

**Hull structure**

The steel plate and reinforcements were calculated to satisfy the ABS rules on strength and buckling, by analytical and numerical tools (FEM). Steel AH 36 was used as basic material.

The monolithic shape of the hull has a good resistance to torsion and presents a very good fatigue life.

**Construction and assembly strategies**

This type hull accepts several constructions plans, being attractive for many players. The construction in one piece may be done in a construction yard, being load out to a barge for finishing along the quay. The solution for a medium size dry dock is to construct the hull in two pieces. The parts can be jointed together and welded, floating in sheltered water, close the quay side.
Mooring system description

The mooring system was dimensioned with the TPN (Numerical Offshore Tank), using a full coupled model.

The mooring system is composed by 13 chain-polyester-chain lines, divided in 3 groups, in a spread mooring semi-taut arrangement.

Each line is assembled with 7 segments of Ø262mm polyester (17,620 kN of effective MBL) and 8 segments of R4 Ø152mm studless chain (17,500 kN of effective MBL), totaling 4,200m and 430m, respectively, allowing a maximum offset of 10% WD.

Offloading

The basic premise for the offloading operation is to use DP vessels with deadweight of 500,000 bbl at 40 ft draft.

The 10-year winter storm is the limiting weather condition, which will indicate the DP capacity of the shuttle tankers.

The risk of collision of the shuttle with the MPSO is lower than the same operation being performed with ship-shape F(P)SO’s. For any direction of the environmental resultant, there is always a convenient equilibrium position of the shuttle tanker that minimizes the risk of collision.

Last words

All the project documentation was developed at the level of conceptual design. Further analyses are recommended to have a full understanding of the system, as well as basic engineering design and a detailed construction design are also required for any specific location.

Summarizing, the most relevant characteristics are:

- Excellent Intact & Damage Stability
- Sea Motion meets the risers’ requirements even for harsh environments
- Storage Capacity
- Less Stress Concentration
- Less sensitive to fatigue
- Flexible fabrication strategy
- Less sensitive to deck weight variation
- Large deck area
- Possibility of deck and hull integrated design
- Transportation of the complete unit to the final location

The Petrobras R&D Center (CENPES) and Seven Marine signed a Technical Cooperation Agreement on the design of the SSP-300 platform for Piranema Field in offshore Sergipe, Northeast of Brazil. This negotiation was leaded by the schedule of the first oil, expected to be in August 2006.

So, from August 2006 on, Petrobras will be the first oil company with experience in operating MPSO Units.

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