

FPSOs in the Gulf of Mexico

International Mooring Seminar
18 February 2003

Arun S. Duggal
FMC SOFEC Floating Systems, Inc.

Abstract

The Floating, Production, Storage and Offloading System (FPSO) is the most mature of all floating production systems with an operation history exceeding 25 years. Currently there are approximately 100 in service worldwide. The systems have been installed in water depths ranging from 20 meters to greater than 1,800 meters, and subjected from mild to the most extreme environmental conditions. Production rates range from less than 10,000 barrels/day to greater than 150,000 barrels/day.

However, this readily adaptable and reliable system is yet to be found in the hotbed of deepwater field development – the US Gulf of Mexico. This is primarily due to the vast infrastructure of existing pipelines in the Gulf of Mexico that to date have negated one of the main attributes of the FPSO - the ability to process and store large volumes of product and offload to shuttle tankers or tankers of opportunity. The MMS and Coast Guard have only recently approved the use of an FPSO in the Gulf of Mexico. However, as the search for oil and gas moves to ultra-deep waters in the Gulf of Mexico (> 2,000 meters), the FPSO is once again showing up as a viable, cost effective, and reliable floating production solution.

This presentation provides an introduction to the FPSO by briefly summarizing various applications of the system worldwide. The presentation outlines conditions that are specific to the US Gulf of Mexico and shows similarities to regions in which FPSOs have operated successfully for many years, e.g. South China Sea. Another important example is the PEMEX FSO in the Bay of Campeche, Mexico. This FSO has been in operation since August 1998 and has had an immaculate record of offloading to tankers in operational seastates very similar to the Gulf of Mexico. A total of 285 million barrels (514 tanker loadings) have been exported to date with 100% uptime and no pollution incidents.

The presentation then begins to focus on some of the key design aspects (from a stationkeeping perspective) of an FPSO in deep water Gulf of Mexico. The hull form of a generic newbuild FPSO is presented and some key features identified regarding location of the turret mooring system, design of the bow and freeboard to minimize greenwater, and general design information to help optimize motions. The features of an internal turret mooring system are presented, and the design of the anchor leg system is briefly discussed. The weathervaning ability of a turret moored FPSO is demonstrated by presenting results from a simulation in a hurricane environment. Typical FPSO motions are compared to that of other FPS in deepwater and differences between the various systems identified.

An important tradeoff in the design of a turret moored FPSO is the location of the turret. For optimum weathervaning performance, the turret is desired at the bow of the vessel. From the point of view of riser design, the turret is desired to be closer to midships to minimize the vertical motion that drives the design of the deepwater riser systems. To meet both mooring and riser requirements the optimum turret location is typically 15 – 20% aft of the forward perpendicular to ensure passive weathervaning capability, and to optimize riser vertical motions. However, even at this location the vertical motions are typically greater than those for other FPS, and thus the typical top tensioned or steel catenary risers are not feasible for use with FPSOs in the Gulf of Mexico. Several FPSO compatible riser systems, suitable for deepwater, are presented to demonstrate the feasibility of the turret moored FPSO.

The final portion of the presentation is devoted to a summary of results from a response-based analysis of a turret moored FPSO in the deep water Gulf of Mexico. These results clearly identify the variation of responses as a function of the environment, and present the response-based 100-year design seastates derived from the analysis.

In summary the FPSO is demonstrated to be a viable candidate for ultra-deepwater development in the Gulf of Mexico. Its operational track record is second to none, and the technology to develop such a system is readily available based on experience gained from systems in operation. The FPSO can also compete with the more traditional floating production systems as a floating production vessel, exporting via a pipeline rather than offloading.

Presentation follows...