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Bonga Water Injection: Subsea Design and Operability Challenges

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Abstract

Bonga is a deepwater prospect located in OPL 212 off the West Coast of Nigeria. Peak production for the FPSO development is expected to be 225,000 BOPD (1,490 m³/h). Since the Bonga reservoirs have poor aquifer support and are only normally pressured, the system is designed to inject up to 300,000 BWP (1,990 m³/h) for reservoir pressure maintenance. Success of the water injection is considered quite crucial to the economics of the project. Injection must be fully operational and reliable at first oil.

The subsea infrastructure for Bonga is fairly complex and consists of two water injection risers, supporting up to 15 water injection wells. Operating such a system is challenging. Some of the subsea challenges faced during commissioning, start-up and regular operations include:

- Subsea water distribution
- Opening downhole FBIV valves from the FPSO
- Hydrate risks during initial start-up
- Injection pressure control to prevent reservoir shale fracturing

This paper discusses some of the subsea challenges and steps taken by the Bonga Project and Operations team to address the above issues.

Introduction

Bonga is a deepwater oil prospect in Block OPL 212, offshore Nigeria, in approximately 1,000 m water depth. It is operated by Shell Nigeria E&P Co. in a joint venture with Esso (20%), Total (12.5%), and AGIP (12.5%). The field will be developed as a subsea network with 1.9 – 9.2 km flowline tiebacks to a permanently moored Floating Production Storage Offloading Vessel (FPSO). Bonga's peak oil production will

be 225,000 Barrels of Oil Per Day (BOPD). The project requires an extensive water injection program that is critical to realising the expected hydrocarbon production volumes. The Bonga development is currently expected to recover approximately 650 - 700 million barrels of oil. However, this volume can drop to a paltry 125 million barrels in the absence of water injection.

Seawater will be treated at topsides for oxygen, biomass, solids, scaling, corrosion, and reservoir souring control. It will then be injected into the reservoirs via two 12" flowlines that depart from the FPSO. One flowline (WFL-01) serves the west side of the field, while the other flowline (WFL-03) serves the east side of the FPSO.

Water injection tees are placed in various sections of the flowlines to deliver water to the wells via well jumpers. Each water injection tee is connected to a maximum of two water injection wells. The water injection wells have subsea chokes to provide flow control for water being delivered to the wells. From the first western side water injection tee (WT-1), flowline WFL-02 branches off to cover more acreage of the field. **Figure 1** shows the subsea architecture of the Bonga development.

The water injection program will be developed in phases. The first phase will consist of seven subsea water injectors, while the next phase will add up to eight more water injectors.

Although there are many challenges associated with the overall Bonga water injection system, this paper will mainly discuss the design and operational challenges encountered within the subsea network. The focus of this paper will mainly be on Phase-1 of the water injection program which consists of seven water injection wells (four on the westside and three on the eastside).

Hydraulic Design of Water Injection Flowlines

The Bonga subsea water injection system is designed to inject 300,000 Barrels of Water Per Day (BWP). The water will be distributed between the western and eastern risers by two high-pressure pumps, which can inject at a maximum operation discharge pressure of 210 bar. The flowlines and steel catenary risers are made of carbon steel with 10 mm of corrosion allowance. The main flowlines are lined with High Density Poly Ethylene (HDPE) to provide corrosion control and a smooth surface for improved hydraulic deliverability.