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Optimizing Production Rates and Reducing Life-Cycle Cost for High-Pressure Fields

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Abstract

High pressure challenges are particularly significant in deep wells on the Gulf of Mexico shelf and in deep and ultra-deepwater. Operators evaluating potential deepwater prospects are beginning to encounter wellhead pressures that exceed current industry development capabilities and/or that results in high CAPEX. Operators are looking for technologies that increase value of these fields by reducing cost and increasing production.

A key enabling technology for developing these high-pressure fields is a high integrity pressure protection system (HIPPS). The HIPPS isolates the lower pressure rated flowlines and riser from an overpressure. Thus HIPPS would allow a high-pressure field to tie-in to existing lower pressure rated infrastructure, a capability that will facilitate the development of high-pressure fields. One of the drivers in developing these high CAPEX HP/HT fields is to optimize production from these subsea fields. Installing a HIPPS system subsea allows the flowline to be designed to just above well flowing pressure instead of well shut-in pressure. This results in de-bottlenecking the flowline/riser by increasing the cross-sectional area for flow for the same nominal size flowline. Based on flow simulation over the life cycle of the field using a reservoir pressure decline curve for an example case, the paper demonstrates that installing subsea HIPPS results in:

- Higher total recoverable reserves from the field
- Abandonment at lower reservoir pressure
- Maintaining economical oil flow rates even at the commencement of water cut
- Secondary benefits including higher flowing wellhead and flowline temperatures.

These benefits will be illustrated based on the analysis of a deepwater field development design case. This paper will give decision makers an insight into the benefits of subsea HIPPS in optimizing production and a method for developing project / portfolio valuation matrices for the HP/HT fields.

Introduction

Investment in new ultra-deepwater technology development is key to increasing energy security[1]. Deepwater production requires specialized technology. Field development in ultra deepwater requires even more sophisticated breakthrough technologies in order to achieve economically sustainable production. These greater water depths create unique production challenges compared to conventional offshore methods. Some of the challenges relate to technical and mechanical limitations while others are associated with the high cost of current technology, and the pristine yet hostile environment of the ultra deepwater.

One of the challenges for the development of high-pressure oil and gas prospects in ultra-deepwater is the high CAPEX cost of subsea flowlines and risers. Operators evaluating potential deepwater GoM prospects are seeing expected pressures and temperatures that are likely to exceed current industry development capabilities, which top out at 15,000 psi. A subsea high integrity pressure protection system (HIPPS) could be a key enabling technology to safely and economically develop these high-pressure fields[2]. Installing a High Integrity Pressure Protection System (HIPPS) in the subsea system allows the flowline to be designed to just above well flowing pressure instead of well shut-in pressure.

Traditionally, the preference to operate with a surface HIPPS system results from the assessment of reliability. A surface HIPPS system is perceived to be more reliable because it is easier to inspect and repair[3]. In addition, it is more cost-effective to test the system regularly without concern for the cool down effects associated with seawater cooling in deepwater, which must be considered when testing a Subsea HIPPS system. Lastly when operating with surface HIPPS it is possible to bleed the upstream side of the process piping, thus reducing the risk of hydrate plugs forming. Ultimately, the decision to select a subsea HIPPS versus a surface HIPPS system is a balance between risk and cost.

There is an extreme aversion to “first-time” utilization of any technology, particularly in deepwater Gulf of Mexico. Companies do not want to take a chance and risk delays in production start up and/or costly production shut downs. Several prospects indicate subsea wellhead shut-in pressure exceeds the practical limits of delivery flowlines from subsea fields. Shut in pressures exceeding 12,000 psi combined with pipe size requirements for gathering manifolds, pipelines and risers (especially SCR) are reaching theoretical limits for materials and practical limits for fabrication methods. If deepwater HPHT fields are to be considered feasible in the future, shut-in pressure requirements for downstream piping