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Comparison of Subsea Separation Systems

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Abstract

Operators can significantly improve hydrocarbon recovery from both Greenfield (new) and Brownfield (existing) reservoirs through the installation of subsea processing systems. Recent and ongoing systems designed for the Gulf of Mexico, West Africa, Brazil and North Sea have employed a variety of separator types and sizes. Designs using gravity based separation similar to surface separators and semi-compact separation techniques have been used. As the industry matures in to deeper and higher pressure applications, there is a need for further development of more advanced separation technologies that can provide enhanced performance with improved compactness, and reduced costs. Principles such as high g-forces, pipe separation technologies and electrostatic coalescence are examples of technologies that may enable the design of compact separators.

This paper will describe conceptual designs and descriptions of the various subsea processing building blocks utilized to improve the economics of production. It will also give an overview of the fundamental phenomena providing the separation for the various technologies. References are made to various installations to demonstrate how the applied technologies and how field specific parameters can affect the selection of the separation solution. Additionally, sand handling philosophy is discussed and its affect on separation design.

Introduction

Subsea processing is one of the most attractive technologies currently being utilized and considered by the oil and gas industry. Treating the production flow at the seabed opens many opportunities to achieve more effective exploitation of oil reservoirs around the world. This is important as the oil industry is running out of the oil that has been “easy” to produce, meaning that the focus now is placed on how to produce oil from offshore fields in deeper waters and in more remote areas cost efficiently.

Subsea processing has been driven by the need to:

- Manage pressure issues related to producing heavy oil;
- Increase pressure and hydrocarbon output at fields with low reservoir pressures;
- Address hydrate formation risks;
- Combat declining oil production and associated increased water cut in brownfields; and
- Reduce constraints topside facilities are faced with by performing functions on the seabed

Produced water separation and re-injection is one of the first subsea processing concepts applied. In Norway both the Troll C Pilot and the Tordis SSBI projects have followed this approach. The advantages of this concept lay in the reduction in back pressure accorded by the reduction in fluid gradient. Not only does this result in increased production but also improved recovery. Additionally this approach eliminates any need to increase produced water handling capacity on the host; retrofits of such expanded capacity are often highly expensive or impossible.

The Tordis Subsea Separation and Boosting and Injection system was installed and started up in 2007. As the name implies, this version of the technology was designed to further improve the project economics by providing boost to the hydrocarbon stream; as well as water separation and disposal. The processing station has proven to work in accordance to design and generally has exceeded expectations. However, operating problems outside the processing station in the injection well has limited the use of the station. The Operator is currently investigating options to resolve this and the system should be returned to full operation in good time.

The majority of subsea processing projects to date employ subsea multiphase pumps without need for separation. Some of these pump systems have been in operation for several years. While improved recovery is possible with a multiphase