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## Flow Assurance Field Solutions (Keynote)

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### Abstract

This paper is the keynote address for the OTC Special Sessions on flow assurance.

Major hydrocarbon resources are now being developed in greater water depths. There are still compelling arguments for wet tree development. Subsea technology continues to be challenged to perform beyond that which has been proven. Though greater confidence in some areas of flow assurance technology is needed, there is a greater need to understand where future development costs may be reduced. To achieve this it is necessary to assess risks more precisely so that investment costs may be minimized. To meet this objective requires willingness to take on pilot studies, and effective knowledge sharing among operators.

The intent of this paper is to provide the continuing<sup>1</sup> context for the remaining papers of this day's sessions. It is a general statement of the author's position on flow assurance technology and is intended to help stimulate debate.

### Introduction

Flow Assurance addresses the petroleum extraction process from the reservoir sandface to surface process facilities and beyond.

Issues in this focus area include key aspects of fluid mechanics, heat transfer, oil field chemistry, and process instrumentation and control. It is important that we can predict fluid pressure and temperature as a function of reservoir behavior over field life, the performance of energy boosting methods and means of reducing pressure and temperature losses. We need to manage corrosion, erosion, wax deposition, scale deposition, and hydrate formation. The effect of unsteady flow on the stability of process controls and equipment continues to limit the operating range of subsea systems.

These flow assurance issues require the application of multiple disciplines, in particular a combination of production chemistry, multiphase hydrodynamics, thermodynamics and materials science. Add to that the need to have a strong understanding of operational constraints, and it becomes clear why expertise in flow assurance remains highly valued by the industry.

### Are We There Yet?

Expansion to harsher environments has stimulated research and field validation. Multiphase flow technology had to develop rapidly to support system design in arctic, hilly terrain, and deepwater environments. Systems became more complex including S-shaped risers, free-standing risers, coil-tubing gas lift, and split-purpose subsea operations. Over the years, field trials have been conducted, and field data collected to validate predictive codes. The intent of all this was to build our confidence in capability to address multiphase flow issues in ultra deepwater developments. We have done so well in this technology in recent years that one could possibly assert that little more development is required.

In parallel, on the production chemistry front, hydrate research continues to forage into kinetic modeling, the potential for cold flow systems, and implementation of antiagglomerant technology in the field. Good headway has been made in kinetic inhibitor development, but subcooling requirements demanded by deepwater development still cannot be met. Anti-agglomerate development is now being implemented selectively in black oil systems, and is often included in emerging hydrate management strategies.

Wax management continues to be treated in an empirical fashion. Some headway has been made with improvements in modeling that more effectively represents field systems. Much of this results from a combination of laboratory experiment and field trials. There is still much to be learned about wax deposition and we may be faced with additional concerns should future subsea systems be built with less thermal protection in the face of potential future cold flow systems.

We are still waiting for the promised delivery of subsea processing as a solution to our flow assurance challenges. These systems were to be developed and proven to complement the flow assurance engineer's toolkit. Still the most challenging is water-oil separation in the well or at the deepwater wellhead, as a design alternative to reduce hydrate inhibitor usage and manage flowline and riser hydraulics.