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Monetizing Reserves Faster by Managing Water Better

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Abstract

Secondary recovery using waterflood is fundamental to the development of reserves that drive the revenue streams of the major E&P companies. Producing more oil faster, for the most part, means producing more and injecting more water. Projects conceived and developed on the basis of oil at less that half the current price must be reconsidered as they move towards and through the production phase. At the same time environmental concerns are putting pressure on water treatment operations to meet more exacting performance standards.

This paper examines some of the barriers and opportunities that exist for improving water management and centres on the application of produced water re-injection. It covers some of the technical tools and techniques available that can help find new solutions to old problems, providing examples, and managing the risks and opportunities offered by produced water re-injection.

Introduction

Water, in the context of waterflood operations, like the head of Janus, has two opposing faces; simultaneously improving and limiting production performance. At some point in the life cycle, water handling starts to dominate operations and continues to do so for the remainder of field life. Figure 1 illustrates the life cycle production and injection profiles for an offshore field and the dominance of water over the majority of field life. Figure 2 underlines this by showing the production forecasts of a number of fields from the same offshore license block grouped together.

A successful waterflood operation can be characterized as one that maximizes the value of water while minimizing the risks to production and costs arising from handling water.

The value of water in a waterflood can be summarized:

- Displacement of hydrocarbons
- Improved well performance/reservoir potential
- Optimising reservoir pressure relative to bubble point

The risks to production include:

- Bypassed oil/early water break-through (poor sweep)
- Loss of well performance as water cut increases
- Injectivity loss
- Environmental discharge limits
- Scale
- Souring
- Corrosion
- Water treatment and handling capacity limitations
- Power limitation

The costs of water in a waterflood can be summarized:

- Chemicals and support services (e.g. laboratory)
- Power (artificial lift and injection)
- Corrosion

The elevated price of oil means that there is less emphasis on cost and more on managing the value and water related risks to production. Higher oil prices also mean a drive to increase the rate of reserves recovery as higher revenues support higher capital expenditure for both new and de-bottlenecking projects (new wells and facilities, work-overs and facilities upgrades). All of which means more water along with the oil and the consequent need to increase injection rate. Figure 3 illustrates the relationship between oil price in a waterflood on decline and an economic cut-off based on water cut. The data is modeled on an actual field operating offshore UK where, for a net oil price of $50/bbl compared with $15/bbl, an average well will operate for 11 years longer and produce an additional 55 million barrels of water.

The risks associated with produced water re-injection are frequently over-estimated and a fuller understanding of the mechanisms of injection and the range of risk mitigation techniques available shows that the benefits often more than outweigh the disadvantages. In many cases the re-injection (or re-cycling) of produced water, as against a total dependence on water from external sources (e.g. sea, aquifer), can leverage value by making it easier to upgrade the water injection, treatment and handling capability. For a waterflood this is crucial for accelerating reserves while securing long term operations against stiffer environmental constraints.

The challenge, simply put, is to increase the efficiency with which we exploit the value of water while controlling the risks of producing and handling water.

The opportunity is two-fold; firstly to improve the management of uncertainty and change through rapid and cost effective responses to field performance, the commercial environment and discharge regulations; and, secondly, to improve overall field performance by introducing the volumes of water required to the right places in the reservoir and by