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Diagnosis of Well Performance Degradation on Elgin-Franklin HP/HT Fields Using Only Wellhead Temperature Measurements

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Abstract

Elgin and Franklin are deep HP/HT gas condensate fields situated in the Central Graben of the UK North Sea. Main reservoir is Upper-Jurassic Fulmar sand buried at more than 5000 meters depth and containing a rich fluid in supercritical conditions (1100 bars and 190 degC). The fields have been on-stream since 2001, and six years after production start-up reservoir pressure had declined by 700 bars.

It was identified that down-hole scale deposit (carbonate calcium) can sometimes plug perforations and lead to well performance impairment in Elgin-Franklin. Significant production gains were achieved by performing down-hole acid wash on 5 wells of Elgin-Franklin between 2006 and 2007. A comprehensive diagnosis of the well performance is critical since each acid wash operations must be thoughtfully justified due to the impact of the operations on others critical activities.

The first diagnosis was completed after a production logging survey and calliper survey in a well. An acid wash operation was then performed and allowed to restore 95% of the production losses estimated. Based on this first successful experience, diagnosis was extended to other wells. But in the lack of down-hole surveys and permanent bottom-hole gauges, well production data alone can not often help to perform detailed diagnosis and estimate predicted gains. It was therefore required to develop a specific method of diagnosis with particular tools to cope with the lack of conventional measurements. Thus, a consistent signature between well-head flowing temperature, well-head noise detector and global field gas production at first stage was identified when a well was affected by down-hole scaling. With a continuous monitoring focused on well-head temperature mainly, it was possible to diagnose steady well performance degradations within days, propose new remedial operations and quantify forecasted benefits of performing acid washes.

Introduction

Elgin and Franklin are deep HP/HT gas condensate fields situated in the Central Graben of the North Sea. Main reservoir is Upper-Jurassic Fulmar sand buried at more than 5000 meters depth and containing a rich fluid in supercritical conditions (1100 bars and 190 degC). The fields have been onstream since 2001. After six years of production the reservoir pressure has declined by approximately 700 bars.

Scale deposition in gas wells is believed to be potentially more severe in HP-HT than on conventional fields because changes of pressure and temperature are greater and because scales could be formed with very small quantities of water vaporised (formation water being of very high salinity close to 300,000 mg/l). This vaporisation of formation water is known to be enhanced by the reverse Joule-Thompson effect, typical of HP/HT fields, which induce an increase of the temperature with pressure drop in the near well bore as long as the reservoir pressure remains above 450 bars. It was, therefore, not surprising to encounter (from time to time) down-hole restrictions in some of the wells due to the scale deposit (mainly calcium carbonate – CaCO3) only one year after field production start-up. However, no major impact on the well performance had been observed initially.

A first diagnosis of productivity degradation on one well

The first diagnosis of major productivity impairment caused by down-hole scale deposit was done later, in 2005, after a routine production logging survey (PLT) and caliper survey in the well A. A detailed interpretation of the data allowed identifying that some perforations were plugged and not producing anymore compared with the last down-hole survey performed in 2003 (as shown on Fig. 1). This diagnosis was confirmed by the pressure build-up analysis which revealed an apparent average reservoir permeability reduction (as shown on Fig. 2). The caliper logging performed during the acquisition confirmed that several restrictions existed at perforation level in the production liner. Furthermore, pieces of carbonate calcium scales were