Increased performance of high liquid rate gas wells using foam in Brent

DEVEX – The Production & Development Conference
11th -12th May 2011

Olumuyiwa Owoyemi
Production Technologist, Shell Aberdeen

Many thanks to: Production Chemistry Lab, Colin Strachan, Baker Hughes, CIU pumps (for pictures), Kees Veeken, Gert De Vries, Ewout Biezen, Statis Kitsios
This presentation contains forward-looking statements concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management’s current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management’s expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as “anticipate”, “believe”, “could”, “estimate”, “expect”, “intend”, “may”, “plan”, “objectives”, “outlook”, “probably”, “project”, “will”, “seek”, “target”, “risks”, “goals”, “should” and similar terms and phrases. Also included as a forward looking statement is our disclosure of reserves, proved oil and gas reserves, proven mining reserves, organic reserves, net reserves and resources. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this presentation, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for the Group’s products; (c) currency fluctuations; (d) drilling and production results; (e) reserve estimates; (f) loss of market and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including potential litigation and regulatory effects arising from recategorisation of reserves; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; and (m) changes in trading conditions. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional factors that may affect future results are contained in Royal Dutch Shell’s 20-F for the year ended December 31, 2010 (available at www.shell.com/investor and www.sec.gov). These factors also should be considered by the reader. Each forward-looking statement speaks only as of 12th May, 2011. Neither Royal Dutch Shell nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

The United States Securities and Exchange Commission (SEC) permits oil and gas companies, in their filings with the SEC, to disclose only proved reserves that a company has demonstrated by actual production or conclusive formation tests to be economically and legally producible under existing economic and operating conditions. We use certain terms in this presentation that SEC’s guidelines strictly prohibit us from including in filings with the SEC. U.S. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov. You can also obtain these forms from the SEC by calling 1-800-SEC-0330.
Presentation Outline

- Nature of Liquid Loading
- The use of foam to deliquify gas wells
- Field Application
- Results
- Challenges
- Way forward
Nature of Liquid Loading

What is liquid loading?, What well types are we using in this trial?, Deliquifying techniques available, Foam unloading of Gas Wells.
What is liquid loading?

- Critical Rate: Minimum gas rate in the tubing required to move liquid droplets upward

- High Gas Rate – Continuous gas phase with liquid droplets
- Slugs form as gas velocity decreases with time,
- Gas bubbles through stagnant liquid column
- If corrective action not taken well dies
What well types are we using in this trial?

- Flowing well – Partially loaded – Producing water
  - Well flowing below its potential.

- Flowing Well - Transient Loading
  - Flows at potential for some time and dies.

- Loaded well
  - Will not flow due to standing liquid column
What deliquifying techniques are available?

- Gas lift (usually applied with large volumes of liquid)
- Velocity strings
- Plunger lift
- Rod pumps, ESP’s, PCP, Hydraulic lift
- **Foamers**
  - Batch injection
  - Continuous injection
  - Soap sticks

Foamers are a simple and inexpensive method for deliquifying gas wells.
Foam Unloading of Gas Wells

- Decreases surface tension between water and gas
- Lowers mixture density of fluids
- Lowers critical gas flow (lift liquids at lower gas rate)
2

Field Trial

Objectives & Risks, Why Brent Alpha, Well information, Building a learning ladder, Injection equipment
Objectives & Risks of Trial

- Objectives
  - To improve flow
  - To restore flow capability

- Risks
  - Upset to Process on Production Platform
  - Stable emulsions – Oil in Water (OIW)
  - Foam Ineffectiveness
BRENT FIELD OVERVIEW - WHY BRENT ALPHA ?

- High liquid rate black-oil gas wells
- Brent Alpha well fluids processed on Brent Bravo via 2.5km pipeline
- Bravo Topsides Process Stable
- Good well candidates
4 high liquid rate gas wells (2 gas-lifted & 2 natural flowing)

<table>
<thead>
<tr>
<th>Well</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Type</td>
<td>Flowing</td>
<td>Flowing</td>
<td>Huff &amp; Puff</td>
<td>Dead Well</td>
</tr>
</tbody>
</table>

A & B –Partially loaded – Producing water
- Reduced flowrate not caused by increased back pressure, reduced THP observed

C – Transient Loading
- Well Normally Cycled

D – Loaded well
- Well with reservoir energy but no flow
Shell Europe previous experience in “drier gas” wells with a success rate of 40-50%

First foam trial in high liquid rate black-oil gas wells in the UK

Started with Wells A & B flowing wells: Does the foam work?
Offshore foam & defoamer injection equipment

- Foam Injection equipment

- Defoamer injection equipment
Foam Application Procedure

■ Wells batch dosed, through the KWV, with 2 % of liquid vol in tubing and flushed with fresh water.

■ Following a shut-in of 18-24hrs, wells restarted with defoamer injected into the flowline.

■ Well temperatures, pressures, flow rates and water overboard quality monitored throughout.
3

Results & Way Forward

Overview of Results, Lessons Learnt & Desired Way forward
Overall the trial was successful with:

- **Well A**
  - Initial flow back: SLUG!!
  - Some production gain

- **Well B**
  - Initial flow back showed 20% increase in total platform gas export
  - Flush production was 119% of normal well production

- **Well C**
  - No flow back due to platform facility issues

- **Well D**
  - Well kicked off strongly. Production restored
Results: Process Benefits

- No refoaming
- No emulsion issue (OIW)
- Process stabilised after slug
Lessons Learnt

- Effective communication with field operations on slug expectation and management
- Aggressive well start-up for unloading
- Closer interaction with process engineers on slug mitigation measures e.g. Seperator level
- Alignment of Injection period and flow back periods with availability of onshore support.
Desired Way Forward

- Foam administration – Training Field personnel & Foamer optimisation – Make it routine
- Extend Trial across field
- Routine application candidate? – Batch Vs Continuous. Considerations include:
  - HSE
  - Logistics
  - CAPEX Vs OPEX
  - NFA Cum Volumes
Abstract

The Brent field, located in the northern part of the North Sea, evolved from an oil to gas field following depressurization in 1998. Since then, reservoir pressure has decreased steadily and some of the high liquid rate gas wells have gradually become liquid loaded. Foam as a deliquification strategy has been used within Shell for several years. This paper seeks to highlight experiences from a foam trial on gas wells in the Brent field. Foam injection was carried out in three different well types (Flowing well- Partially loaded, Cyclic Well and a well with kick off issues). Results from injection were mixed with 50% of the wells responding positively to treatment. Challenges as well as future strategy within Brent will also be presented.