Managing well integrity on Erskine Normally Unattended Installation
The first HPHT development in the UKCS

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Presentation Overview

• Erskine field development
• Well design
• Well integrity experiences
  – Tubing condition and liner deformation
  – Scale
  – Annulus Management
  – Subsurface Safety Valves
  – Christmas tree and wellhead
• Closing thoughts
Field Overview

- Gas condensate field discovered in 1981
- First gas in 1997 via 5 production wells
  - Still the same 5 wells producing
- Chevron (50% operator)
  Chrysaor (32%)
  Serica Energy (18%)
- Tied-back to the Chrysaor operated *Lomond* platform via 30km multiphase pipeline
  - Condensate exported to the Forties Pipeline System
  - Gas exported to CATS
- High pressure (960 bar) and high temperature (175°C)
  - Currently depleted by ~600 bar
- Water depth 100m
- Field developed using an innovative NUI
  - Normal POB of 12
  - Maximum of 134 days attended per year
  - Minimal facilities design
Reservoir and Fluid Properties
- Jurassic sandstone
  - Heather Tubidite
  - Erskine (Puffin)
  - Pentland
- CGR 180-210 bbl/scf
- Condensate gravity 40° API
- Column height: 500ft
- Reservoir depth: 15,500ft
- Porosity 20%
- Permeability 80mD

SPE 56899
Erskine Field: Early Operating Experience
Erskine Well Design

• Design Considerations
  – High pressure and high temperature
  – Flow rates up to 60MMscf/d
  – Ability to perform rig-less interventions (i.e. plug back wells and perforate in upper sands)
  – High reliability

• Design Features
  – Monobore completion for through tubing plug backs
  – PBR instead of production packers
  – Corrosion resistant alloys
  – Tubing Retrievable Subsurface Safety Valve (TR-SSSV) with the option for Wireline Retrievable Subsurface Safety Valves (WR-SSSV) in case of TR-SSSV failure
  – Designed for a 20 year life (now at 21 years) with several years to COP date

• W4 was successfully worked over in 1999 following failure of the tubing

SPE 30364: HPHT Drilling and Completion Design for the Erskine Field
SPE 67779: Erskine Field HPHT Workover and Tubing Corrosion Failure Investigation
Well Integrity Experiences

1. Tubing condition & liner deformation

• In order to assess the condition of the liner and tubing, calliper logs are routinely run on all Erskine wells

• Tubing condition is good throughout

• All wells have experienced some form of liner deformation
  – Shear Deformation
  – Axial Buckling

• Following initial deformation, subsequent surveys show that limited further deformation has occurred
  – Risk of well failure due to liner deformation is therefore presumed to be low

• Deformation can restrict access to the perforations putting limits on data-gathering and well interventions

Example of a typical deformation features in the 5” liner
Well Integrity Experiences

2. Scale

- Severe scale deposition has occurred on some wells where we have experienced significant water production
  - W5 lost production due to scale in 2005. A coiled tubing intervention was required to restore production
- Moderate scale deposition has been observed on all wells
  - Recent impact of scale has been on deposition across the SSSV which has required wireline milling operations to mitigate
- Calliper logs have shown scale deposition across the perforations on several wells
  - Scale can restrict access to the perforations
  - May be limiting production
- Most common scales are barium sulphate, zinc sulphide, lead sulphide and calcium carbonate
- No downhole inhibition or scale squeezes have been performed
- Scale inhibition is used for protection of the platform pipework
Well Integrity Experiences

3. Annulus Management

- Annuli are monitored constantly using real-time pressure transducers linked to PI
  - Alarm and trip levels defined to prevent exceeding safe limits
  - Monitored at Lomond and by Chevron onshore team
- Periodic bleed-downs of annulus pressure required to maintain well integrity
  - Can require rapid intervention when Erskine is unattended
  - Bleed-down fluids are analysed onshore as required
- Majority of bleed-offs for the C and D annuli
  - A and B annulus bleed downs are very infrequent
Well Integrity Experience
4. Subsurface Safety Valves

- All wells were initially fitted with TR-SSSVs
- Over time some TR-SSSVs have been replaced with WR-SSSVs
- Two wells have suffered from SSSV control line failures so have had storm chokes fitted
  - Removes the need for a workover
  - Storm chokes cannot be tested in-situ
  - Requirement for annual changeout
  - Inspections after each replacement have found no significant issues
- Alternatives to storm chokes that don’t require a workover would be beneficial to the asset
  - Could be tested in-situ
  - Remove the annual changeout requirement
  - Save on the cost of replacement and a workover
Well Integrity Experiences
5. Christmas Tree and Wellhead

- Tree and wellhead are rated to 15,000psi
- Tree valves and wellhead are subject to annual testing and inspection (PMR)
- If a pressure test cannot be achieved, either maintenance is performed or a risk assessment is done to ensure sufficient barriers are in place to safely operate the well
- All wells have had a tree change in the past
- The main issue experienced is the wellhead test-port elastomeric seals failing. This prevents adequate testing of the metal to metal seals
  - More prevalent when testing cold
  - This needs to be monitored as the wellhead ages

OTC 8742 : HPHT Platform Wellheads & Christmas Trees- Performance Testing to Installation
Example Tree Change Photos - 2010
Closing Thoughts

• Erskine wells are still operating safely after 21 years and need to keep going to maximise economic recovery
• The well design has facilitated low cost interventions to maintain well integrity
• Liner deformation has been observed in all wells but does not appear to be dramatically worsening with time
• Wireline offshore days have typically been used for well integrity related activities rather than production enhancement opportunities
• Scale management has been reactive. Options are being looked at for proactive scale management
• Alternatives to storm chokes that don’t require a workover would be beneficial for the asset
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