Southern North Sea Velocity String Installation Campaign

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More than 30% of total 300 gas wells are currently liquid loading. GWD can increase ultimate recovery by 1-10%.

GWD strategy:
- Velocity String
- Continuous Foam
- Intermittent Production

Please note that the situation as shown is not geographical correct!
- Velocity string always reduces well capacity
- Achieve minimum reservoir pressure without introducing excessive deferment – best candidates are wells with “oversized” tubing
Need to construct production profiles for alternative scenarios
- CRA material (16Cr) to ensure long term integrity
- Coiled tubing installation to reduce time & cost
- Maximum size 16Cr coiled tubing is 2-7/8”
Velocity String Geometry [1]

Bottom Hole Pressure vs Flowrate

Top 150m not straddled
Bottom 150m not straddled

Top 150m straddled
Bottom 150m not straddled

Top 150m straddled
Bottom 150m straddled

+ Top = -4.0 bar
+ Bottom = -8.0 bar

Gas Rate [MMcf/day]

Bottomhole pressure [psi]

7” Tubing
9-5/8” Liner
2-7/8” VS
Velocity String Geometry [2]

**Bottom Hole Pressure vs Flowrate**

- **BC**
  - $Q_{\text{min}}$: 3.7 MMcf/d
  - $P_{\text{min}}$: 1450 psia

- **DS**
  - $Q_{\text{min}}$: 2.5 MMcf/d
  - $P_{\text{min}}$: 1250 psia

- **VS1**
  - $Q_{\text{min}}$: 0.9 MMcf/d
  - $P_{\text{min}}$: 915 psia

- **VS2**
  - $Q_{\text{min}}$: 1.0 MMcf/d
  - $P_{\text{min}}$: 1015 psia

**5” Tubing**

2-3/8” VS / DS
• Install top string (TS) above SCSSSV? In some wells, but later using wireline
• Install bottom string (BS) below tailpipe? Not in this campaign
• Install sliding side door (SSD) below VS hanger? Yes, in all wells
Velocity String Design [1]

- Hang off VS across SCSSSV, make use of wireline insert valve landing profile and sealbore, VS hanger contains tubing insert valve or smaller size landing profile and sealbore to accommodate (smaller) wireline insert valve

- Use wireline plugs as bottom barriers – no problems retrieving from coiled tubing VS despite presence of seam and helical buckling
Velocity String Design [2]

- Use Wellgripp and Carsac connections to make up hanger and bottom assemblies – good experience so far
- Use “completion type” curved moulded seals for hanger – small gas leaks were experienced with “wireline type” V-pack and crimp seals
- Use CT straightener to ease deployment by reducing buckling
Preparring Wells

• Some wells with corroded surface casing and/or tubing cannot sustain the extra loads imposed by coiled tubing VS installation
  – Conductor and surface casing corrosion surveys and load calculations carried out for all wells
  – Shim collars installed as required to transfer excess load from surface casing to conductor (relevant in about 50% of wells)
  – Check tubing loads as well – one candidate cancelled based on results of tubing corrosion survey (40 years old CS tubing)
Preparing Wells & Platforms

- Some wells require pre-work to restore and/or safeguard capacity
  - No more interventions
- Some wellhead decks cannot sustain the extra load imposed during coiled tubing VS installation
  - Reinforce structure as required
VS Installation Experience/Efficiency [1]

- Installed 11 strings on 4 platforms
  - 4x 2-7/8”
    - 12,000 ft max
  - 7x 2-3/8”
    - 16,000 ft max
Increased efficiency & resolved technical issues

**A-1:** Re-run VS 1x to install swellable hanger seals, delays installing top string

**A-2:** Dropped VS in hole, related to GS running tool

**C-1:** Re-run VS 3x to fix hanger seals

**WOW (Windy Season)**

**D-1:** 2.4 days
**D-2:** 2.8 days

**Pre-work planning – work platform time is expensive**

**Work instructions – one dropped VS is enough**

**Hanger seal design – cannot tolerate gas leaks**
• **Use appropriate hanger seal technology**
  
  - Passive V-pack, crimp and swellable seals did not suffice when installed with CT even though they had passed testing on WL – lateral forces and residual bending need more “fat” to ensure gas tight seal, led to use of curved moulded seals
  
  - Keys with square shoulders hung up in well A-1 – led to use of chamfered keys
Flow capacity inside VS and via DS consistent with model.
Campaign Results to Date

Kraken VS Campaign: VS performance

- A platform
- B platform
- C platform
- D platform

High WGRs despite WSO
Summary

• Campaign style execution was essential to achieve efficient operation and maximise learnings

• Integrity of old wells and platforms is not a given

• VS hanger seals required re-design to achieve pressure integrity

• Velocity string well capacities are as predicted

• Annular liquid loading rate increases with eccentricity

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