FIBRE OPTIC BASED GAS LIFT SURVEILLANCE USING

DISTRIBUTED TEMPERATURE SENSING & DISTRIBUTED ACOUSTIC SENSING

39TH GAS-LIFT WORKSHOP
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Requirements for fibre optic based gas lift surveillance

- An optical fibre on the production tubing across the gas lift mandrels
- A DTS or DAS system located close, but away from the well head

Content of presentation

✓ (basic) Understanding the temperatures and acoustics in the well and how these relate to gas lift

✓ Examples from field data
1.0 IMPROVED INTERPRETATION METHODOLOGY
There are three thermal phenomena related to lift gas injection

1) Decompression of the lift gas (Joule-Thompson cooling) when injected through a port into the production tubing

2) The thermal conductivity differences of the annular fluids (liquid interface)

3) The velocity of the lift gas in the annulus (impacted by the gas mass rate and annular volume) and its interaction with the flowing production fluid
1) The DTS FO system measures a combination of the *Tubing Temperature* ($T_T$) as well as a *Annular Fluid Temperature* ($T_A$).
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2) The measured **Temperature** depends on the fluid fill and flowing velocity of this fluid.

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**Diagram Notes:****

- **Casing**
- **Annulus**
- **Tubing**

**Cable is clamped on tubing**

**Oil/Gas:**

- \( T_A = T_T \) \( (Q,v) \) (d\(T\) by heat exchanger)

**Oil/Brine:**

- \( T_A \approx T_T \) (d\(T\) ~ thermal conductivity)

**Gas lift:**

- \( T_A \neq T_T \) (d\(T\) ~ thermal conductivity)
1) The DTS FO system measures a combination of the **Tubing Temperature** \((T_T)\) as well as a **Annular Fluid Temperature** \((T_A)\).

2) The measured **Temperature** depends on the fluid fill and flowing velocity of this fluid.
What do we expect to measured

- Strong broadband frequency signal
- The trick is to understand how to ‘filter-out’ the contributions of other acoustic sources
Example of isolating the gas lift signature contained in the DAS measurement
2.0
EXAMPLES OF DTS AND DAS USED TO ASSESS GAS LIFT INJECTION STATUS
Injection of lift gas is indicated at the depth of the orifice valve as,

- **[DAS]** Shows strong acoustic signal at Orifice valve
- **[DTS]** Shows strong temperature cooling effect at orifice depth
- **[DTS]** Width of DTS trace indicates annular liquid level below Orifice valve
CASE II: CHANGING GAS INJECTION RATE

DAS data was acquired while the gas injection rate was set ON/OFF

- [DAS] There is a clear signal at the depth of the orifice valve (± 20min)
- DTS is unable to capture this changes (1 trace every 3 hrs)
CASE III: INJECTION DEPTH SHALLOWER THAN EXPECTED

[DAS] There is no signal observed at the orifice valve as was expected

[DTS] Shows temperature drop and change in trace width @ SPM #4 indicating the lifting point (no DAS data available at this depth) and annular liquid level
CASE IV: DTS & DAS IN WELL WITH PPO VALVES

**Observations:**

- **[DAS/DAS]** Gas injection at SPM 2
- **[DTS]** Liquid level in between SPM 3 and 4 (unloading unsuccessful?)
3.0
CONCLUSIONS
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- Various field cases have demonstrated that both DTS & DAS data can be used for the surveillance of the gas lift status when using the presented improved interpretation methodology.

- DTS data can be used to identify the depth of (steady-state) gas injection and can be used to distinguish between flowing gas, stagnant gas and a liquid in the annulus.

- DAS data can be used to identify the depth of gas injection, even when valves are chattering. It is therefore more suited than DTS to monitor non-steady state situations as for example a regular start up of the well.

- There should be enough temperature contrast and acoustic signal for the technologies to work (depending on: T signal @ valves, $Q_{prod}$, $Q_{gas-inj-rate}$, orifice size, and $\Delta P$ across valves).
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