Velocity String Installation & Performance Review

VERMILION ENERGY
S.W. TUMMERS
VOGN Overview

- Entered the Netherlands in 2004 by acquiring TOTAL’s onshore assets;
- Acquisition included ~2 million Nm\(^3\)/day of mature natural gas properties;
- 40 production locations, 60 producing wells, 5 water injection wells;
- **Direct focus on production optimization:**
  - Install smaller diameter production tubing to improve well flow;
  - Shut-off water encroachment zones;
Currently Vermilion has installed 39 velocity strings (33 onshore, 6 on Zuidwal Platform);
The sizes are: 1 ½” 1 ¾” 2” 2 ¾/8” 2 7/8”
Material: mostly (used) coiled tubing (carbon steel);
Hang off depth: just below DHSV until top perfs (also found in literature: best performance is reached between top perfs and 1/3 of top perfs);
Typical assembly: usage of a packer and pump out subs;
Typical reservoir pressure: 20 bars;
Typical WHP: 5 bar;
Typical flow: 5,000 – 20,000 Nm³/day with 1 m³ water.
Data Gathering and Modeling (1)
Data Gathering and Modeling (2)

Gas AOF/TPC
Reservoir Model

Legend
- **A**
- **B**
- **C**
- **D**

Current 3.5" Tubing

1.5" Coiled Tubing VS
1.75" Coiled Tubing VS
2" Coiled Tubing VS

- **FLO**

Graph showing flow rates vs gas rate.
**Well Diagram Example and BHA**

### Field: LW EAST
### Well: NIGEGA 9

- **Rate of penetration (R/T):** 6.96 m
- **Annulus Fluid:** COMPLETION DATE: 4/80 INHIBITED KCL BRINE S.G. 1.02

**Volumes:**
- Drilling Depth: HS
- **Tubing:** 9.52 m³
- **Top Cement in 7" Shell:** 2155.5 m/RKB
- **Annulus:** 29.65 m³
- **Shoe:** 1200 m/RKB
- **Hole:** 44.25 m³
- **Cement Top Behind 7":** 900 m/RKB

**Items:**
- Tree 2
- **Tubing Head Merip 11" - 11.5000 X 7 1/16" - 11.5000**
- **Tubing Hanger Merip 3 1/2" EUE Top**
- **Master Valve Merip 3 1/8" X 5000**
- **Wing Valves Merip 3 1/8" X 5000**
- **Top Cap Moti 6 1/2" - 4 ACME Quick Union**

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<thead>
<tr>
<th>Item</th>
<th>QTY</th>
<th>Designation</th>
<th>Depth/Th</th>
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<tr>
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<td>Merip Tubing Hanger with 3&quot; Cameron BPV Profile</td>
<td>28</td>
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<td>2</td>
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<td>Pup Joint</td>
<td>3 1/2&quot; VAM</td>
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<td>2.75&quot; Baker F Nipple</td>
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<td>Velocity String&amp;STC</td>
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<td>Internal West Coiled tubing Wall Thick.</td>
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<td>External Coil connector-0.14 m (2.188'' OD, 1.25'' ID)</td>
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<td>Wireline Entry Guide</td>
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**Perforations:**
- **Deviations:**
  - From To
    - 21 43 21 37 Barkone 2 1/8" 4 SHTS/FT.
  - Deviation: 29dg.

**Velocity Strings:**
- Liner
- Coiled Tubing
- Wireline Entry Guide
- Of the total of 39 velocity strings, 5 did not perform properly;
- This makes a success rate of 87.2%;
- Reasons for failures:
  - Attempt as last resort (with the knowledge of low probability of success);
  - Data is insufficient or wrongly interpreted;
  - Last minute changes in design.

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<th>Length</th>
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<td>0.78&quot;</td>
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<td>3</td>
<td>2.188&quot;</td>
<td>1.375&quot;</td>
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Total length: 170
**Vermilion**

**DHSV Restriction**

- **Field:** LW EAST
- **Well:** OP 1
- **Completion Date:** 1/76
- **Annulus Fluid:** 1.03 SG MGCL2 Brine
- **Drilling Depth:** 1969 m
- **Top Cement in 7":** 1940.70 m

**Hole Volumes**
- **4 1/2" Tubing:** 16 m³
- **7" Shoe:** 17.9 m³
- **9 5/8" Shoe:** 39.3 m³

**Tubing Heads and Casings**
- **Xmas Tree:** 32
- **Tubing Head:** Cameron Type F 11"-10000
- **Tubing Hanger:** Cameron 11"-10000 4.5 X 4.5 EUE Top 4.5 VAM Bot.
- **Master Valve:** Cameron Gate Valve 4 1/16"-10000 F Type
- **Swab Valve:** Cameron Gate Valve 4 1/16"-10000 F Type
- **Wing Valves:** Cameron Gate Valve 4 1/16"-10000 F Type
- **Top Cap:**

**Item:**
- **1 1 Tubing Hanger With 4" Cameron BPV Profile 0,26 4,00 0**
- **2 3 Tubing 4 1/2" VAM 11.60 # N80 32,50 3,875**
- **3 1 Pup Joint 4 1/2" VAM 11.60 # N80 35,43 3,875**
- **4 1 Baker 3.81" B SCSSSV Nipple 35,94 3,812**
- **5 1 Pup Joint 4 1/2" VAM 11.60 # N80 38,74 3,875**
- **6 155 Tubing 4 1/2" VAM 11.60 # N80 1860,18 3,875**
- **7 1 Pup Joint 4 1/2" VAM 11.60 # N80 1863,06 3,875**
- **8 1 Xover 4 1/2" VAM B X 4 1/2" TDS P 1863,60 3,875**
- **9a 1 Xtra Long TBG Seal Receiver EBA1 46-30**
- **9b 1 Sllick Joint With 3.688 Baker F Profile 1875,90 3,688**
- **10 1 Xover 4 1/2" TDS B X 4 1/2" VAM P 1875,88 3,875**
- **11 1 Baker K22 Anchor Seal 1876,13 3,125**
- **12 1 Baker F1 Packer Size 86-40 1876,94 4,000**
- **13 1 Millout Extension 5" VAM 1878,61**
- **14 1 Xover 5" VAM X 3 1/2" VAM 1878,82 2,876**
- **15 1 Pup Joint 3 1/2" VAM N80 9.2# 1879,81 2,876**
- **16 1 Baker 2.75" F Nipple 1880,15 2,750**
- **17 1 Pup Joint 3 1/2" VAM N80 9.2# 1890,36 2,876**
- **18 1 Tubing 3 1/2" VAM N80 9.2# 1891,88 2,876**
- **19 1 Baker 2.75" R Nipple 1882,22 2,697**
- **20 1 Pup Joint 3 1/2" VAM N80 9.2# 1894,67 2,876**
- **21 1 Wireline Entry Guide 1894,85 2,876**
- **22 1 Baker 2.75" F Nipple 1880,86 2,750**
- **23 1 Baker 2.75" R Nipple 1882,95 2,750**
- **24 1 Baker 2.75" F Nipple 1880,15 2,750**
- **25 1 Xover 2 3/8" EU X CS Hyd Rill Tuber String 2 3/8" CS Hyd. N80 4.7#**
- **26 1 Xover 2 3/8" X 1.9 CS Hyd. , No Go To Land In 3.68" F Profile**
- **27 1 Otis 1.5" X Profile**
- **28 1 Xover 1.9 CS Hyd. X 1.25" NPT**
- **29 1 Otis 1.5" X Profile**
- **30 1 BPV Profile With Seal Sleave, 0.8 M 0,26 1,900**
- **31 1 4" Receptical 1,50 2,600**
- **32 3 2.3/8" Tubing 35,25 1,900**
- **33 1 Seal Stinger For WR-SCSSSV 35,50 1,900**
- **34 1**

**Perforations**
- **1906-1909:** 2 1/8" UNIJET
- **1910-1913:** 2" SCALLOP
- **1912-1916:** 2 1/8" UNIJET

**Deviation**
- **Vertical:**
- **Revision:** 20-11-2008

**Norm:**
- **Classification:** NO
Future Developments and Challenges

Challenges:
- Pulling velocity strings (corrosion);
- Barriers.

Future Developments:
- Exemption for DHSV for mature onshore gas wells?
- DHSV system installed in the velocity string so they can be run to surface? Expensive?
- ...?
Velocity strings in mature onshore gas wells, despite the challenges, offer a cost effective way of deliquifying those (small) wells.