BP Canada Plastic Pipe Experience

Bill Baack, Sr. Petroleum Engineering Advisor
BP Canada
Jay Wright, President
Polyflow Inc.
Agenda

- BP Canada Installation
- Polyflow Installations Outside BP Canada
• Rationale for Running Plastic Pipe
  – Determine economic benefit of lower friction plastic verses steel
  – Evaluate if plastic could address bitumen problem by lifting out of wellbore
    • Surface data suggested significantly less sticking and easier to clean
    • Testing on Forton lining showed little or no sticking
  – Potential thermal insulation effect of the tubing preventing liquid from dropping out – needs further work to determine if this is true.
  – Determine benefit for running in deeper wells – 2500 meters
Background for BP Canada (cont.)

• **Previous Plastic Pipe experience** (44mm polyethylene)
  – 2002 ran 4 strings
  – 2005 and 2006 strings pulled – stretched below perfs and shut-off or limited production

• **New type of plastic pipe**
  – a Fortron lined Thermoflex material. It consists of two polymer layers which are reinforced with Kevlar threads
History and Overview

• In winter 2006 – 2007 there were 2 successful installs (shallow 300 meters):

• There was an attempted install
  – November 2006: The plastic string cracked during install
  – Cold weather (-20 C) and coil to close to gooseneck likely causes

• Success achieved with staff building a nipple and landing assembly with Service Company

• Results

• Going forward 8-10 more wells
  – First wells not landed due to bitumen problem, other
## Plastic Pipe Details

<table>
<thead>
<tr>
<th></th>
<th>Forton Thermoflex Kevlar reinforced Velocity string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size O.D. mm</td>
<td>38.1 (1.5 inch, 1.08 inch ID)</td>
</tr>
<tr>
<td>Material</td>
<td>two polymer layers which are reinforced with Kevlar threads</td>
</tr>
<tr>
<td>Max. operating temp</td>
<td>82°C</td>
</tr>
<tr>
<td>Min. operating temp</td>
<td>-10°C</td>
</tr>
<tr>
<td>Pressure rating kPa</td>
<td>3450 (500 psi)</td>
</tr>
<tr>
<td>Max pressure rating kPa</td>
<td>5100 (740 psi)</td>
</tr>
<tr>
<td>Burst strength kPa</td>
<td>15,860 (2300 psi)</td>
</tr>
<tr>
<td>Max tensile load lbs</td>
<td>4000</td>
</tr>
<tr>
<td>Kevlar reinforced bond load rating lbs</td>
<td>13 000</td>
</tr>
<tr>
<td>Collapse kPa</td>
<td>2760 (400 psi)</td>
</tr>
</tbody>
</table>
Plastic String Lifting
Crimping Tool to Install Transition Joint
Transition Pipe for Landing Equipment
Bottom Hole Assembly
Example Well

- Prior – only loaded with compressor down time, stayed loaded – difficult site (muskeg).

flare well to a BD tank to unload

- Prior Production was 6.0 e3m3 (210 mcfd) @ 383 kpa (56 psig)

- Production after v-string 8.8 e3m3 (310 mcfd) @ 373 kpa (54 psig)

- One year later 7.1 e3m3 (249 mcfd) at 445 kpa (64 psi) - No operator intervention
210 mscfd (6 e3m³) at 383 kpg (56 psig)

Critical Flow Rate - Pressure with Gray (Mod)

Depth (1000 ft MD)

Calculate

Tubing ID 1.9950 in
Critical Gas Rate (Exxon, Plube < 800 psi) 221 Mscfd
Critical Gas Rate (Turner, Plube > 800 psi) 263 Mscfd

Calculate

Tubing Diameter
Critical Flow Rate

Gas Rate (Mscfd) vs. Gas Rate (MSCF/D)
Well Conditions After Plastic Tubing

310 mscfd (8.8 e3m3) at 373 kpg (54 pisg)
Plastic Tubing Observations

- Post job – significant change in well performance based on BHP calculations and performance
  - PI increase or not understood
  - Prior well loading and BHP calculation not representative near or at critical rate
- Based on Steel (.0018) verses plastic (.00001), friction factors incremental:
  - 20 psi
  - >100,000 $m revenue (50 mcf)
  - Friction factor is not confirmed by data
- No data on bitumen for analysis
- Temperature analysis?
Growth in Downhole Applications for Thermoflex

- Velocity Strings
  - Low Pressure Formations
  - 10:1 Gas Fluid Ratio
  - Corrosive Environments
- Submersible Pump Tubing
  - Critical Flow Rate to Lift Solids
  - Low Cost Rapid Installation
- Jetting Wells
Slim Hole Completion Case

Background

• 6,425ft, 2 7/8” Casing
• 400 PSI Shut In
• Liquid Loading
• Swabbing or Shut in to Reduce Water Level
• Installed 1” Thermoflex
• Continuous Lifting Gas Increase from 22 to 53MCF/day
Multi-Zone Case

• Five Perforation Zones over 1,000ft
• 4,200ft Depth
• 600PSI Shut In
• 2 bbl/day fluid
• Weekly Soaping and Blowing/ Monthly Swabbing
• Where to Set the Tubing?
Results of Multi-zone Case

Benefits of Thermoflex Tubing

MCF/day vs. Cumulative Days
Kansas Example

- 1250 ft. Depth, 50psi BHP
- 575 bbl/day Fluid Production
- Grundfos Submersible with 1.25” Thermoflex Tubing
- VFD to Regulate Flow
- Regulate Fluid Height not Fluid Flow
Jetting Wells

- 1.75” Tubing to Jet, 4.5” Casing
- Rate of Jetting: 20ft/min
- 275PSI Jetting Pressure
- Depths to 7,000ft
- No Fatigue of the Pipe
Reinforced Polymer Tubing not For All Applications

- Critical Issues
  - Collapse Resistance (e.g. don’t overpressure annulus)
  - Cold Temperature Installation
  - Salt Off/ Freeze Off Around Restrictions
- Velocity Strings Work if the Tubing Size is Correct
- Polymers Must Match the Environment
Copyright

Rights to this presentation are owned by the company(ies) and/or author(s) listed on the title page. By submitting this presentation to the Gas Well Deliquification Workshop, they grant to the Workshop, the Artificial Lift Research and Development Council (ALRDC), and the Southwestern Petroleum Short Course (SWPSC), rights to:

- Display the presentation at the Workshop.
- Place it on the www.alrdc.com web site, with access to the site to be as directed by the Workshop Steering Committee.
- Place it on a CD for distribution and/or sale as directed by the Workshop Steering Committee.

Other uses of this presentation are prohibited without the expressed written permission of the company(ies) and/or author(s) who own it and the Workshop Steering Committee.
Disclaimer

The following disclaimer shall be included as the last page of a Technical Presentation or Continuing Education Course. A similar disclaimer is included on the front page of the Gas Well Deliquification Web Site.

The Artificial Lift Research and Development Council and its officers and trustees, and the Gas Well Deliquification Workshop Steering Committee members, and their supporting organizations and companies (here-in-after referred to as the Sponsoring Organizations), and the author(s) of this Technical Presentation or Continuing Education Training Course and their company(ies), provide this presentation and/or training material at the Gas Well Deliquification Workshop "as is" without any warranty of any kind, express or implied, as to the accuracy of the information or the products or services referred to by any presenter (in so far as such warranties may be excluded under any relevant law) and these members and their companies will not be liable for unlawful actions and any losses or damage that may result from use of any presentation as a consequence of any inaccuracies in, or any omission from, the information which therein may be contained.

The views, opinions, and conclusions expressed in these presentations and/or training materials are those of the author and not necessarily those of the Sponsoring Organizations. The author is solely responsible for the content of the materials.

The Sponsoring Organizations cannot and do not warrant the accuracy of these documents beyond the source documents, although we do make every attempt to work from authoritative sources. The Sponsoring Organizations provide these presentations and/or training materials as a service. The Sponsoring Organizations make no representations or warranties, express or implied, with respect to the presentations and/or training materials, or any part thereof, including any warrantees of title, non-infringement of copyright or patent rights of others, merchantability, or fitness or suitability for any purpose.