2019 Artificial Lift Strategies for Unconventional Wells Workshop

Cox Convention Center, Oklahoma City, OK

February 11-14, 2019

Keynote Address

GOING BEYOND CONVENTIONAL

By

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President
Proline Energy Resources Inc
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5 MINUTES OPEN DISCUSSION

- Artificial Lift Strategies - Understanding our job
  - Wellbore Fluid Evacuator
- Unconventional Technology Adoption & Application
- Late Life Problem
  - Going back to the basics
  - Going Beyond Conventional
- Key Take Away

Q&A
About Keynote Speaker

Peter Oyewole
President
Proline Energy Resources Inc

✓ 25 Years Industrial Experience
✓ Leading expert in Artificial Lift, Well Recompletions, Production Optimization & Operations
✓ Author of several publications in Artificial Lift and Production Optimization & Operations
✓ Diverse experience in many US petroleum producing basins & international
✓ Master in Petroleum Engineering degree at the University of Houston
✓ Previously Worked for NOC, Texaco, Valero Energy, Schlumberger, BP, BassPet (BOPCO)
About Proline Energy Resources Inc

Mission

✓ Acquire non/under optimized assets
✓ Focus on Liquid/Oil Rich Gas Assets
✓ Leveraging exceptional in-house skills in ARTIFICIAL LIFT APPLICATION acquired in both Onshore US Gas basin and various international oil and gas fields
✓ Add value to all Stakeholders owners through best practices in base production management
✓ Deploy organizational efficiency to reduce lifting cost
Proline’s Asset Overview

- 550 Operated Wells (Q1-2019)
- 70 Non-Operated Wells (Q1-2019)
- >85,000 Gross HBP Acreage
- Current Reserves Estimates:
  - >200 BCF
  - >4 MMBO
  - Production ~15MMcfd (~ 30% Liquid)

- Austin Chalk, ETX Haynesville, Cotton Valley, STX Eagle Ford & Conventional Oil & Gas Play – Frio, Yegua, Vicksburg, Wilcox

- 85 Miles of Pipeline
- ALL AL Type except ESP & PCP
- 2 Swab Rigs
Economic Impact of Artificial Lift Strategies

Crude Oil WTI Prices (1989 to 2019)

Per bbl


$140 $120 $100 $80 $60 $40 $20

45 60
Economic Impact of Artificial Lift Strategies

| TECHNICAL----------NYMEX WTI CRUDE OIL PRICES---------- |
|------------------|----------------|------------------|-----------------|-----------------|------------------|
|                  | 1ST-RES | CLOSE | CHANGE | % CHANGE | 1ST-SUP |
| Mar-19           | 54.63   | 52.72 | 0.08   | 0.2%     | 51.28  |
| Apr-19           | 55.00   | 53.09 | 0.09   | 0.2%     | 51.65  |
| May-19           | 55.46   | 53.55 | 0.10   | 0.2%     | 52.11  |
| Jun-19           | 55.93   | 54.02 | 0.09   | 0.2%     | 52.58  |
| 6 MONTH          | 55.68   | 53.77 | 0.08   | 0.2%     | 52.33  |
| 12 MONTH         | 56.44   | 54.53 | 0.06   | 0.1%     | 53.09  |
| CAL 2020         | 56.93   | 55.02 | 0.03   | 0.1%     | 53.58  |
| CAL 2021         | 55.80   | 53.89 | 0.05   | 0.1%     | 52.45  |
| CAL 2022         | 54.94   | 53.03 | 0.02   | 0.0%     | 51.59  |
| CAL 2023         | 54.70   | 52.79 | -0.03  | -0.1%    | 51.35  |

NYMEX WTI, ICE Brent & Atlantic Spread - Forward Curves (Daily Settlement)
Economic Impact of Artificial Lift Strategies

Natural Gas Henry HUB Prices (1989 – 2019)

Per MMBTU

- **CONVENTIONAL**
  - 2000
  - 2005

- **BEYOND CONVENTIONAL**
  - 2010
  - 2015

Henry HUB Prices:
- 2.50
- 3.50

Per MMBTU Prices:
- $2
- $4
- $6
- $8
- $10
- $12
- $14
- $16
Economic Impact of Artificial Lift Strategies

US NATURAL GAS PRODUCTION

U.S. DRY MARKETED PRODUCTION

DRY MARKETED PRODUCTION

2018 | 2015 | 2016 | 2017

BCFD

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Economic Impact of Artificial Lift Strategies
As laid out several times before, 2019 is a big expansion year for LNG export capacity with year-end capacity at almost 9 bcf/d (assuming all projects indeed come on line as scheduled). We would be quite bullish for overall market pricing with this single factor were it not for the extremely high and fast-rising U.S. production levels - the pace of such increases possibly to likely to continue into 2019. Still, this is a significant mitigating factor that will somewhat offset plentiful U.S. supply. Current feed-gas levels in January are already averaging around 4.0 bcf/d.

Longer term however, we do expect the overseas price arbitrage to contract with the dampening effect of lower crude prices and a substantial amount of LNG export capacity coming on line domestically and globally (going to become a crowded trade).
Economic Impact of Artificial Lift Strategies

US LNG FUTURE EXPORT CAPACITY

ExxonMobil, Qatar bet on U.S. gas export with $10 billion Golden Pass Project (World oil)

The investment from Qatar, the world’s biggest seller of LNG, comes as the nation seeks to pour $20 billion into America’s oil and gas fields

Venture Global’s Calcasieu Pass facility in Louisiana

Royal Dutch Shell Plc’s Lake Charles joint venture in Louisiana with Energy Transfer LP
Artificial Lift (AL) Market Share

- 2 million oil wells in the world -50% on AL - PetroWiki
- >95 percent of all U.S. oil wells and several gas wells
  - US in leading position
- COST EFFECTIVE - Stripper wells and increasing Horizontal Wells is the biggest opportunity for the market
5 Minutes
OPEN DISCUSSION
## Artificial Lift Categories

<table>
<thead>
<tr>
<th>Reservoir Pressure Driven</th>
<th>Fluid Driven</th>
<th>Mechanical Driven</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Plunger lift (PL)</td>
<td><strong>5</strong> Gas lift (GL)</td>
<td><strong>9</strong> Electric submersible pump (ESP)</td>
</tr>
<tr>
<td><strong>2</strong> Surface control lift (WCL) - compressors, ejectors etc.</td>
<td><strong>6</strong> Gas lift assisted plunger lift (GLAPL)</td>
<td><strong>10</strong> Hydraulic submersible pump (HSP)</td>
</tr>
<tr>
<td><strong>3</strong> Foam lift (FL)</td>
<td><strong>7</strong> Downhole ejector lift (DEL) - gas powered</td>
<td><strong>11</strong> Hydraulic piston pump (HPP)</td>
</tr>
<tr>
<td><strong>4</strong> Velocity string lift (VSL) - tubing size reduction</td>
<td><strong>8</strong> Hydraulic jet pump (HJP)</td>
<td><strong>12</strong> Downhole multiphase pump (DMP)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>13</strong> Rod pump (RP) - including hydraulic Prime Mover</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>14</strong> Rod driven progressive cavity pump (RD-PCP)</td>
</tr>
</tbody>
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Regional Artificial Lift Strategies & Drivers

Giant Permian Basin

Lower 48 states shale plays

Current play - oldest stacked play
Current play - intermediate depth/age stacked play
Current play - shallowest/youngest stacked play
Prospective play
Basin

* Mixed shale & chalk play
** Mixed shale & limestone play
*** Mixed shale & dolostone-siltstone-sandstone play
**** Mixed shale & limestone-siltstone-sandstone play

Source: U.S. Energy Information Administration based on data from various published studies. Updated: June 2019

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Regional Artificial Lift Strategies & Drivers

Eagleford & STX Basin

Major Tight Gas Plays, Lower 48 States

Source: Energy Information Administration based on data from various published studies
Updated June 6, 2010
Regional Artificial Lift Strategies & Drivers

Haynesville & ETX Tight Gas Shale

✓ “Giant Permian Basin” = ESP, Rod Pump, GL, PAGL
✓ Eagleford = GL, PAGL, Rod Pump GL, PAGL
✓ Bakken = Rod Pump, ESP
✓ Haynesville Shale & ETX Tight Gas = Plungers, PAGL, GL, Rod Pump
✓ Marcellus and Utica shales = Plungers, GL, PAGL
✓ Rock Mountains = Plungers, GL, Rod Pump, PCP
Regional Artificial Lift Strategies & Drivers

Reservoir Characterization and Fluid Phase Behavior

180 Day GOR’s Plot – 2nd Bone Spring Sand Horizontal

<table>
<thead>
<tr>
<th></th>
<th>Well 1</th>
<th>Well 2</th>
<th>Well 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Fluid-Type</td>
<td>Under saturated Black Oil</td>
<td>Under saturated - Volatile Oil</td>
<td>Saturated Oil</td>
</tr>
<tr>
<td>Reservoir Pressure (psig)</td>
<td>3,950</td>
<td>5,580</td>
<td>4,476</td>
</tr>
<tr>
<td>Bubble Point Pressure (psig)</td>
<td>2,900</td>
<td>5,235</td>
<td>4,503</td>
</tr>
<tr>
<td>Gravity of Separator Oil (API)</td>
<td>40.9°</td>
<td>48.0°</td>
<td>53.9°</td>
</tr>
<tr>
<td>Reservoir Temperature °F</td>
<td>132</td>
<td>143</td>
<td>136</td>
</tr>
<tr>
<td>TVD (ft)</td>
<td>8900</td>
<td>9850</td>
<td>8927</td>
</tr>
<tr>
<td>Solution GOR scf/bbl</td>
<td>912</td>
<td>1832</td>
<td>1975</td>
</tr>
<tr>
<td>Relative Oil Volume (Bo) RB/STB (R T&amp;P)</td>
<td>1.48</td>
<td>2.24</td>
<td>2.49</td>
</tr>
</tbody>
</table>
5 Minutes
OPEN DISCUSSION
Artificial Lift Strategies

Understanding Our Job

✓ Optimum Artificial Lift Type
✓ Optimize Gas & Oil Production (with Lowest $p_{wf}$) @ lowest Capex & Opex for life of the well/field

Challenges:
✓ Several Lift Types ➔ Numerous Choices
✓ Dynamic changes in the Life of the well (& Field)
✓ Application Limitation on every Lift Type
✓ Liquid loading in Gas well (Special Application)
Understanding Our Job

Compression on tight and higher perm well. There is less production increase as pressure lowered near AOF on tight well than for higher perm well.

- ✓ Close to Absolute Open Flow (AOF)
- ✓ Steep slope of the IPR curve
- ✓ (Difficult obtain accurate IPR for a tight fractured gas well – high DT to pseudo steady state Pr (avg)).
Are You Too Busy to Improve?

No thanks!

We’re too busy!
Unconventional Technology
Adaption & Application

✓ Cloud Computing and Edge Processors
✓ Internet of Things (IoT)
✓ Artificial Intelligence (AI)
✓ Advanced Robotics
✓ Programmed Drones
✓ Blockchains
Unconventional Technology
Adaption & Application
Late Life Problem
Late Life Problem

Going Back To the Basics

Going Beyond Conventional
Late Life Problem

Unconventional Well → Stripper Well

Managed Production
Managed Flowback
Managed Depletion

Case Name: FIRST BONE SPRING TYPE DECLINE 1000'
BONE SPRING

Proj Oil Cum: 268.39 Mbbbl
Oil EUR: 268.39 Mbbbl

Proj Gas Cum: 1,616.99 MMcf
Gas EUR: 1,616.99 MMcf

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Late Life Problem

N2 membrane Lift & GL - 4X Production Increase

Welder A2 Monthly Production History

Return Well on expected decline Feb 2017
✓ “Wellbore Fluid Evacuators” are providing cheaper energy option for global consumers

✓ “Lower for Long commodity price” is the new era Beyond Conventional

✓ Unconventional Horizontal Wells will eventually become stripper well (some as early as 3rd year of Production)

✓ Effective cost management for horizontal wells and late life stripper wells is the only winning strategy beyond conventional

✓ Proper application of New Information Technology & New AL Product development will be the most deciding factor toward delivery value

✓ Understand our JOB ------- Wellbore Fluid Evacuators
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