“Unconventional Artificial Lift Configurations and Deployment Methods”

SPE Applied Technology Workshop

13-14 March 2012
Amwaj Rotana Hotel, JBR Dubai, UAE

High GOR Environment
Gas Handling Solutions

Aslan Mollaev
Overview

- Why is High GOR a Problem
- How to Recognize the Gas Influence
- Solutions Available
- Gas Separators
- Abrasion Problems
- Multiphase Pump
ä Gas tends to "Gas Lock" a pump

ä Gas does not allow to properly lubricate bearings

ä Pumping efficiency is reduced

ä Overall System efficiency will be reduced
Gas Impact

- Pump efficient capacity is reduced when Gas occupies part of a space in pump’s lower stages
Recognizing a “Gas Problem”

1 – motor load, 27-55%
2 – bottom hole pressure, 1300psi (90atm)
Stage Designs

Pancake Stages

10 to 15% free gas by volume

Vortex Type 20%

Mixed Flow Stages

15 to 25% free gas by volume

Vortex Type 30%
Managing a Gas

SOLUTIONS AVAILABLE:

GAS SEPARATION
- Rotary or Vortex Gas Separator

GAS HANDLING
- Multiphase Pump
Challenges/limitations:

1. Severe abrasive down-hole conditions (bearings failure)
2. Extremely gassy wells
3. Oil production with non-vented packers
4. Horizontal wells

AR Bearings – Tungsten and Silicon Carbide
Gas Separators

Housing Cutting
Problem Investigation
• Maximum solids concentration is in the area of vortex impeller.

• At 1900 BPD flow rate solids concentration in the critical area is 8 times as much than concentration of the injected solids, and 11-14 times as much at 950 BPD flow rate.
No gas – bigger wear

Blue – 20% gas, red – no gas
New Gas Separator design

Helical inducer of varied pitch 1, containing sleeve 2 with spiral vanes 3, inclined toward the fluid flow

Pumping and separation units are combined
Results Achieved

• Dependence of sleeve thickness along its length after 100 hours of Hydro-Abrasive testing on test bench at equal flow rate 500-630 BPD
Actual Experience

- Wide experience: since 2006 more than 1420 abrasion resistant gas separators were supplied to the Customers

- Application of such gas separators helped to eliminate the problem of housing cutting by abrasive flow
High GOR Solutions

Application of Gas separators

Challenges/limitations:

1. Extremely gassy wells
3. Producing in non-venting conditions
4. Deviated/horizontal wells

Solutions

1. Application of Multiphase Pump
Multiphase Pump Application

What does it do?

- Homogenizes the fluid
- Pushes gas-liquid mixture thru Main ESP stages
- Drastically reduces a possibility of pump to Gas Lock at low Pi
How does it work?

MPP stage design has axial screw type impeller and gas handling diffuser

**Operation:**

1. Flow streams to the axial type impeller → gas volume is compressed
2. Compressed gas streams to the diffuser → gas bubbles break into small

**Result:** homogeneous gas-liquid mixture

MPP primes the Main ESP and pushes the gas-liquid flow into centrifugal stages with no gas locks
ESP Sizing considerations when using MPP

- MPP flow capacity should be not less than main pump capacity
- Pump Head degradation
- Better to use ESP with vortex-type stages.
**ESP system designs for gassy fluids production**

Test results for different ESP configurations achieved on working fluid (water+gas+surface-active substance) imitated reservoir fluid properties on Test bench for gas handling application

<table>
<thead>
<tr>
<th>Maximum gas content at pump intake, %</th>
<th>25</th>
<th>30</th>
<th>65</th>
<th>70</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>C - Pump**</td>
<td>Intake</td>
<td>Protector Motor</td>
<td>CV - Pump**</td>
<td>Gas separator</td>
<td>CV - Pump**</td>
</tr>
<tr>
<td>CV - Pump**</td>
<td>Intake</td>
<td>Protector Motor</td>
<td>CV - Pump**</td>
<td>Multi-phase pump</td>
<td>CV - Pump**</td>
</tr>
<tr>
<td>Intake Multiphase pump</td>
<td>Gas separator</td>
<td>Protector Motor</td>
<td>Intake</td>
<td>Gas separator</td>
<td>Protector Motor</td>
</tr>
</tbody>
</table>

* centrifugal pump  
** centrifugal-vortex pump
ESP Vs. MPP

ESP: OD 4.06”, 3145 bpd (500m³/day)

MPP: OD 4.06”, 3145 bpd (500m³/day)

MPP has stable and wide range operation (even at low intake pressure) vs. ESP performance
Motor current analysis

ESP without MPP:
1 – motor load, 27-55%
2 – bottom hole pressure, 1300psi (90atm)

ESP with MPP:
1 – motor load, 42%
2 – bottom hole pressure, 1000psi (70atm)

532 well, Vyngapurovskoye oilfield
# MPP operation at different intake pressure

<table>
<thead>
<tr>
<th>MPP</th>
<th>Max free gas volume up to @ Pi = 40psi (3atm)</th>
<th>@ Pi = 700psi (50atm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>406 series</td>
<td>&gt;40-45%</td>
<td>&gt;60-65%</td>
</tr>
<tr>
<td>362 series</td>
<td>&gt;35%</td>
<td>&gt;45-50%</td>
</tr>
<tr>
<td>319 series</td>
<td>&gt;30%</td>
<td>&gt;40-45%</td>
</tr>
</tbody>
</table>

The bigger MPP series the bigger volume of gas can be handled.
## MPP nomenclature

<table>
<thead>
<tr>
<th>MPP</th>
<th>Flow rate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bpd @60Hz</td>
<td>m³/day @50Hz</td>
</tr>
<tr>
<td>272 series</td>
<td>950</td>
<td>125</td>
</tr>
<tr>
<td>319 series</td>
<td>950</td>
<td>125</td>
</tr>
<tr>
<td>362 series</td>
<td>1500</td>
<td>200</td>
</tr>
<tr>
<td>406 series</td>
<td>940, 2400, 3800</td>
<td>125, 320, 500</td>
</tr>
<tr>
<td>449 series*</td>
<td>7600</td>
<td>1000</td>
</tr>
<tr>
<td>535 series*</td>
<td>12000</td>
<td>1600</td>
</tr>
</tbody>
</table>

* coming soon
Achieved results:

- Increased production and reservoir life in gassy wells by increasing drawdown and allowing effective pump operation at lower intake pressure
- Due to gas-lift effect greater lift per stage and efficiency are ensured
- Increased production by reducing gas locking production shutdowns
- Extended System Runlife by stabilizing motor current
- Laboratory tests and actual field applications proved MPP to be an excellent solution for high GOR wells
- Wide experience: since 2006 more than 550 MPP were supplied to the Customers
Case study data

- **Customer:** GazPromNeft-Noyabrsk
- **Number of operating well:** 80
- **Problems:**
  - High reservoirs free gas content
  - High number of ESP shutdowns caused by high free gas content
  - No possibility to use gas separator due to under-packer design
  - Wells after interventions
Operating results: MTBF increase

Solution:
Installation of Novomet Multiphase pump to avoid gas locks

Result:
Increase of run life by 230%
Number of shutdowns due to free gas content decrease 20 times as less!
THANK YOU !!!