PCP - ESP - SRP
Choosing the best artificial lift; the first step to profitability

Krzysztof Palka, Imaginea Energy
We want the same thing you want.

An energy industry that’s better for the **planet**, **and** for **people**, **and** for **profits**
over 2,000 bbl/d for now..

96% WC

140 producing wells

1,000m TVD

59% horizontal

37% vertical

4% deviated

54% PCP

46% SRP

75% electrified
Choosing the best artificial lift

○ expertise of suppliers

○ our experience and comfort level

○ to maximize production from each well

○ to maximize profit from each well and total recovery from reservoir
# Expertise of suppliers

<table>
<thead>
<tr>
<th></th>
<th>SRP</th>
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<tbody>
<tr>
<td>Maximum Operating Depth</td>
<td>4,078m TVD</td>
<td>3,300m TVT</td>
</tr>
<tr>
<td>Maximum Operating Volume</td>
<td>795m³/d</td>
<td>952m³/d</td>
</tr>
<tr>
<td>Maximum Operating Temperature</td>
<td>288°C</td>
<td>350°C</td>
</tr>
<tr>
<td>System Efficiency</td>
<td>45% - 60%</td>
<td>55% - 80%</td>
</tr>
<tr>
<td>Fluid Gravity</td>
<td>10°API - 45°API</td>
<td>5°API - 45°API</td>
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<tr>
<td><strong>Maximum Operating</strong></td>
<td><strong>Depth TVD</strong></td>
<td><strong>600 - 1,370m</strong></td>
<td><strong>300 - 3,050m</strong></td>
</tr>
<tr>
<td></td>
<td><strong>30 - 3,350m</strong></td>
<td><strong>Max. 4,800m</strong></td>
<td><strong>Max. 4,570m</strong></td>
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<tr>
<td><strong>Volume</strong></td>
<td>0.5 - 240m³/d</td>
<td>1 - 350m³/d</td>
<td><strong>30 - 3,180m³/d</strong></td>
</tr>
<tr>
<td></td>
<td>Max. 795m³/d</td>
<td>Max. 715m³/d</td>
<td>Max. 4,750m³/d</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td><strong>38 - 177°C</strong></td>
<td>24 - 66°C</td>
<td><strong>38 - 135°C</strong></td>
</tr>
<tr>
<td></td>
<td>Max. 288°C</td>
<td>Max. 121°C</td>
<td>Max. 205°C</td>
</tr>
<tr>
<td><strong>System Efficiency</strong></td>
<td>45% - 60%</td>
<td><strong>40% - 70%</strong></td>
<td>35% - 60%</td>
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<tr>
<td><strong>Fluid Gravity</strong></td>
<td>&gt; 8° API</td>
<td>&lt; 35° API</td>
<td>&gt; 10° API</td>
</tr>
<tr>
<td><strong>Wellbore Deviation</strong></td>
<td><strong>0 - 20°</strong></td>
<td>0°</td>
<td><strong>10°</strong></td>
</tr>
<tr>
<td></td>
<td>Max. 90° &lt; 15°/30m</td>
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**Expertise of suppliers**

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Finding the sweet spot

- SRPs and PCPs were originally developed for vertical wells

- SRPs work well in low to medium volumes with medium to low viscosity

- PCPs are great for high viscosity fluids, with solids and good lubricating qualities

- ESP are the only effective option for high volume wells with >500m$^3$/d production
## My sweet spot

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<td>500 - 3,000m</td>
<td>500 - 1,000m</td>
<td>500 - 2,000m</td>
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<tr>
<td>Operating Volume</td>
<td>0.5 - 150m³/d</td>
<td>50 - 350m³/d</td>
<td>300 - 3,000m³/d</td>
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<td>Max. Temperature</td>
<td>250°C</td>
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Horizontal well reality

Dogleg Severity °/30m
Horizontal well reality
Horizontal well reality

sideload depends on wellbore deviation and tension in sucker rods

tension depends on (SRP and PCP):
- pump diameter
- intake and discharge pressure
- buoyant weight of the rods
- dynamic forces (SRP only)

sideload acting on sucker rods results in friction force
Horizontal well reality

friction force causes decrease in your system efficiency and \textit{increase} in energy consumption

friction force between sucker rods and tubing combined with movement causes wear

more movement (strokes, rpms) results in more wear

wear guaranties that you will have workover \textit{earlier} rather than later
Horizontal well reality with SRP

slow down with longer surface stroke
  ○ fewer strokes per day equals fewer workovers per year

smaller but higher strength rods
  ○ lighter rods equals less tension on your rods

smaller pump
  ○ smaller TV load equals less tension on your rods

protect your rod connections
  ○ put guides where they can make a difference
Slow down with longer stroke

Option I
2” BHP
120” Stroke
API 76, D Rods
70% Rod Loading
5.6 SPM

Option II
2” BHP
192” Stroke
API 76, D Rods
65% Rod Loading
3.4 SPM

+43%
Smaller pump & rods, longer stroke

Option I
- 2” BHP
- 120” Stroke
- API 76, D Rods
- 70% Rod Loading
- 5.6 SPM

Option II
- 1.5” BHP
- 192” Stroke
- API 66, HS Rods
- 51% Rod Loading
- 5.8 SPM

+41%
Protect your rod connections
Protect your rod connections

Dogleg Severity °/30m

BHP

Smarter 6per rod

45°

Slim Hole Coupling

+150%
Horizontal well reality with PCP

- Slower rpm requires larger pump diameter
  - Smaller pump but higher rpm may be better

- Cyclic torque (stick and slip) is the real problem
  - Decrease efficiency with larger clearance
  - Use continuous rod
  - Use stronger rod connections

- Locate your pump in a tangent section
Find out what is working for you

how can we easily compare different types of artificial lift?

how can we find out which are more efficient and work well for you?

how can you easily identify if there is a potential problem with any particular well?
Power intensity of artificial lift

a simple measure of efficiency for every well and type of artificial lift

$kWh$ consumption per $m^3$ of produced liquid per $km$ of lift

- kWh’s used in a month by your artificial lift
- liquid volume produced in a month by your well
- pump intake TVD
Power intensity of artificial lift

Theoretical PI for water is ~2.8

If your PI is higher than 2.8

- Extra energy is most likely spent on wear

If your PI is lower than 2.8

- Your fluid level is above pump intake
Power intensity of artificial lift

41 producing wells
12 horizontal
26 vertical
3 deviated
23 PCP
18 SRP

PI of AL
H+D 7.6
V 7.3
SRP 9.9
PCP 5.4
When choosing artificial lift type

understand your strategy
  ○ short term decisions lead to larger long term costs

understand your wells
  ○ at what volume will your well be most profitable

understand what is already working for you
  ○ better is the enemy of good

be an educated and inquisitive buyer
  ○ be an engineer, not a purchasing agent
What happened to common sense?

drill and complete your wells so they are easy to produce with any artificial lift

use equipment that will work for the life of the well

pump from the vertical section of the well for as long as possible

maintain your reservoir like you would own it forever

workover is not a substitute for poor operating practices
Thank You!

PLANET and PEOPLE and PROFIT

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