Low and volatile oil price environment. Technical responses in the Pannonian basin
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Production System Selection
For
High-Pour Point Crude Producing Well

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**Well Data**

**Perforations:** 1850–1900 m  
**Bottom:** 2000 m

- **9 5/8″ casing shoe:** Cement on surface
- **13 3/8″ casing shoe:** Cement on surface
- **7″ casing shoe:** Cement on surface

- **2 7/8″ OD tubing:** Packer 1800 m

**AOFP:** 46.8 Sm³/d  
**PI:** 0.24 Sm³/(bar d)  
**Tr:** 110 °C

**Properties of Dead Oil**

- **Density:**
  \[ \rho = \rho_{20} - \beta \cdot (T - 20) \]

  \[ \rho_{20} = 885 \, \text{kg/m}^3 \]
  \[ \beta = 0.870 \, \text{kg/(m}^3\text{°C}) \]

**Dynamic Viscosity, Pas**  
**Temperature, °C**
Problems

- High Pour Point Crude
- Limited Reservoir Energy, Small Rates
- System for Production Test/Production
Flowing Well
Transient Temperature Distribution by Enthalpy Balance

Temperature profile stabilized in short time!
Flowing Well
Dynamic Viscosity vs. Depth

Production Time: 1 day
No significant difference!

Friction loss is not significant!

Main task is the fluid lifting not the friction loss due to high viscosity!

The chart does not show the effect of cooling in production breaks, neither the paraffin deposition on pipe wall!

Both are serious problem!
Flowing Well, Insulated Tubing

Reduced Deposition on Pipe Wall!

Cooling Down Remain Problem in Production Breaks!

Fluid Lift Required!

Production Time: 1 day
Top 800 m of tubing is insulated by 4 cm foam, 0.035 W/(m K)
Artificial Lift Required!

• Appropriate for Production Test
  – Cheap enough for single well
  – Easy to install
  – Flexible
  – Applicable for highly pour point, heavy oil
  – Applicability after production test is an Advantage
„Steam Lift”?

Required Minimal „gas lift pressure” - 30 bar ~ 220 °C
Examined 305 °C ~ 80 bar
Temperature vs. Depth of Steam Injected into the Annulus

- Tinj: 305 °C
- Pinj: 80 bar
- Sat Temp: 295 °C

The cooling effect of tubing is neglected!
Temperature vs. Depth of Steam Injected into the Annulus

The cooling effect of tubing is neglected!
Temperature Distribution in Tubing

Steam Lift is not Possible in this case!

Possible:
- Small Injection Pressure,
- steam mass is greater than the produced fluid mass!

Uneconomic!

Convective Heat Transfer!
Dilutant Injection

To Decrease Viscosity and Pour Point
Constant Effect, Production Break Problems Eliminated
Dilutant Injection

To Decrease Viscosity and Pour Point
Constant Effect, Production Break Problems Eliminated
Must be combined by artificial lift!
Dilutant Injection

To Decrease Viscosity and Pour Point
Constant Effect, Production Break Problems Eliminated

Effect of Diluting Agent on Oil Viscosity

Dynamic Viscosity, Pas

Temperature, °C

0% 10%
20% 40%
50% 66%
Jet Pump

- The diluting agent can be the power fluid of the jet pump system.

- Diluting agent can be:
  - heated water, revers flow application
  - heated well fluid, revers flow application
  - heated light oil, gasoline, lower temperature; normal or revers flow application
Jet Pump

- Using heated water and heated well fluids
  - small power fluid requirement, continuous cleaning and recirculating
- Using light oil, or gasoline
  - continuous power fluid supply is required
- Possible power fluid choice could be water with 5-10% gasoline, bigger safety in case of production breaks.
- The surface units required for jet pumping is slightly more complicated than in case of simple diluting agent injection.
Jet Pump

- No moving parts in the downhole pump, long production life, low repair cost
- If free-pump installation is used, the pump can be circulated to the bottom, to produce, or can be circulated to the surface for repair. No need for high cost tubing operations.
Jet Pump

The best fluid ratio (Produced liquid rate/Power fluid rate):

- 30 Sm$^3$/day power fluid rate
- 210 bars surface injection pressure.

Production rate < the required 30 m$^3$/day.

Suggested:
- 185 bar power fluid surface injection pressure,
- 60 Sm$^3$/day injection rate.
Conclusions

• In case of low rates the high viscosity does not cause high friction loss

• Insulation decrease the problems due to production breaks and deposition

• Fluid lifting is the main problem

• Steam Lift is not an economic solution

• Dilitant injection Must be combined with artificial lifting

• Jet Pump is a valuable tool for heavy oil production
Thank You for Your Attention!