# Development and Evaluation of a new Electrical Submersible Pump for High Viscosity Environments

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# AGENDA

- Introduction
- Design methodology
- Well selection and field test planing
- Field results
- Conclusions

# EXTRA HEAVY OIL IN COLOMBIA

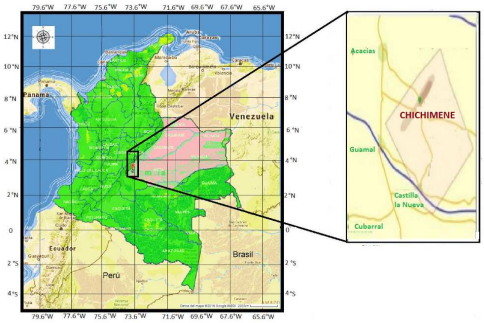
The impact of the viscosity

- Reduction of head per stage
- Increasing the energy consumption
- Reduction of the efficiency of the overall system

Results of excessive friction during operation

- Start-up: frequent Stuck-up of pump
- Operation: system overheat and stability
- Reliability: run life decreases

A new pump for extra heavy-oil has been introduced



# DESIGN METODOLOGY

- Fluid characterization
- Software Simulation
- Laboratory results and comparison
- Well selection and field test planning
- Field tests and result analysis

# RESERVOIR FLUID CHARACTERISTICS

| Parameter | Value |
|---|---|
| **°API** | 8.8 |
| **SG** | 1.02 |
| **Viscosity [cp] @150 °F** | 6918 @14.7 psi |
| **Viscosity [cp] @180 °F** | 1850 @14.7 psi |
| **Bottom hole temperature [F]** | 205 |

# SIMULATION

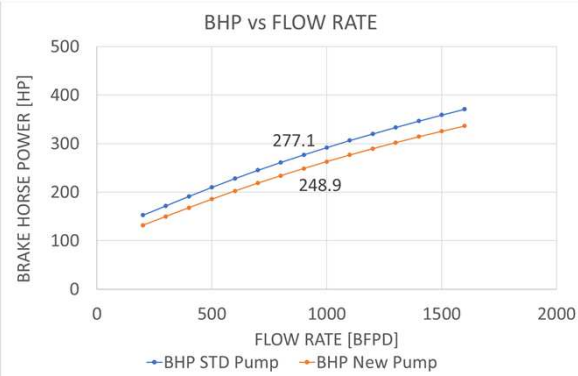
Different pump configurations were analyzed.

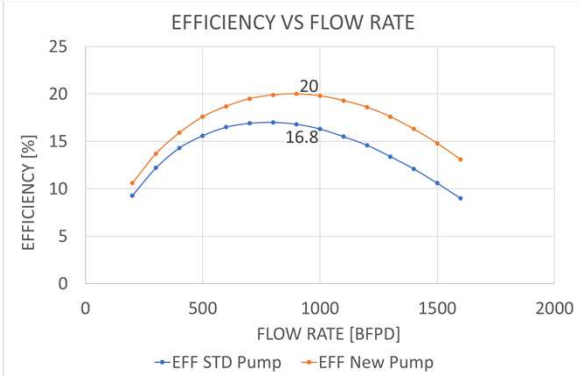
Simulation concept included the following items:

- Considers motor heat
- No single viscosity correction factor for pump
- Continuously applied heat generated by pump stages
- Calculate new viscosities for each temperature
- Stage by stage performance calculation

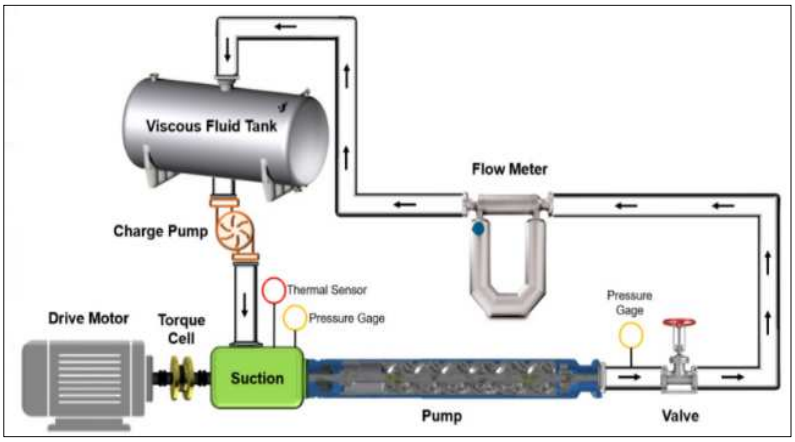
| Parameter | Value |
|---|---|
| **Flowrate [BPD]** | 300-1500 |
| **Setting depth MD [Ft]** | 8109 |
| **BSW [%]** | 2-15 |
| **GOR [SCFD/BOPD]** | 60-500 |
| **Bubble pressure [psi]** | 600 |

# SIMULATION RESULTS

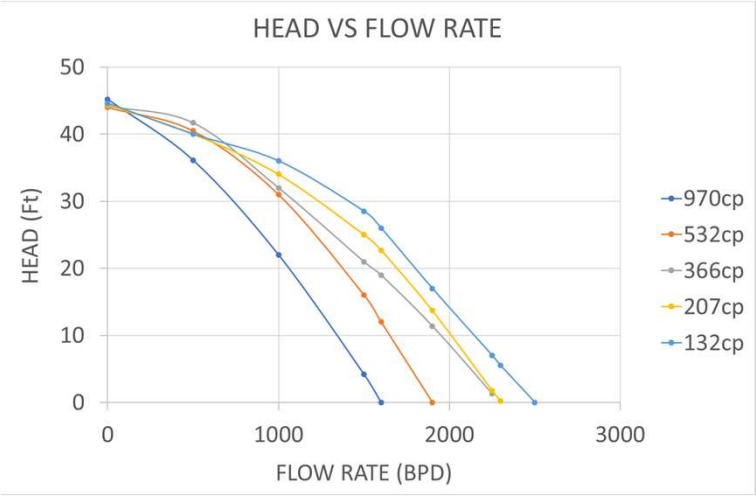


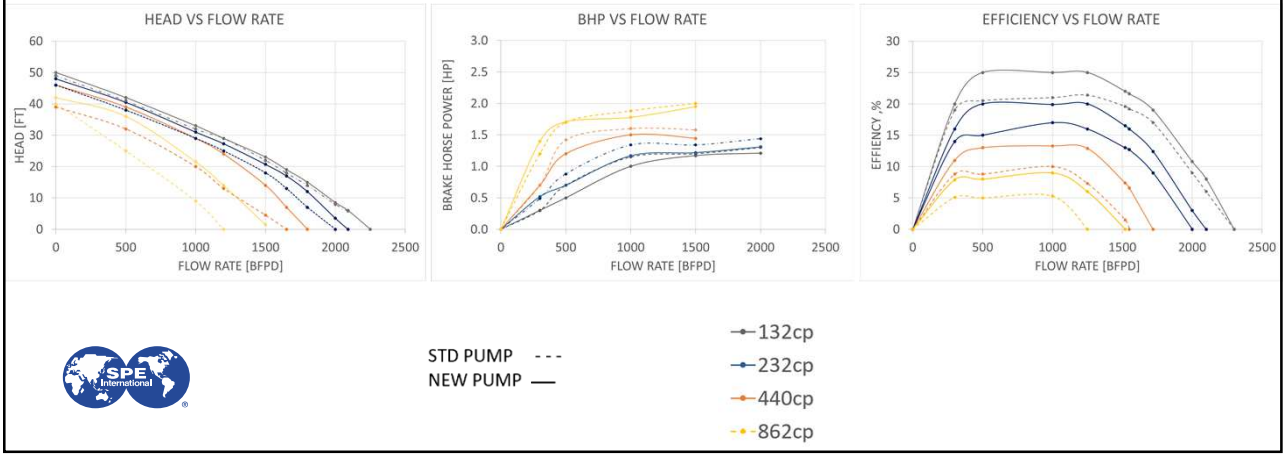
# PROTOTYPE TEST




# PRELIMINARY RESULTS



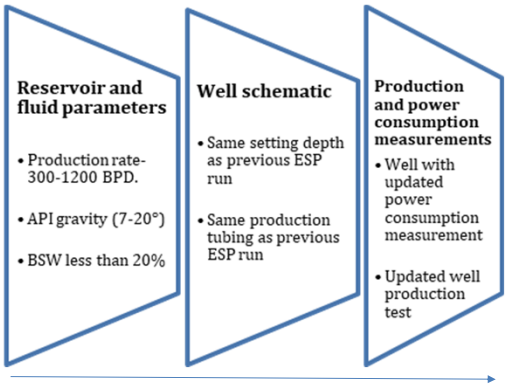
# EXPERIMENTAL RESULTS




# PUMP CONFIGURATION

| | |
|---|---|
| **Series** | **538** |
| **Stage** | Open |
| **Pump type** | Floater |
| **Stage design** | Mixed Flow design |
| **Material** | Ni-resist 1 |
| **AR configuration** | Tungsten carbide<br>STD, 1:3, FULL AR |
| **Shaft material** | |
| **Flowrates** | 300-1700 |

# WELL SELECTION



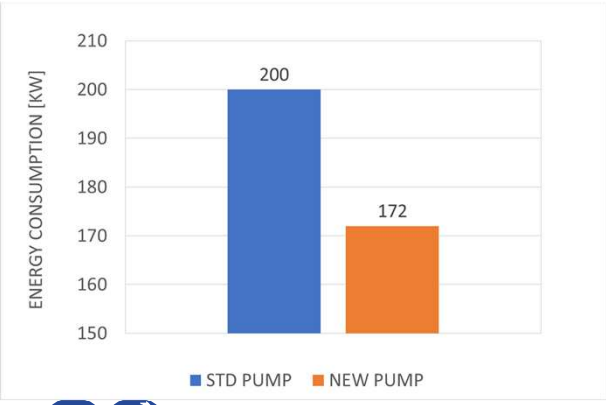

# FIELD RESULTS

## Challenges:

- Changes in the well inflow production rate
- Increase of the fluid water cut
- Changes in the pump setting depth
- Availability of energy consumption data

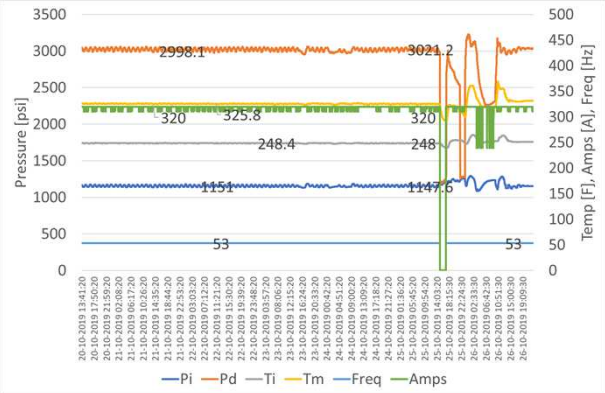
For wells where these issues were found, analysis have been performed using the in-house simulation software

# FIELD RESULTS

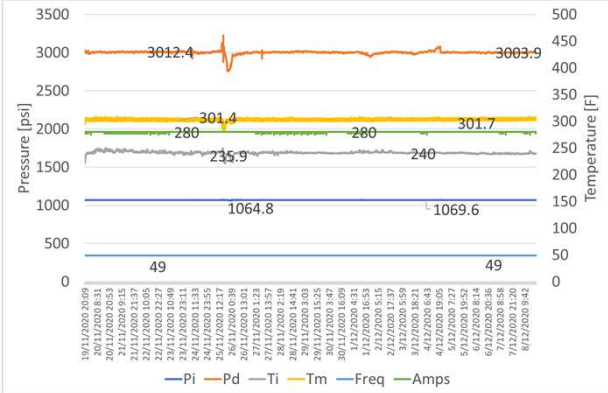




# FIELD RESULTS



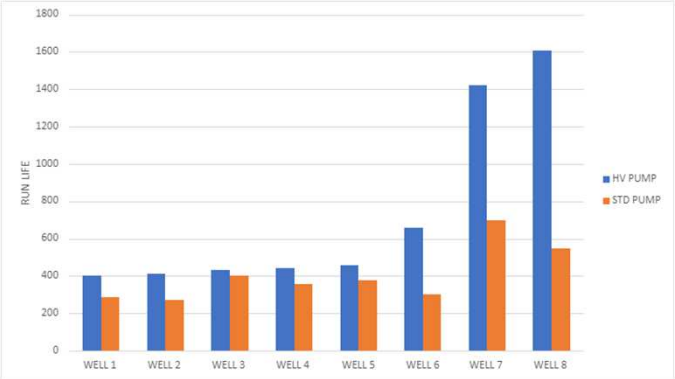

Previous




Current

# FIELD RESULTS

- 12 wells have been successfully commissioned using the new pump.
- First well installed with more than 3 years of operation.
- Vibration readings within range.
- No mechanical failures associated to the pump.
- Wells with lower run lifes were recently installed.




# CONCLUSIONS

- Increased lift per stage
- Improved hydraulic efficiency between 15-20%
- Reduced power requirements between 10-15%
- Lower operating costs and CAPEX investments
- Proven reliability with 12 successful installations to date
- Pump has showed good performance under gassy conditions