

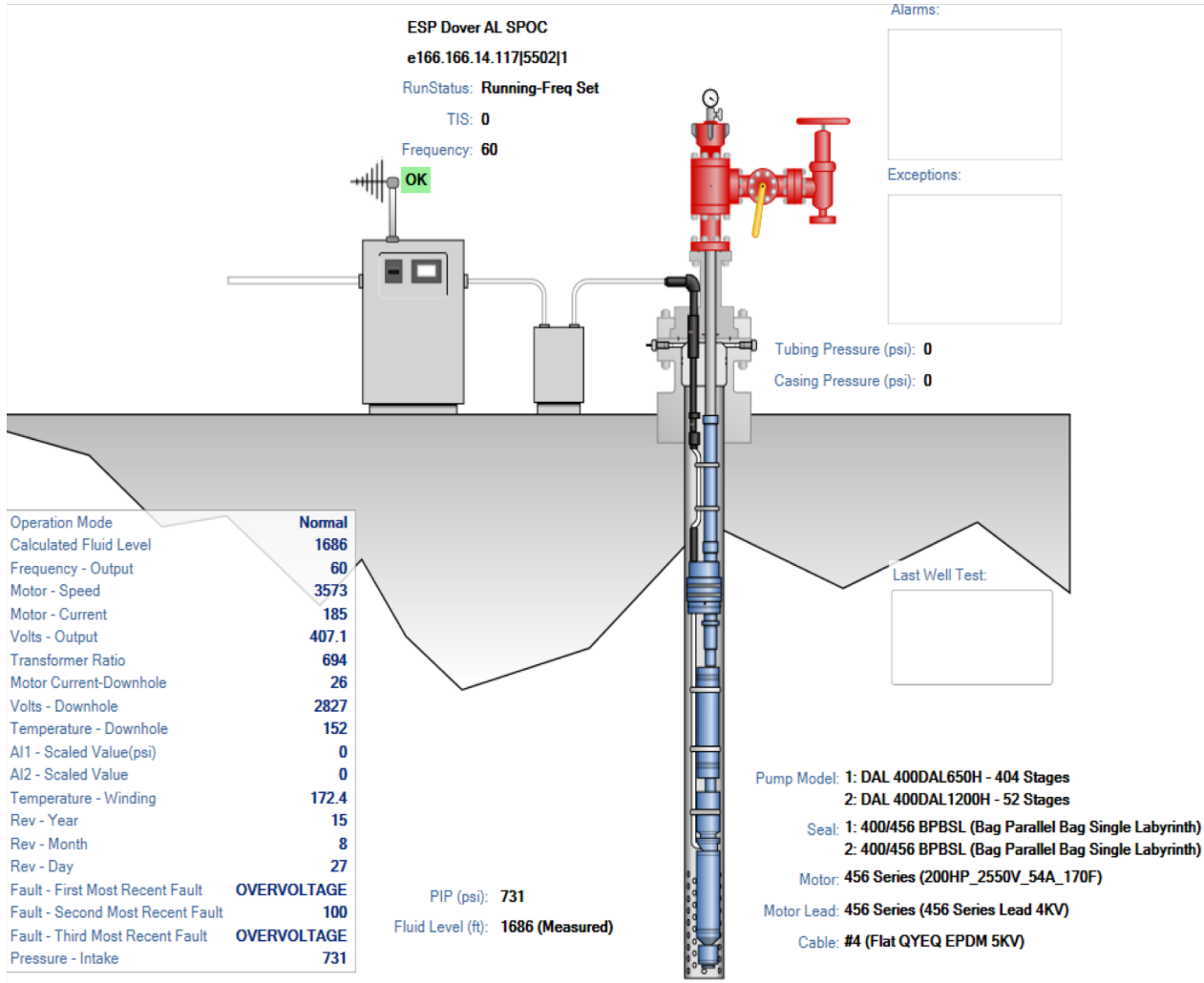
Apergy
Production Automation Technologies
XSPOC ESP Documentation

XSPOC ESP Module

Overview

- ESP tool to monitor, analyze and optimize ESP systems
- Extensive pump curve library for all major vendors with the ability to add custom pumps through coefficients or coordinates
- Support for tapered (multiple) pump designs and gas handling pumps
- Proper handling of gas at pump intake using multiphase flow models
- Support for many Multiphase Flow correlations for accurate flow modelling
- Detailed well pressure profile analysis
- Evaluation of pump design based on well performance curve
- Artificial Intelligence to interpret pump performance, pump design, and current operating conditions
- Warning for improper flow conditions that are outside the pumps recommended range
- Trending of all key gas lift parameters with intelligent host alarms to indicate out of conformance and noticeable changes

XSPOC ESP Status



- Most recent key parameters trended from the controller are displayed
- Details of the communication status between XSPOC and the well is shown
- If any alarms or exceptions for the well are triggered, they will show up in the corresponding boxes
- ESP equipment display in bottom right

XSPOC ESP Setup

Configuration – ESP Equipment tab

Controller **ESP Equipment** | Downhole Equipment | Alarm Actions | IPR | Measurements | Cameras

Pump Information

DAL 400DAL650H 300 bbl/1000 bbl + Customize

Pump Min Flow 300 bpd Pump Housing Limit 5000 psi
Pump Max Flow 1000 bpd Pump Opt Flow 650 bpd

#	Pump	Min Flow	Max Flow	Housing Limit	Opt. Flow	Stages
1	400DAL650H	300 bbl	1000 bbl	5000 psi	650 bbl	404
2	400DAL1200H	300 bbl	2000 bbl		1200 bbl	52

Basic | **Advanced**

Motor: 456 Series (200HP_2550V_54A_170F) +

#	Description
1	456 Series (200HP_2550V_54A_170F)

Cable: #4 (Flat QYEQ EPDM 5KV) +

#	Description
1	#4 (Flat QYEQ EPDM 5KV)

Motor Lead: 456 Series (456 Series Lead 4KV) +

#	Description
1	456 Series (456 Series Lead 4KV)

Seal: 400/456 BPBSL (Bag Parallel Bag Single Labyri) +

#	Description
1	400/456 BPBSL (Bag Parallel Bag Single Labyrinth)
2	400/456 BPBSL (Bag Parallel Bag Single

- Pump must be selected from drop down menu and # of stages entered in the table
- If pump vendor is unavailable, custom pumps can be created
- Add main ESP equipment in corresponding tables

XSPOC ESP Setup

Configuration – ESP Equipment tab

Other information

Date Installed

Enable Gas Handling

Gas Separator Installed

Gas Separator Efficiency

Tubing Pipe Quality Factor

50 Used New 150

Pump Depth (Vertical) ft

Pump Depth (Measured) ft

Frequency

Variable Frequency

Multiphase Flow Correlation

- The ESP analysis run in single phase or multiphase flow. By enabling the Gas Handling option, it is assumed that certain amount of gas enters the pump and the multiphase flow correlation is enabled
- Use the slider bar to indicate the tubing roughness based on the age of the tubing
- If the frequency can be obtained from a drive, then the variable frequency option can be enabled, if not enter the frequency setting manually

XSPOC ESP Setup

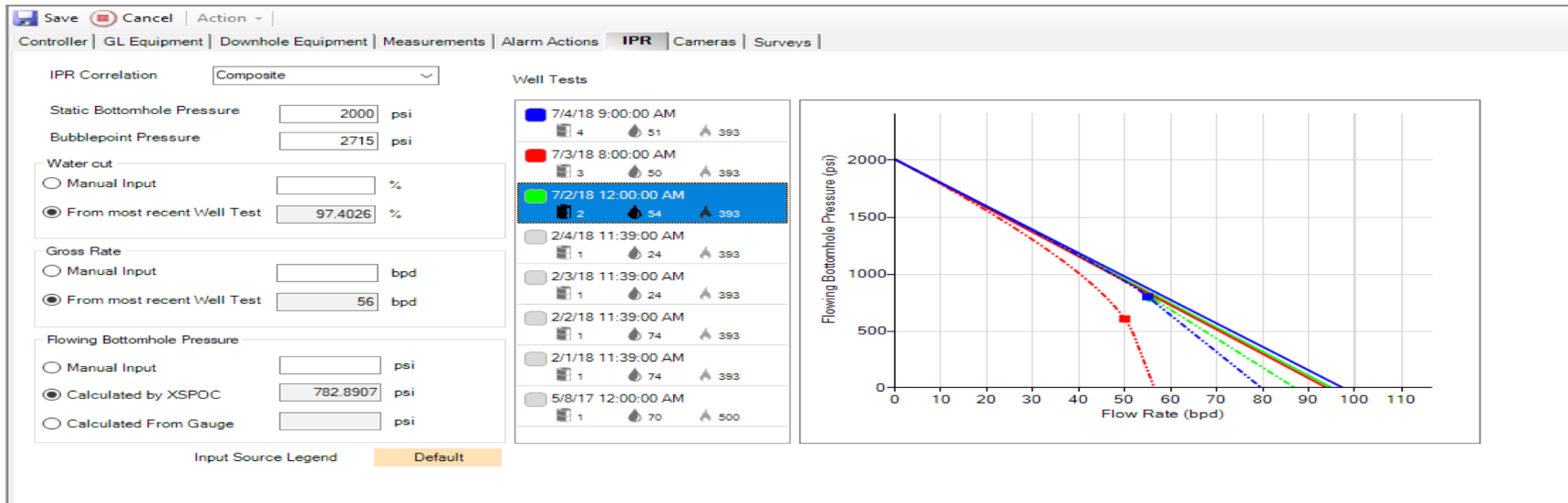
Configuration – Downhole Equipment tab

#	Diameter (OD/ID - Weight)	Length (ft)
1	5.5\" / 4.778\" - 20 lb/ft	1000

Casing Valve Closed

- It is necessary to enter the casing, tubing and perforation information in all three tabs. The deviation survey is optional.
- It is also optional to enter each perforation individually. There is an option to input a single vertical depth which should be the average vertical depth of the horizontal portion of the well.

XSPOC ESP Setup Configuration – IPR tab



- Having good IPR data is necessary to have a high quality analysis - a composite model is used by XSPOC
- The static bottomhole pressure (Reservoir or Fracture Pressure) should be accurately estimated and updated over time. An estimation can be obtained from the PIP sensor if the well was shutdown for a long period of time
- The Flowing Bottomhole Pressure can be calculated using the current PIP value and fluid properties
- It is recommended to utilize the Gross Rate of a recent well test

XSPOC ESP Setup

Configuration – Measurement tab

Controller | ESP Equipment | Downhole Equipment | Alarm Actions | IPR | **Measurements** | Cameras

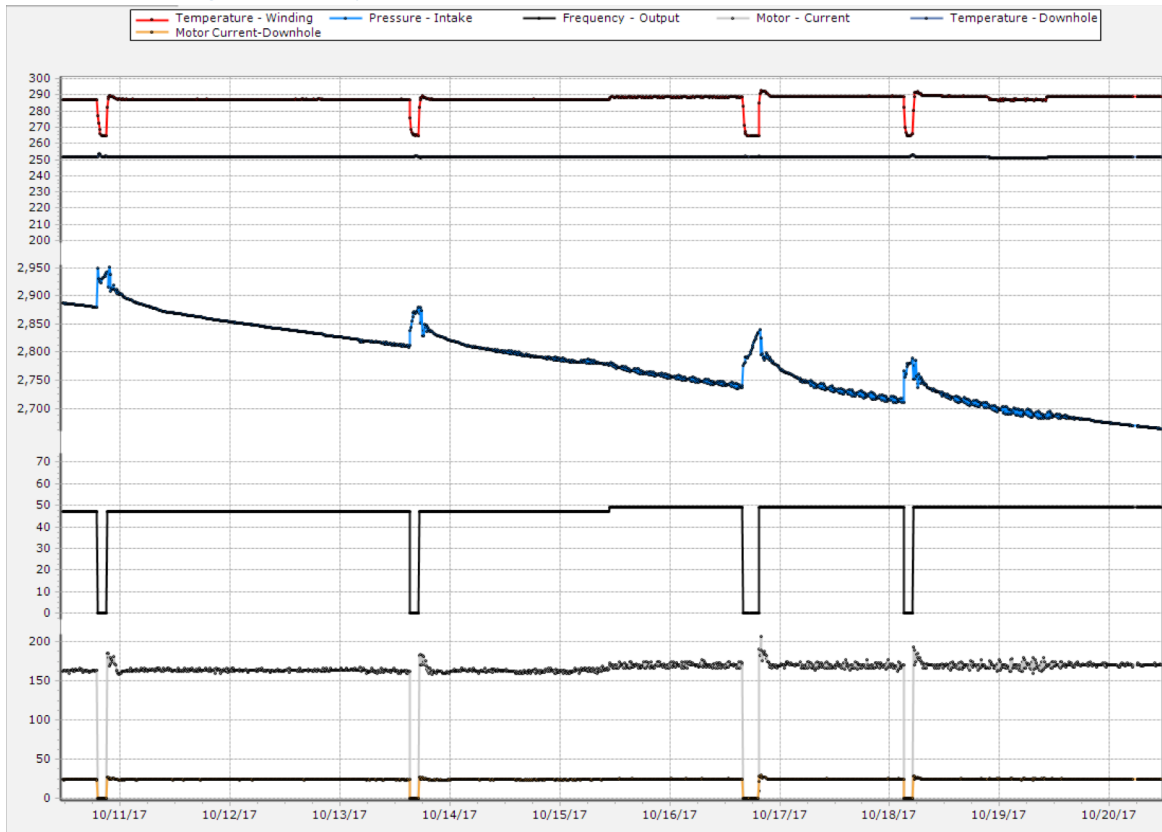
Oil Gravity (API °)	40	API°	
Water Specific Gravity	1.06	g/cm³	
Gas Specific Gravity	0.75	g/cm³	
Tubing Pressure	0	psi	
Casing Pressure	0	psi	
Flowline Temperature	125	°F	
Bottomhole Temperature	130	°F	
Fluid Level Above Pump	671	ft	
Pump Intake Pressure	495	psi	

Date	Value
4/11/17 12:12:25 PM	40
1/11/17 12:12:17 PM	40

- Important parameters required to run the ESP analysis are stored on the Measurement Tab
- Parameters such as the Oil Gravity which do not change frequently are usually user inputs
- While parameters such as the Temperature are often recorded by a field device which transmits in real time to XSPOC
- User input values show up in yellow while field device values are in blue
- It is important to note that measurements need to occur prior (backdated) to a well test to be associated
- If PIP value is available, it is not necessary to enter Fluid Level Above Pump value

XSPOC ESP Trends

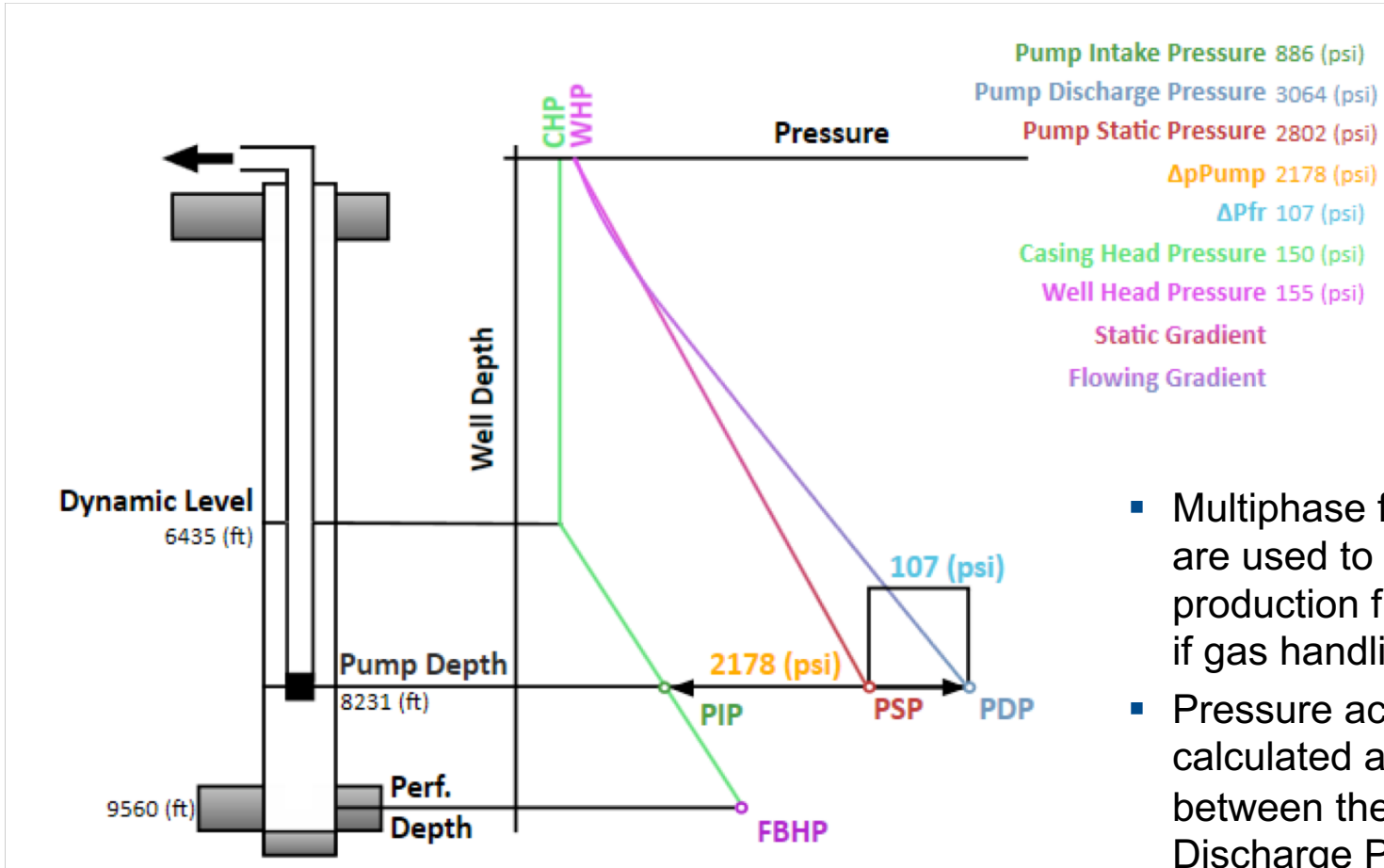
Historical Graphing of Key Parameters



- All parameters obtained from the RTU can be trended through the Historical Graphs. Typically, PIP, Amps, Temperature and Frequency are trended for ESP applications
- It is also possible to historically trend any other parameters obtained in the field or through the analysis calculations.

ESP Analysis

Pressure Profile



- Multiphase flow correlations are used to model the production fluid in the tubing if gas handling is enabled
- Pressure across the pump is calculated and displayed between the PIP and Discharge Pressure

ESP Analysis

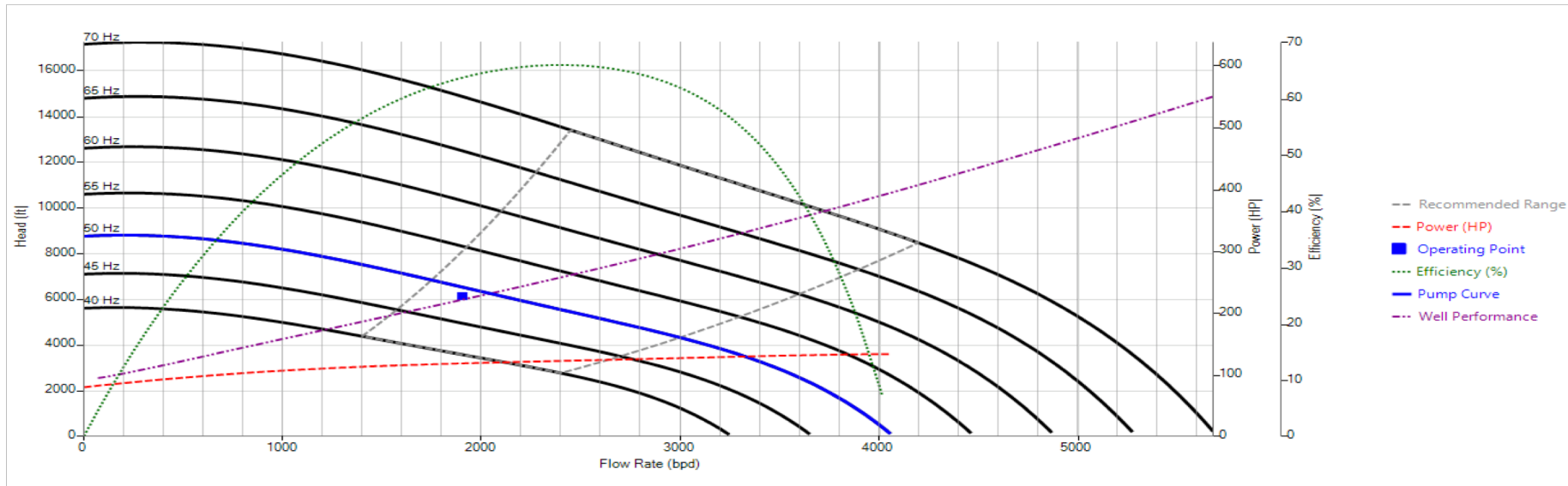
Input/output Calculations

Analysis					
Input		Output		Gas Handling	
Pump 1 (Top)	DAL	Productivity Index	2.05	Inputs	
	400DAL3000	Pressure Across Pump	6121 ft	Casing Valve State	Open
	81 stages			Specific Gravity of Gas	0.75
Pump 2	DAL	Pump Discharge Pressure	3064 psi	Bottomhole Temperature	130 °F
	400DAL3000	ΔPtr	107.5 psi	Gas Separator Efficiency	72 %
	81 stages			Oil API	40 API*
Pump 3	DAL	Pump Efficiency	59.86%	Casing Inner Diameter	4.778 in
	400DAL3000	Fluid Level Above Pump	1796 ft	Tubing Outer Diameter	2.875 in
	81 stages	Flowing BHP	1199 psi		
Pump 4	DAL	Pump Degradation	6%	Outputs	
	400DAL3000	Input Source Legend		Solution GOR	236.5 scf/b
	81 stages	Scan		Specific Gravity of Oil	0.8251
Pump 5 (Bottom)	DAL	User Input		Formation Volume Factor	1.134
	400DAL3000	Well Test		Gas Compressibility	0.862
	81 stages			Gas Volume Factor	2.891 b/mscf
Test Date	4/10/17			Producing GOR	793.7 scf/b
Oil Rate	756 bpd			Gas in Solution	178.8 mscf/d
Water Rate	805 bpd			Free Gas at Pump	421.2 mscf/d
Gross Rate	1561 bpd			Oil Volume at Pump	857.2 bpd
Gas Rate	600 mscf/d			Gas Volume at Pump	243.1 bpd
Pump Intake Pressure	-			Total Volume at Pump	1905 bpd
Fluid Level Above Pump	1800 ft			Free Gas	12.76 %
Tubing Pressure	155 psi			Turpin Parameter	0.11
Casing Pressure	150 psi			Composite Tubing Spec.	0.8217
Frequency	50 Hz			Gas Density	3.529 lb/cf
Pump Depth (Vertical)	8231 ft			Liquid Density	55.13 lb/cf
Pump Depth (Measured)	8231 ft			Annular Separation	28.7 %
				Tubing Gas	262.9 mscf/d
				Tubing GOR	347.8 scf/b

- Analytical calculations regarding the pump are displayed
- Gas handling results provide the total volume at the pump intake which is used for the pump operating point

ESP Analysis

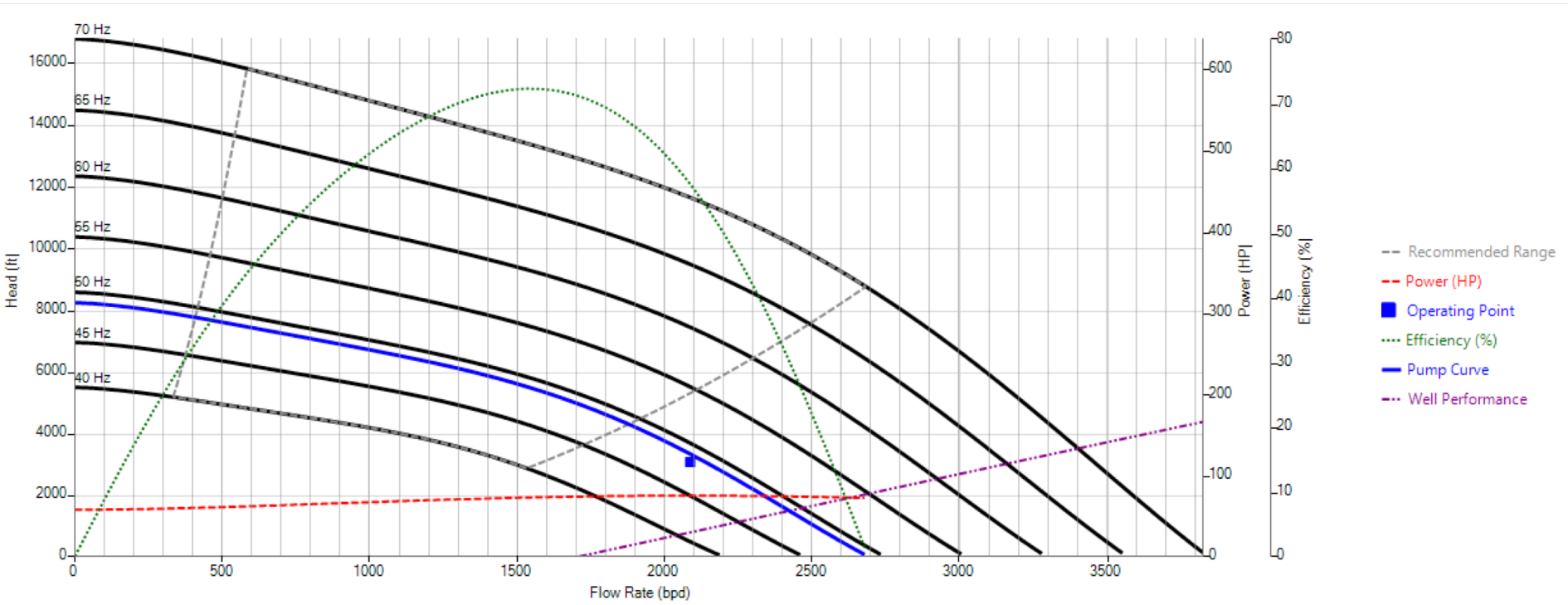
Pump Curves



- The pump curves are displayed in black with the operating frequency highlighted in blue. The recommended range envelope is shown by grey dotted lines
- The well performance curve is shown in purple. This curve shows the theoretical performance of the well based on the operating frequency
- When all the input data is correct and the pump is in good condition, the analysis should show the Operating Point intersect with the well performance curve and the pump curve while being inside the operating range

ESP Analysis

How to Interpret Pump Curves – Example



- The operating point is outside the recommended range of the pump. The pump is operating in up thrust which could cause a lot of damage
- The well performance curve is off the operating point which could indicate incorrect IPR data or well test data
- It would be recommended to fix data problems and update well analysis to make a decision regarding the pump size

ESP Analysis

Diagnostics

XDiag Analysis

The selected well test was processed successfully.

The well is operating significantly off the well performance curve. This is usually caused by incorrect IPR data or incorrect production data. Because of this potential data error, the following results may be inaccurate.

Pump is operating in severe upthrust and should be immediately evaluated to prevent damage. Continued operation in upthrust region can significantly decrease pump run life. This condition can be resolved by: increasing tubing pressure, decreasing pump speed, or by changing the pump design.

The selected pump does not appear to be a good design for this well, as the well will not operate within recommended limits across a wide range of flow. Design Score: 0/100

- Based on the results of the analysis XSPOC provides some diagnostics and recommendations on how to improve and better optimize the conditions of the well
- A lot of R&D is underway to improve and increase the diagnostics and recommendations provided by XSPOC to help the end user better manage and optimize their ESP systems
- In suitable well conditions, XSPOC provides a recommendation for the optimal operating frequency to safely maximize oil production

Theta Oilfield Services

Engineering & Tech Support

- For more information on all of our product please visit our website:
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