Optimization, Predictive Analytics, & Real-Time Process Models

OptiRamp Electrical Submersible Pump Solution

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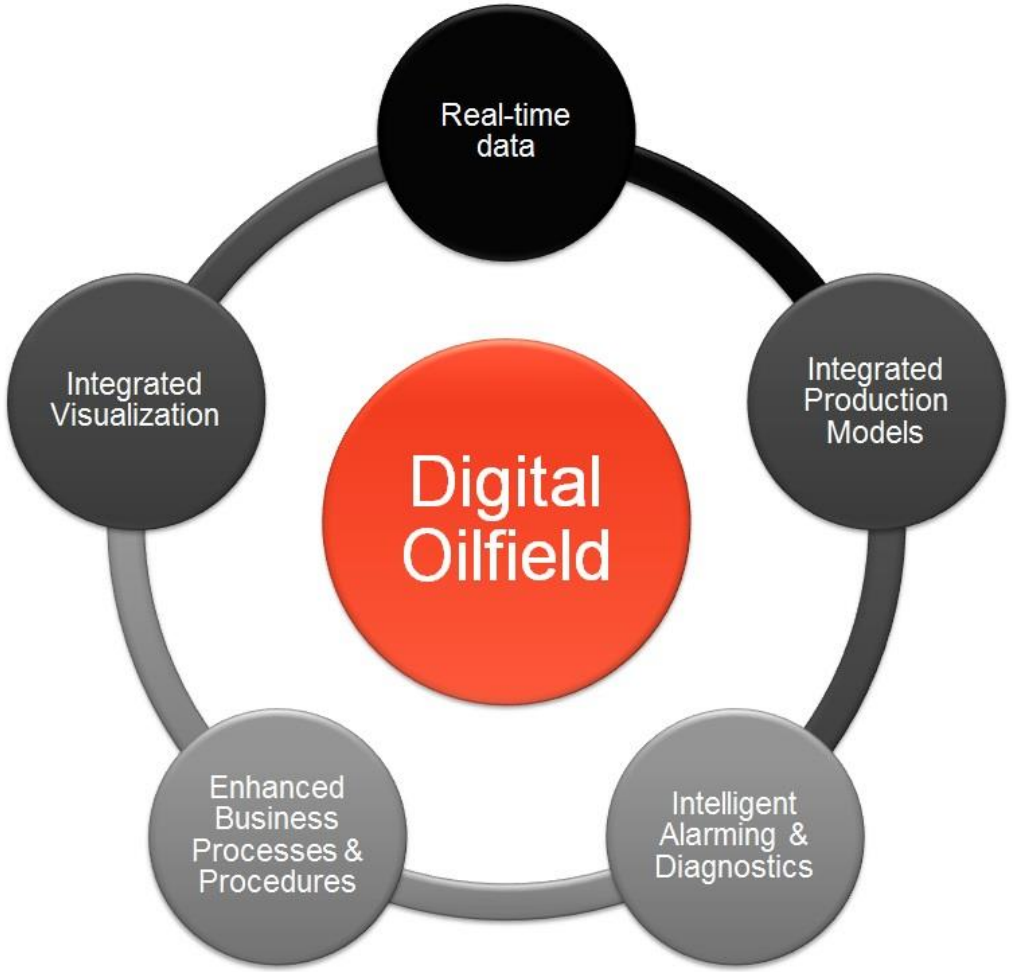
Introduction



- Currently, the oil and gas, power industries are shifting towards an increase in the efficiency of the operating processes by applying new techniques and methods, such as Advanced Process Controls and Real-Time Optimization.
- All oil fields are declining- customer needs to offset the decline with more drilling and in parallel, optimize the surface facility operations.
- Oil and gas, power generation markets demonstrate high interest in Real-Time Simulation and Optimization Technology. This technology is designed to handle complex brownfield systems commonly found in the upstream oil and gas industry.
- Technology allows brownfield operations to extract value where instrumentation and SCADA systems are not fully deployed. Virtual instrumentation is another very important result of the dynamic simulation that allows customer to have a better understanding of real instrumentation performance and most importantly, provides with the ability to rationalize the instrumentation count and hence, reduce OPEX.

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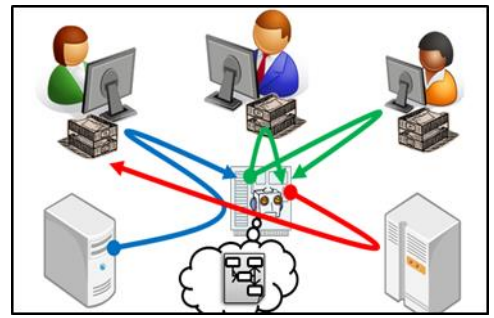
Dispatch Control Functions

- Monitor by exception key process variables (KPI)
- Generate value from collaborative decision support center
- Rely on real-time simulation technologies to provide virtual process models to solve complex operational challenges 24/7
- Remove personnel from harms' way
- Enable effective decision-making with the use of fit-for-purpose technology
- Delivering standard technologies and data management guidelines to address diverse asset installations
- Achieve optimal operation by accurately responding to real-time demands and limitations
- Optimize the process to maximize throughput while minimizing fuel consumption, cost, and emissions
- Enhance the company's ability to manage data and make better operating and prospecting decisions
- Improve process stability, allowing operation closer to target, constraint, and optimum values
- Forecast, simulate the process, and determine the ability to meet obligations
- Concentrate years of experience by translating operational knowledge into a working simulator



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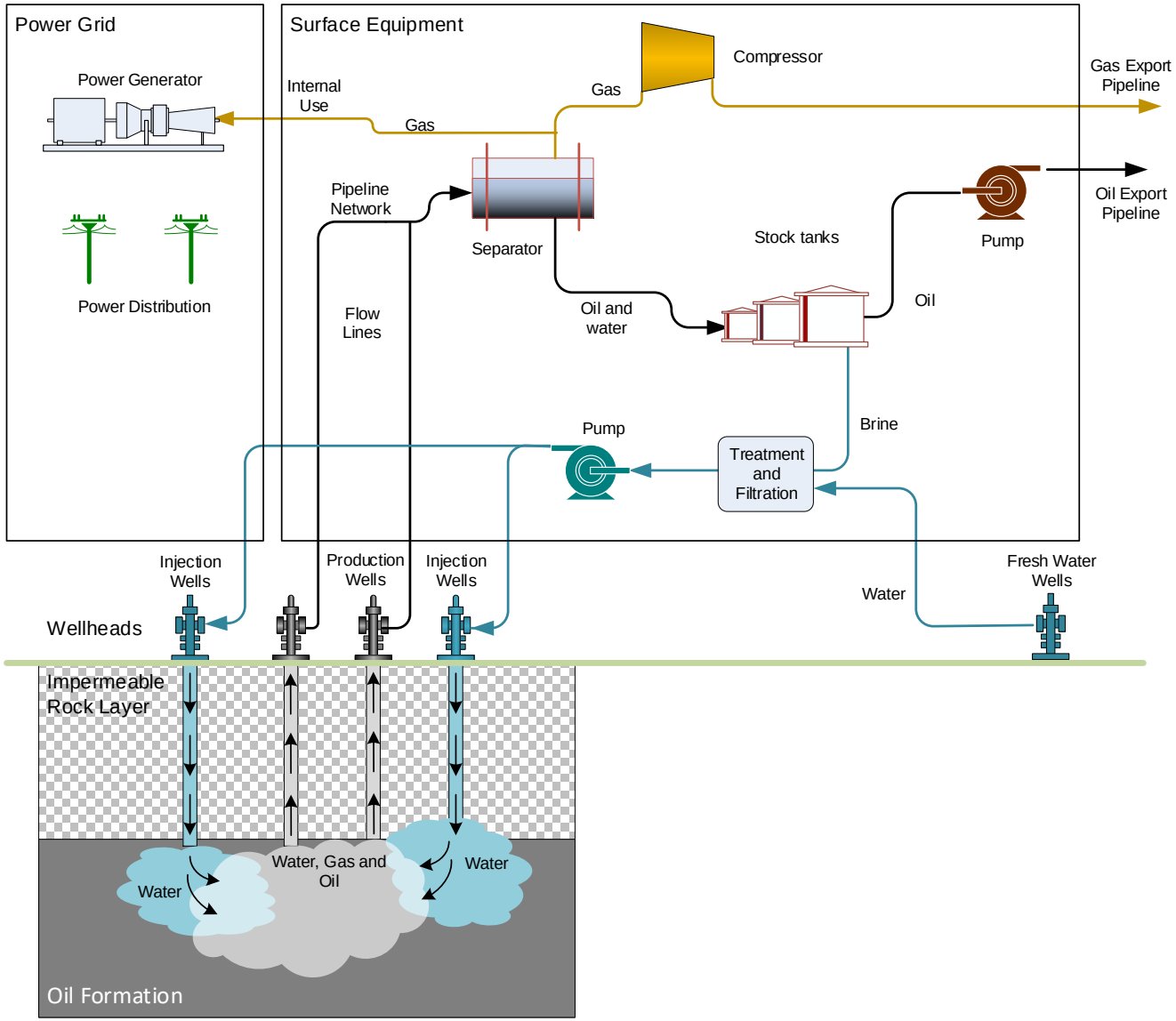
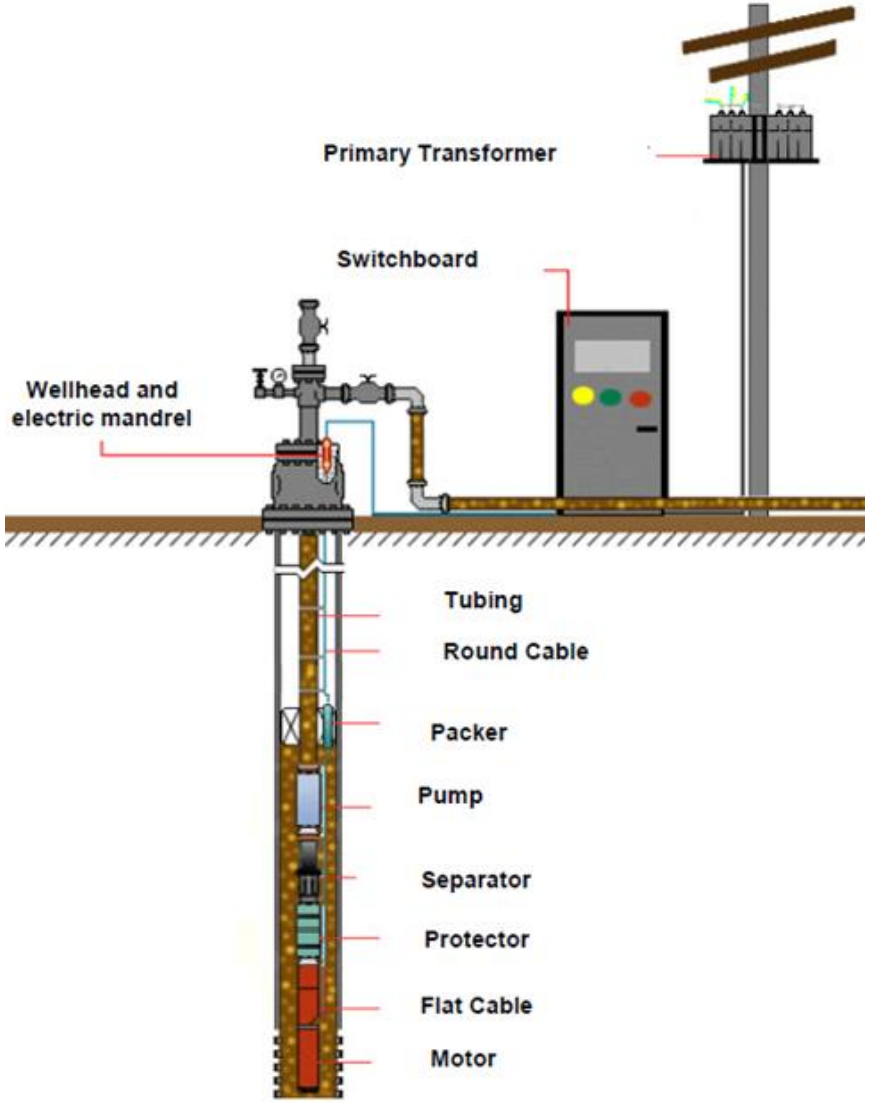
DSC Modeling Scope

- Production wells
- Liquid pipelines
- Separators and processing facilities
- Injection wells
- Fresh water wells
- Water pipelines and pumping stations
- Tank farms and storages
- Export oil pipelines and pumping stations
- Export gas pipelines and compressor stations
- Power distribution network
- Electrical generators
- Reservoir (non-OptiRamp model)



Electric Submersible Pump

- ESP is an artificial lift system, it is considered an economical and effective to raise low to high volumes of fluid (200 to 20.000 bfpd) from medium to high depths (700 m to 5.000 m) and in a variety of conditions from well. It is applicable in fields with variable Water Cut (1% – 99%) and at present time ESP have obtained excellent results for high-viscosity fluids (heavy oil), high Gas Oil Ratio, abrasive fluids (formation solids, corrosive water), high temperatures (260 ºC) and reduced diameter (less than 5.5").
- The pumping end of the ESP system is a multistage centrifugal pump with a specified flow range required to ensure high efficiency and proper thrust balance across the many pump stages.



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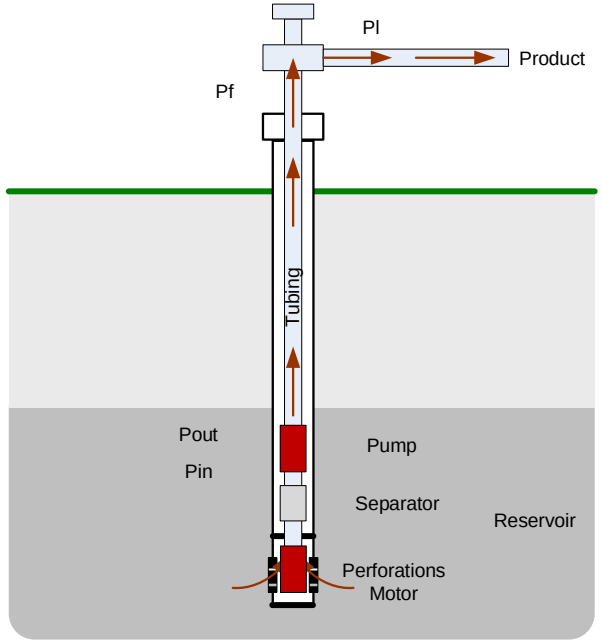
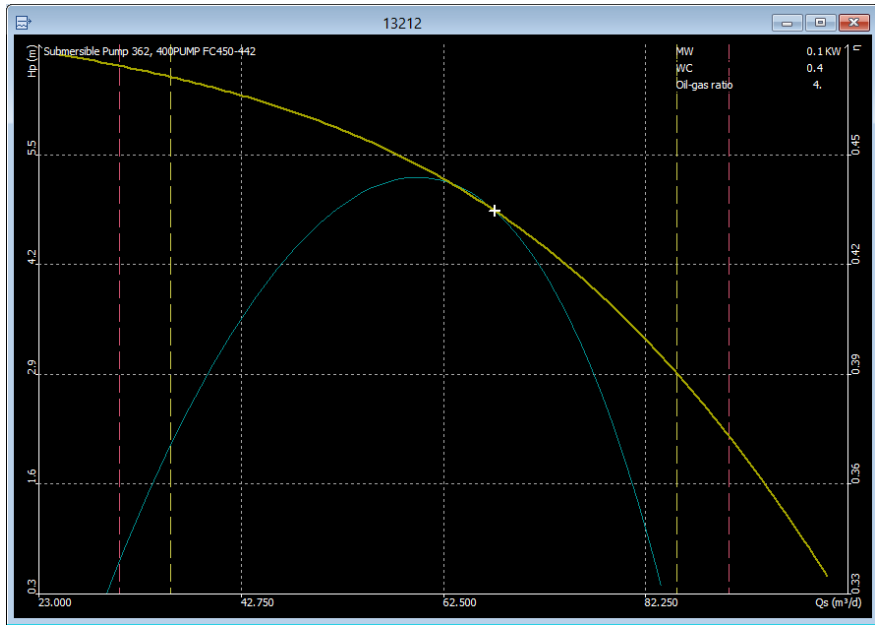
Submersible Pump Curve





Configuration:

- Hpn=f(Qn), (m) – head, characterizer in Configurator (OEM spec)
- Eff= f(Qn) (%)– efficiency, characterizer in Configurator (OEM spec)
- Qn (m3/s) – nominal volumetric flow (OEM spec)
- Q=M/ρ, (m3/s) – volumetric flow in suction
- ρ- Density in suction (kg/m3), is function of WC and Rog
- Q=Qn*N/Nn, (m3) (Speed correction)
- Hp=Hpn*(N/Nn)^2*Pin/Pinn (Speed correction)
- Where N and Nn are speed (RPM)
- H=Hp*g, (m2/s2 or J/kg) calculated based on Pin and Pf

Where g=9.81 m/s2 gravitational acceleration

- kW=Hp*M/eff – shaft power

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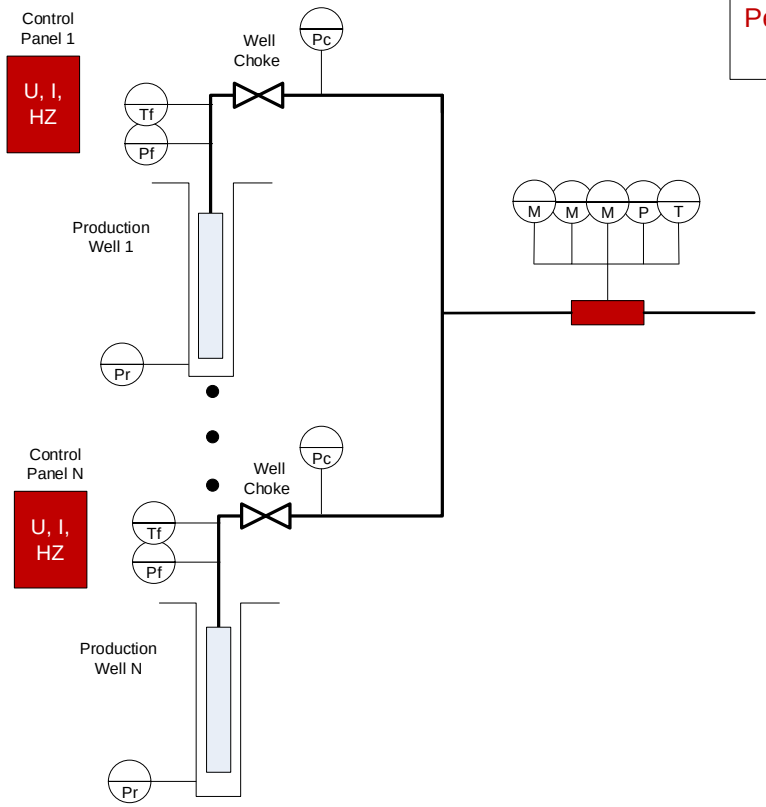
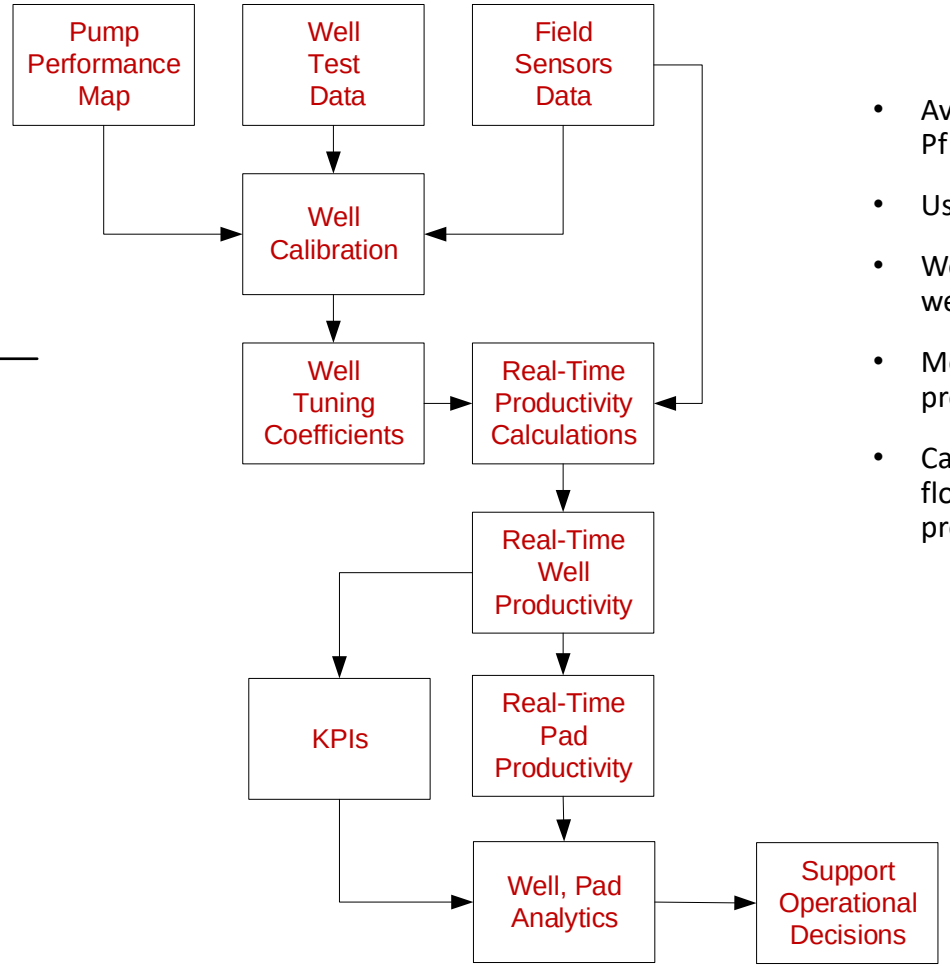
Well Modeling and Analytics Procedure





- Available real time signals are: Pin, Tin, kW, Pf
- Usually Pout sensor is not available
- Well model should be calibrated against well test unit records
- Model coefficients are used in real time productivity calculations
- Calculated outputs: Water cut, oil gas ratio, flow rate, density, efficiency, cost, profitability

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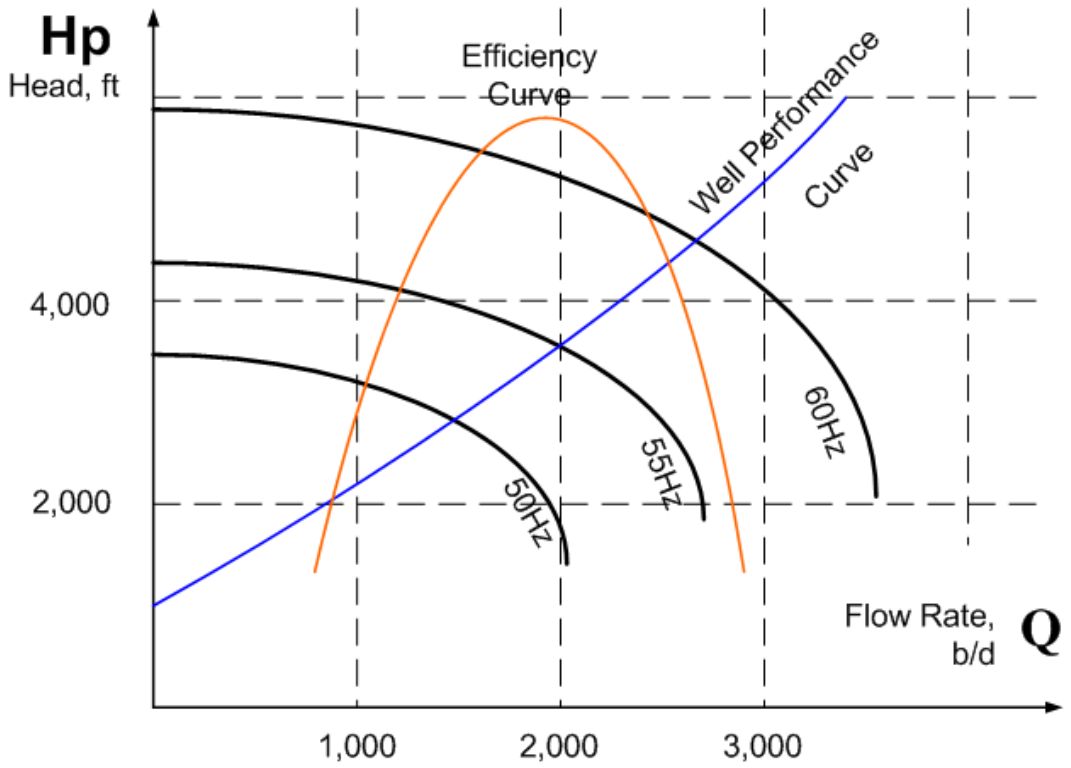
Submersible Pump Optimization



A pump's impellers are designed to operate efficiently over a specific capacity range. Operating the pump below its design capacity causes the impeller to downthrust against the diffuser, resulting in wear on the bearings and washers. This recommended operating range will allow the pump to run at highest efficiency:

- System alarms if pump operates outside of designed range
- VFD allows to manipulate speed
- Pump ON /OFF is another way of productivity control

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Benefits

- Use spectrum of analytics
  - Optimize well production
  - Reduce energy and maintenance costs
  - Extend life cycle
  - Improve availability and reliability
- Combine with web applications
  - Build domain knowledge
  - Increase operational intelligence

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