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Autonomous VSD Setpoint Optimization for Sucker Rod Artificially Lifted Oil and Gas Wells

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Rod Pump VSD Theory

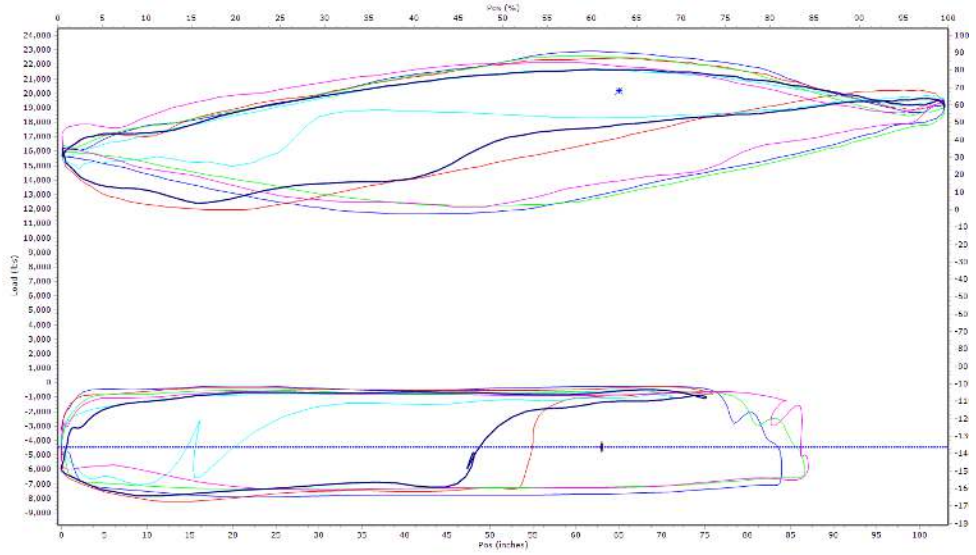
- VSD can be used to optimize a rod pump artificially lifted well to match the dynamic wellbore conditions by changing speed based on measured parameters from the rod pump controller
  - Slows down when pump fillage decreases
  - Speeds up when pump fillage increases

Rod Pump VSD Operational Strategy

- Run the well 24 hours and vary the speed to maximize production while mitigating failures
  - Obtain maximum production
  - Optimize pump fillage
  - Match capacity when conditions change

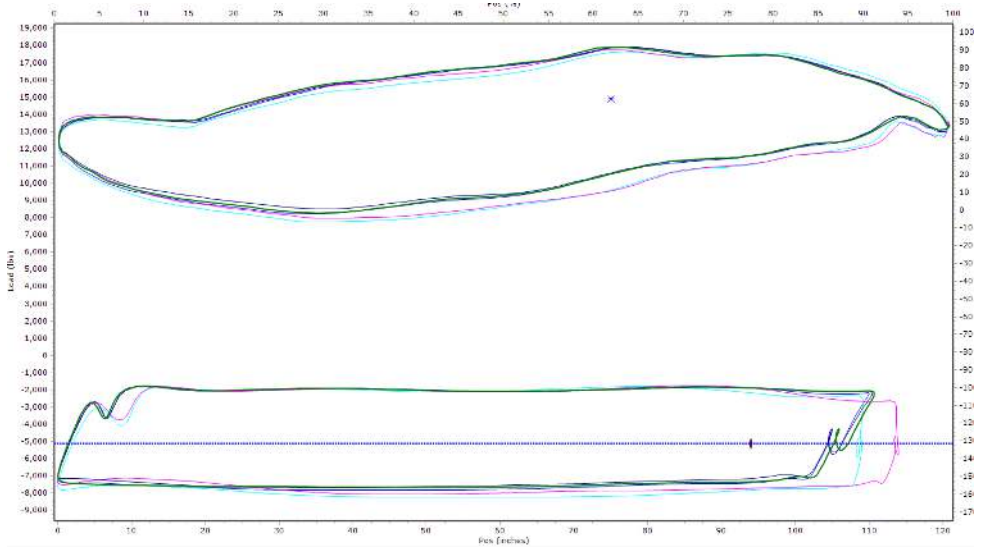
VSD Operational Problem #1: Poor Runtime

- Well is still cycling even though utilizing a VFD
  - Over displacing fluid
  - Unable to slow well down fast enough
  - Going into downtime instead of increasing fillage



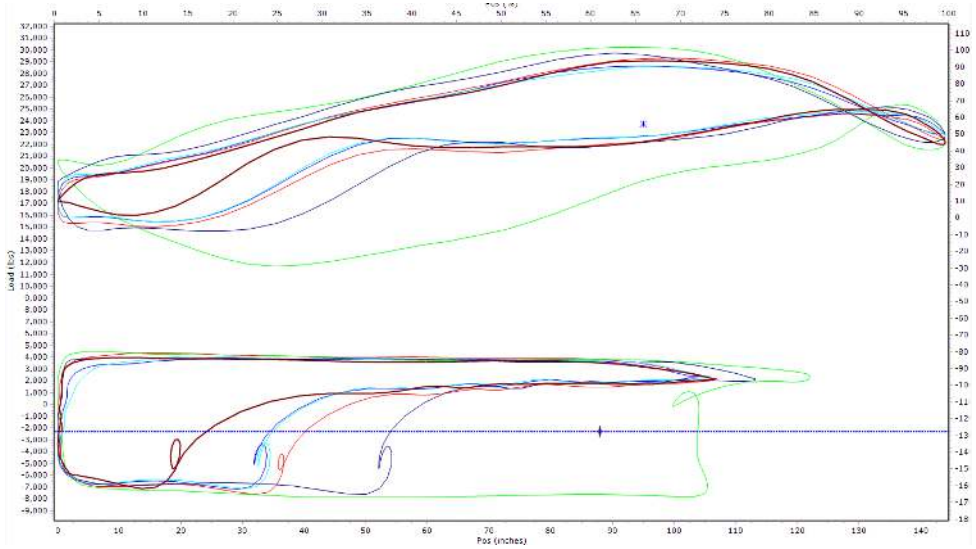
VSD Operational Problem #2: Undersized Design

- Running 24 hours per day with 100% filllage
  - Incapable of pumping the well off with current setpoints
  - Increase capacity to optimize well and maximize production



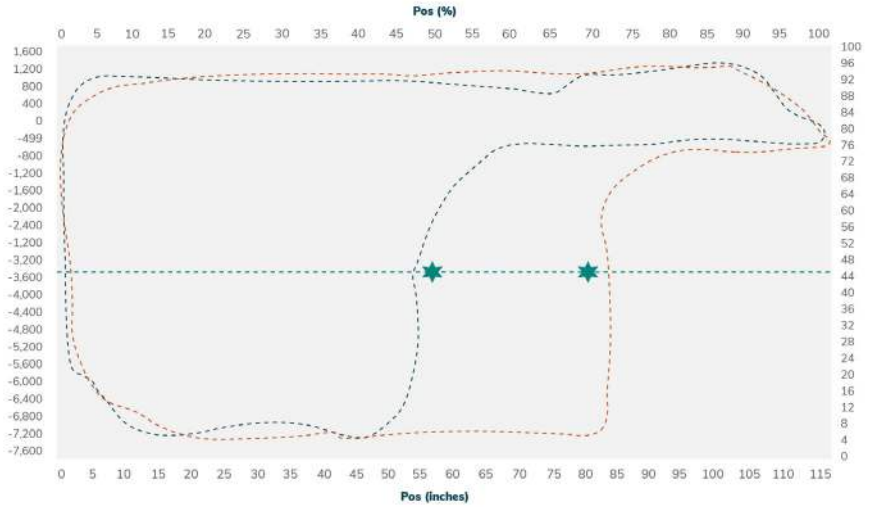
VSD Operational Problem #3: Poor Fillage

- Running 24 hours but the fillage is poor
  - Displacing too much fluid
  - Despite speed changes fillage does not improve
  - Unable to normalize speed or fillage



VSD Autonomous Control

- Optimize fillage and speed setpoints
- Maximize runtime (run 24 hours)
- Increase production
- Reduce failures



Rod Lift Setpoint Optimization Details

- Pump Fillage Setpoint Deadband
- Speed Change Stroke Delay
- Start Up Speed
- Speed Increase Size
- Speed Decrease Size
- Reference Pump Fillage Setpoint
- Secondary Pump Fillage Setpoint
- Low Speed Time Setpoint
- Slow Speed Time Setpoint
- VSD Idling Enabled
- Consecutive Pump off Strokes Allowed
- Max Scaling
- Min Scaling
- Peak Speed
- Low Speed
- Max Speed
- Min Speed

Case History: Poor Runtime

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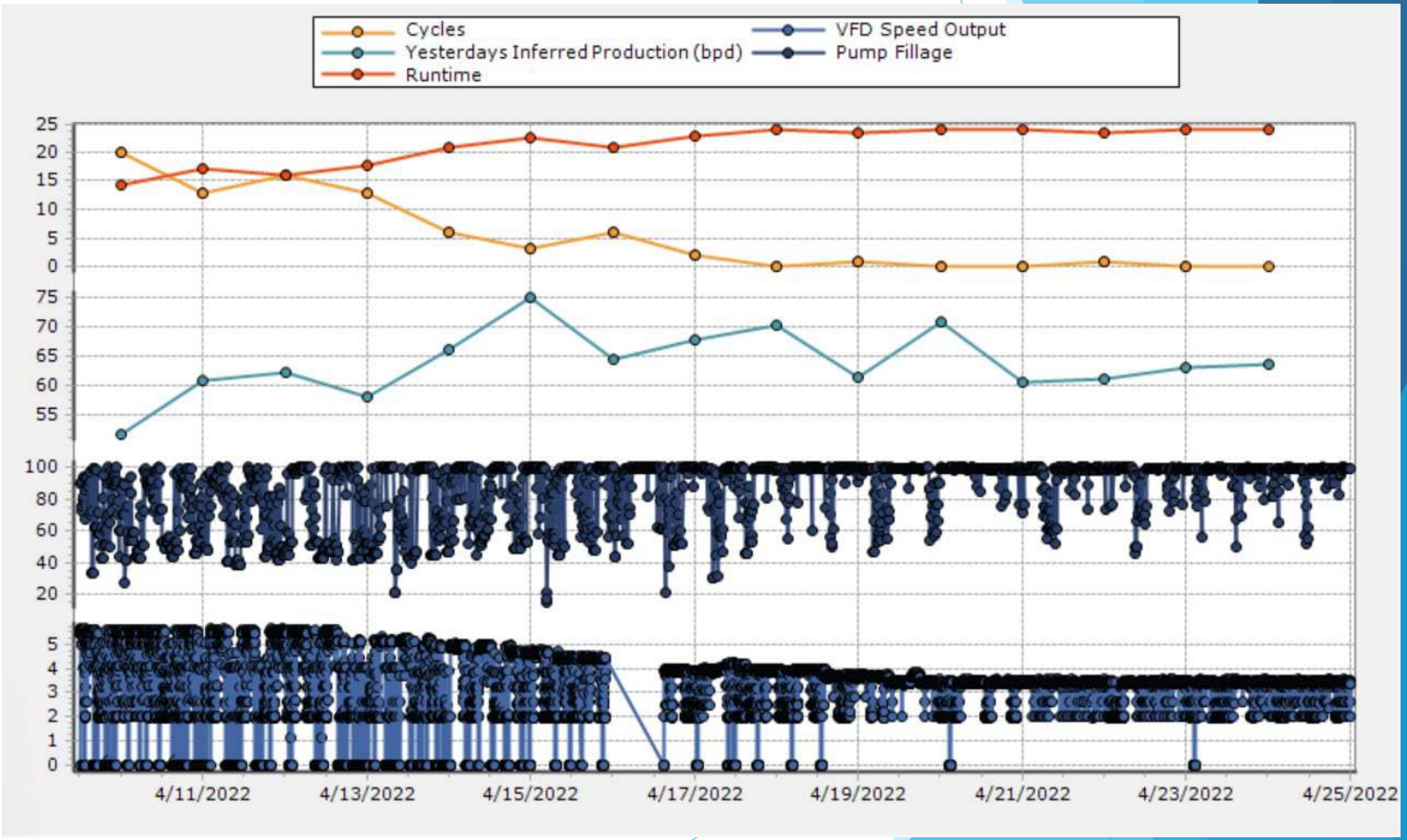
CHALLENGE

- The well was pumping too fast and cycling unnecessarily, causing a low run time of ~14 hours per day

RESULTS

- Decreased Max Speed setpoint and normalized Pump Fillage setpoints
- Increased run time and pump fillage
- Cut cycling down to essentially zero
- Increased production (~10 bbls) and runtime (~10 hrs) and decreased harmful incomplete fillage strokes



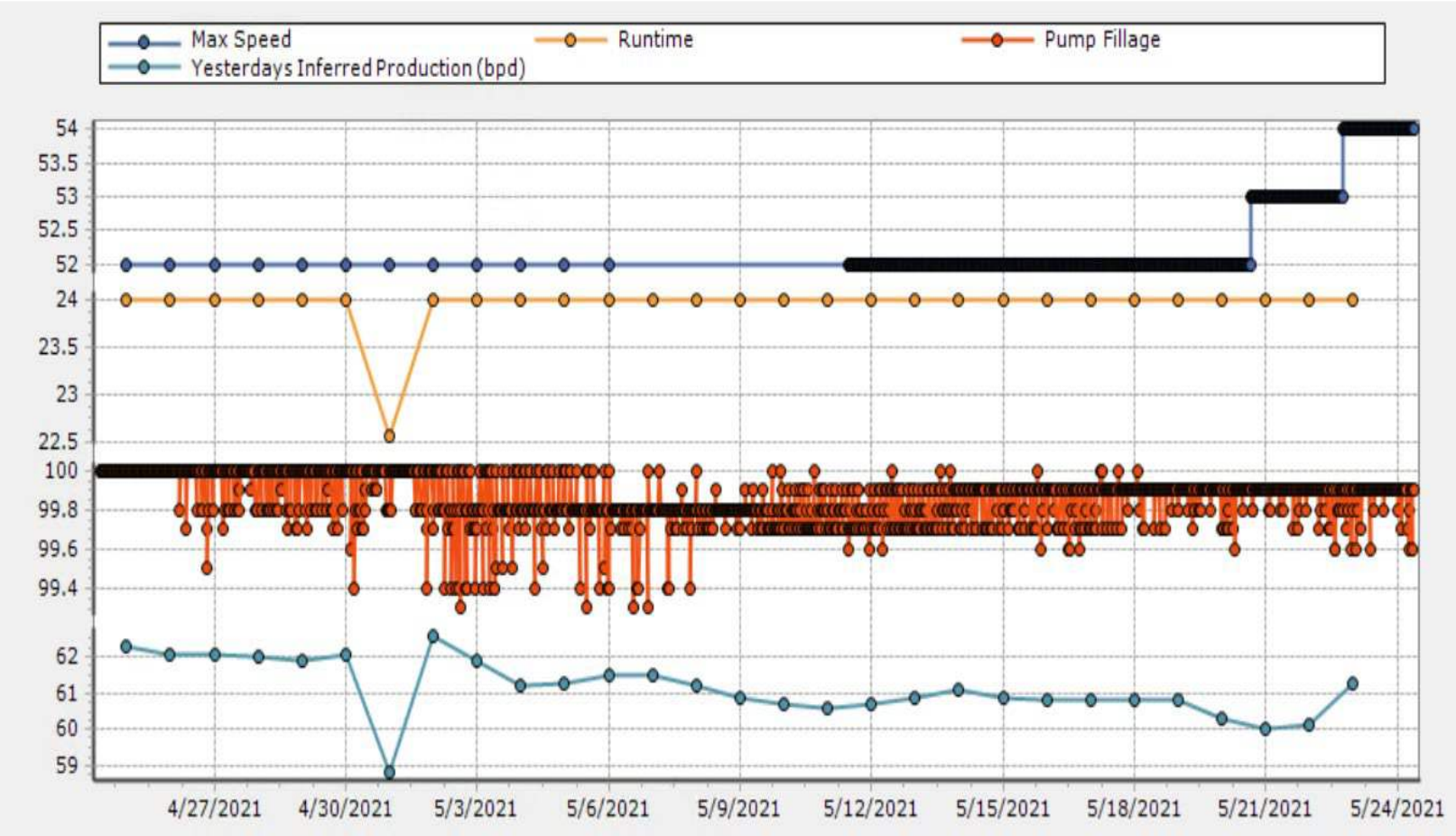
Case History: Undersized Design

CHALLENGE

- VSD well running at constant max frequency

RESULTS

- Increased Max Speed setpoint
- Increased production (~2 bbls)
- Run time and pump fillage maintained



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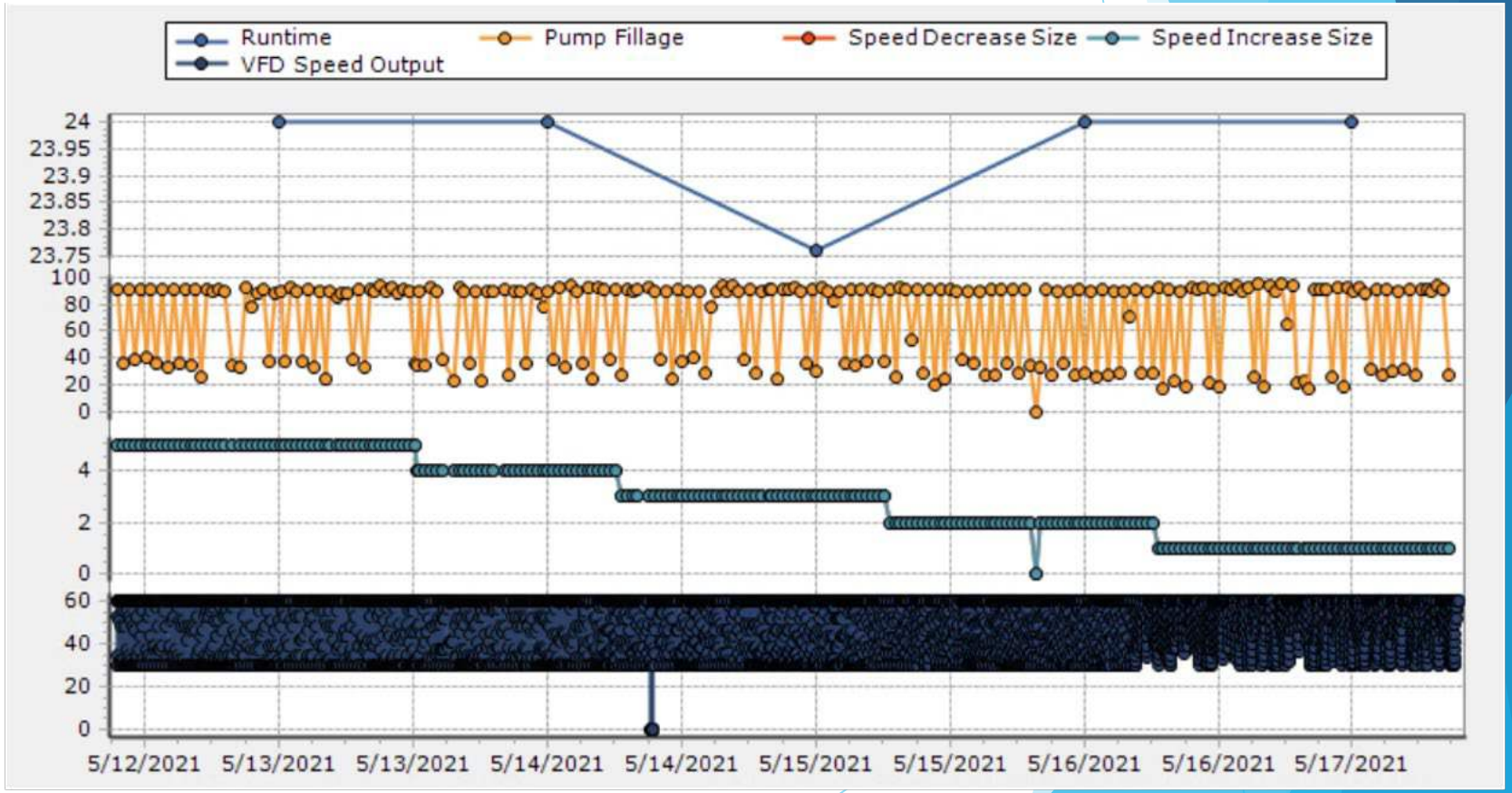
Case History: Poor Fillage

CHALLENGE

- Fluid pound well speed cycling several times per day

RESULTS

- Reduced Speed Increase and Speed Decrease setpoints
- Limit speed fluctuations (VFD speed output normalized)
- Less wear and tear on equipment
- Lowered electricity costs
- Maintained pump fillage



Conclusion and Continuing Development

- Accurately optimizes VFD setpoints on a variety of wells with different operating problems
- Leverages historical data, and physics-based diagnostics to optimize setpoints
- Works with existing equipment (no need for installing additional field equipment)

- Improve gas detection logic
- Specific logic for unconventional wells
- Additional logic to increase production
- More user configurability
- Support more controllers/drives

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