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Autonomous Control of Well Downtime to Optimize Production and Cycling in Sucker Rod Pump Artificially Lifted Wells

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Problem Statement

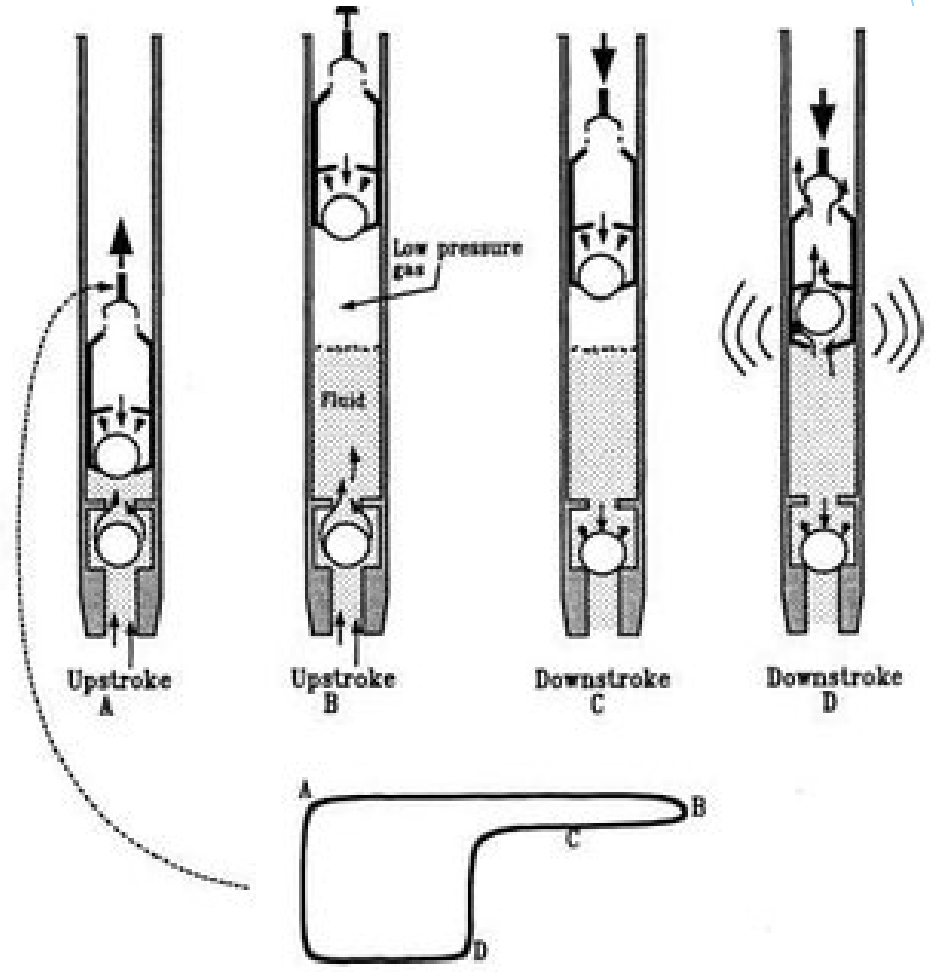
- Matching a well’s capacity to production
- Needing to reduce cycles without losing production on idling wells
- Manually updating wells to determine the optimal downtime
- Limited resources to spend time on this manual process

Objectives

- Using a host software solution develop algorithms that:
  - Automatically determines the optimal downtime for wells
  - Reduces cycles where possible
  - Ensures well is maximizing production
  - Solution must run fully autonomous and not require any human intervention once input requirements are met

Downtime for Rod Pump Wells

- Allows wells to maximize production without running 24 hours a day with incomplete fillage
- When downtime is too short wells cycle more frequently than necessary
- When downtime is too long wells lose production
- Downtime should be as long as possible without losing production



Solution: Idle Time Setpoint Optimization

- Develop algorithms that vary the well's downtime and self asses if the setpoint changes have helped or hindered production
  - Reduce cycles: reduce bad pump strokes
  - Increase runtime: capture production by reducing backpressure on reservoir

Autonomous Control Process

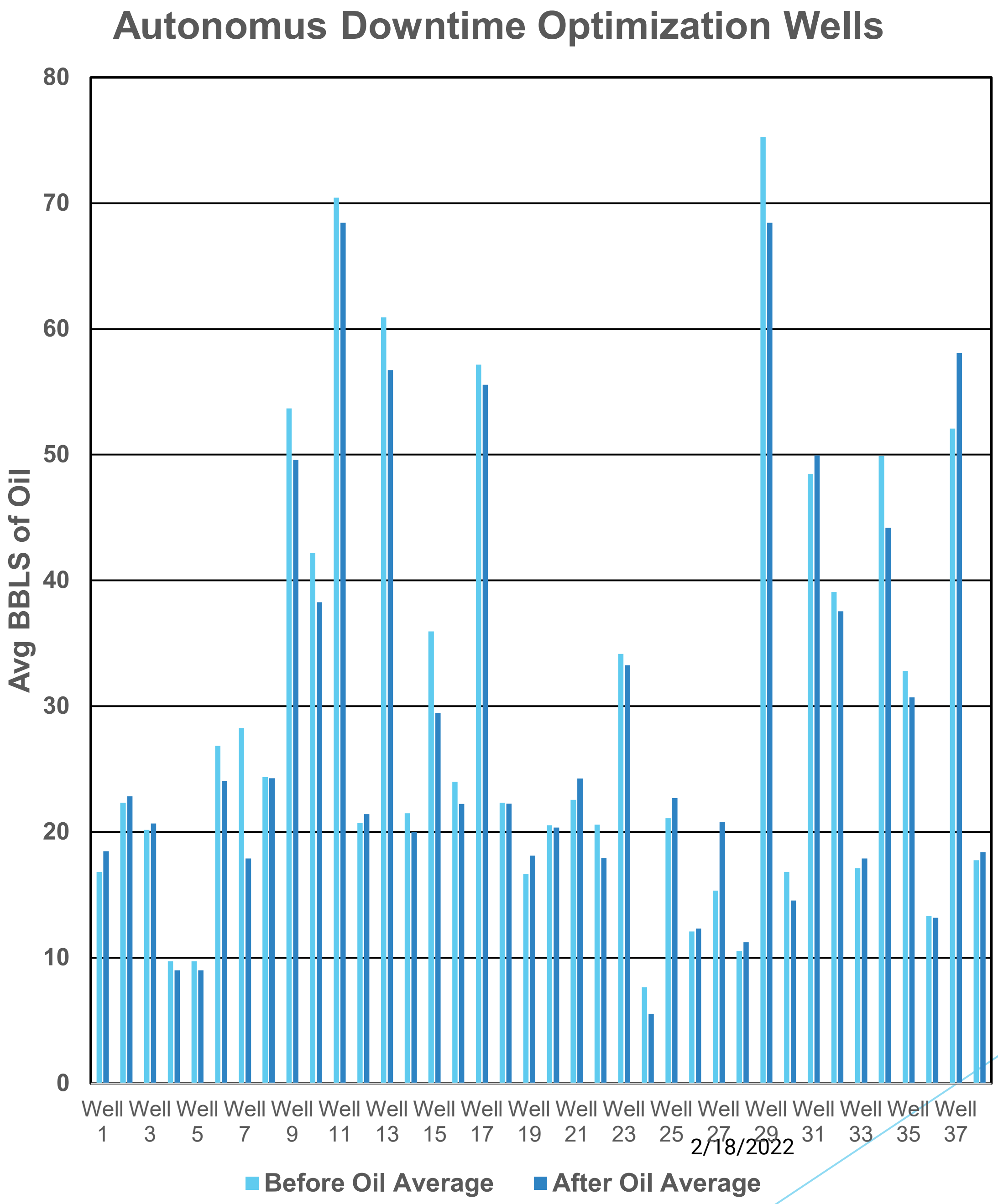
1. **Identify issues** – Host software will identify changes from normal operations, leading to possible issues with wells
2. **Diagnose the problem** – Through physics-based diagnostics and data analytics, host software will determine what the problem is
3. **Recommend corrective action** – Host software will help you take corrective action to resolve or mitigate the problem
4. **Achieve closed-loop autonomous control** – Our most recent step on our journey introduced autonomous control for rod lift wells to help with the continuous optimization of setpoints to increase production and minimize failures.

Methods

- Algorithms that autonomously increased and decreased the wells downtime were developed to achieve the optimal downtime
  - Algorithms measure cycles, runtime, and inferred production
  - If cycles are increasing without increasing production, the downtime is increased, if cycles are decreasing but production is also decreasing, downtime is decreased
  - The well's downtime is continuously autonomously changed by the algorithms
  - Downtime is considered optimized when the downtime is as long as possible without losing production
  - Even when downtime is optimized, algorithms continually change the downtime to ensure the well conditions have not changed

Trial Summary

- ~100 rod pump well in Bakken
- Majority of wells were able to increase idle time and reduce cycles
- Production consistent throughout trial
- No wells identified as under producing
- Cycles reduced by ~15% on trial wells



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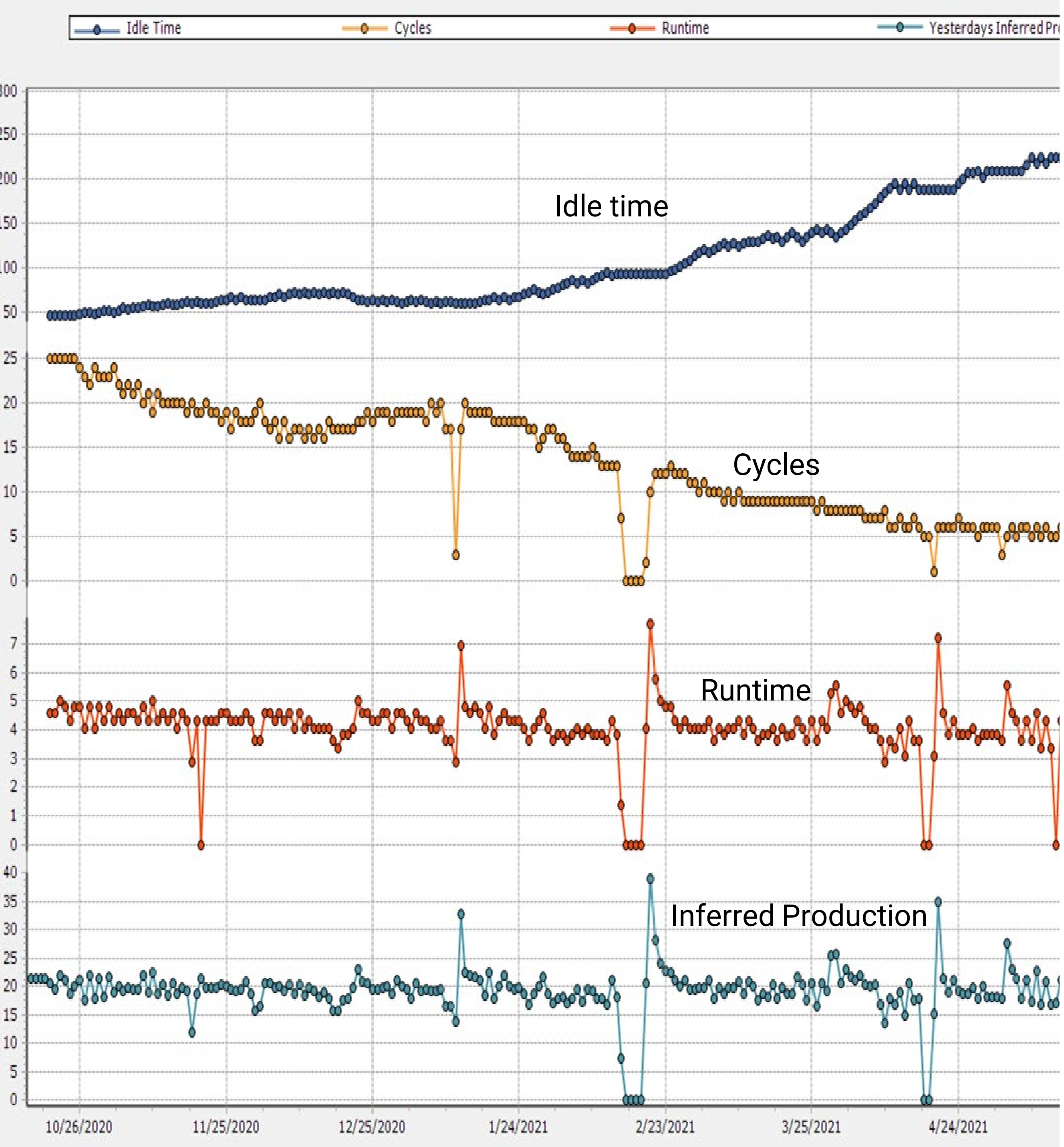
Case Study #1

- Idle time increased for 30 minutes to 100 minutes
- Cycles decreased form ~30 to ~8 cycles per day
- Reduced incomplete fillage strokes by 40,000 per year
- No drop off in production



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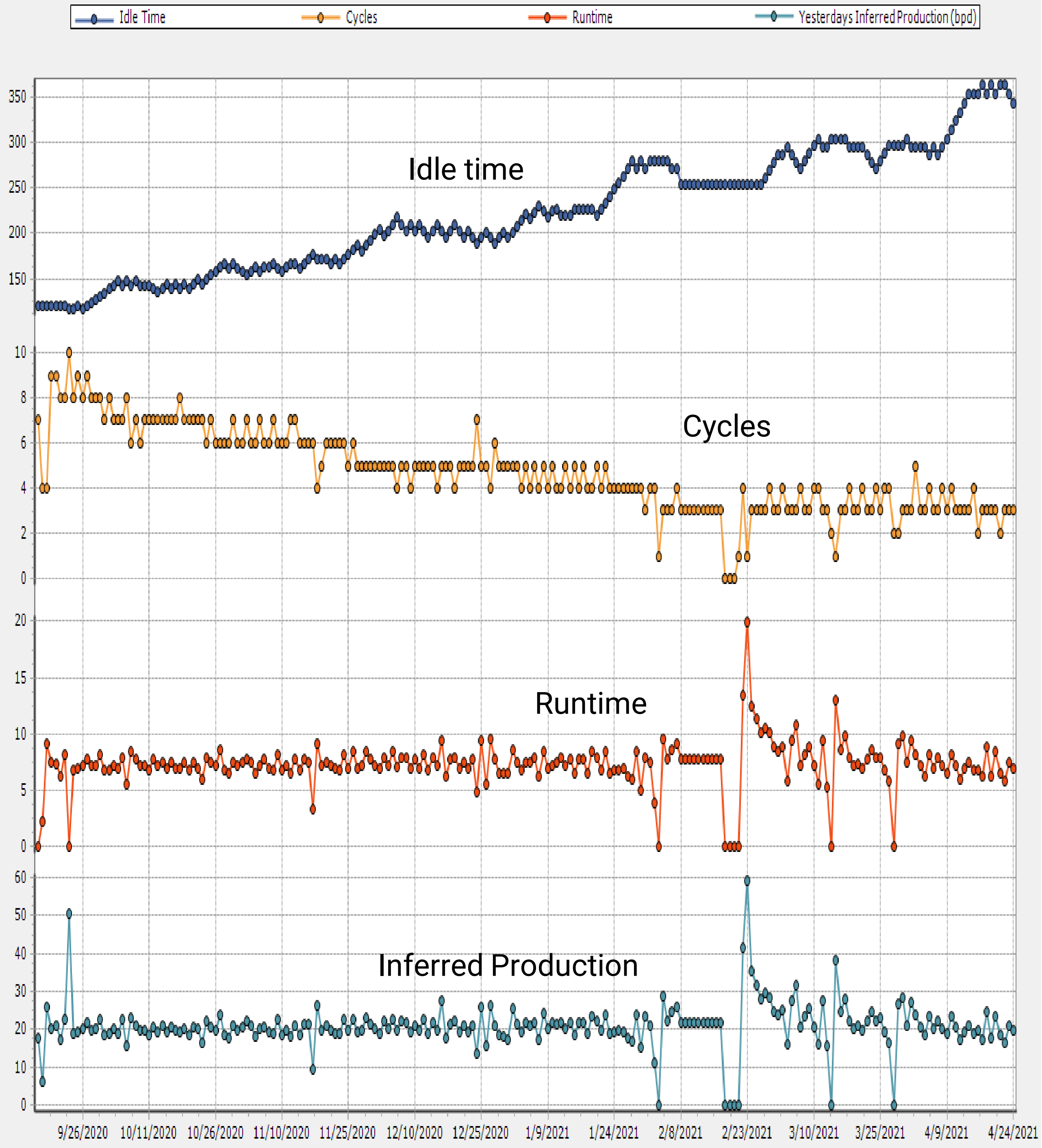
Case Study #2

- Idle time increased for 50 minutes to 300 minutes
- Cycles decreased form ~25 to ~5 cycles per day
- Reduced incomplete fillage strokes by 36,500 per year
- No drop off in production



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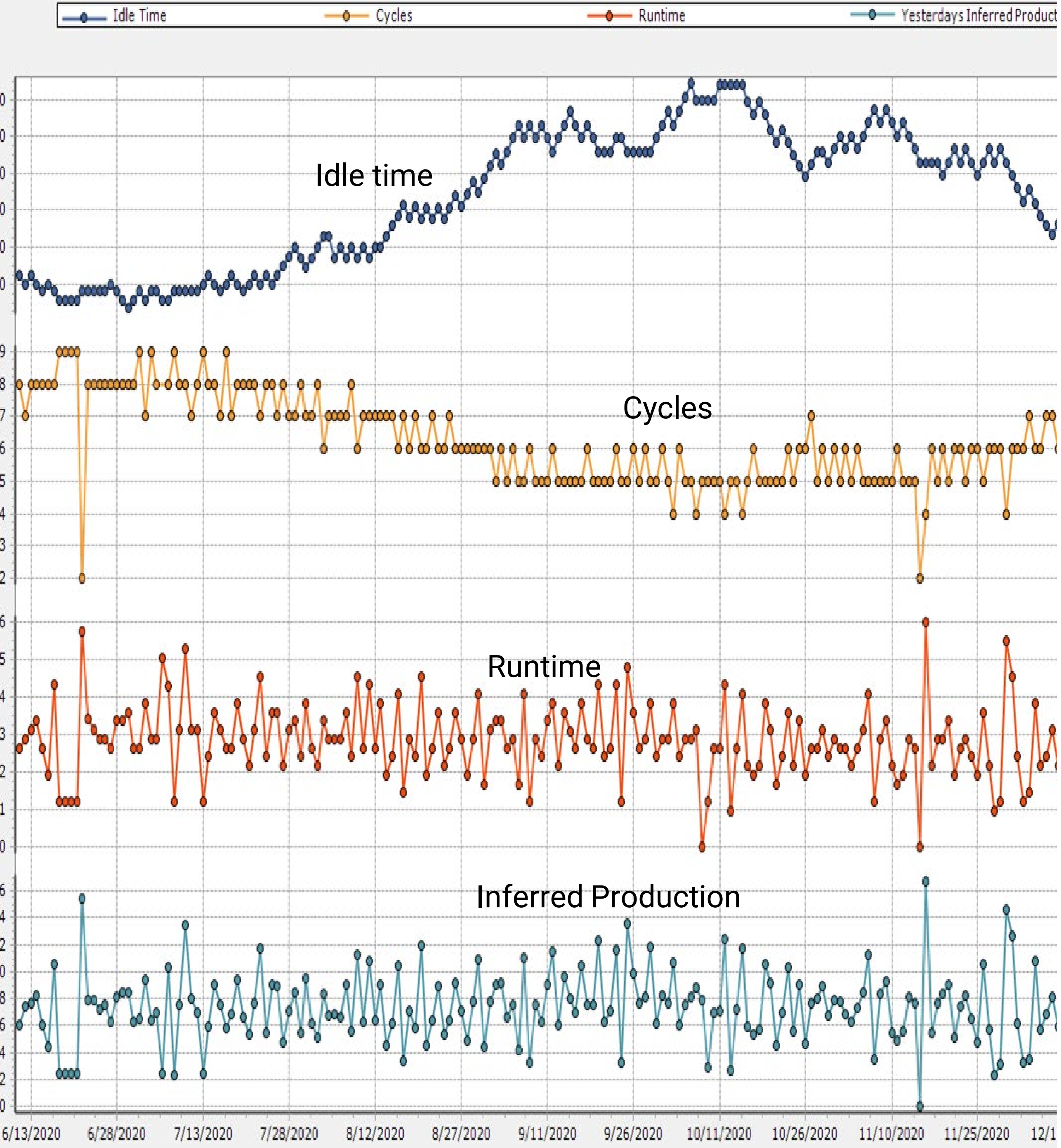
Case Study #3

- Idle time increased for 90 minutes to 345 minutes
- Cycles decreased form ~8 to ~4 cycles per day
- Reduced fluid pound strokes by 20 per day
- No drop off in production



Case Study #4

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- Idle time increased for 160 minutes to 215 minutes
- Cycles decreased form ~8 to ~5 cycles per day
- Found that well was operating close to optimal downtime
- Algorithm did not significantly change downtime to ensure maximum production

Conclusion

- Host algorithms can be used to optimize downtime in SRP wells that cycle frequently
- Many wells can reduce cycles per day without losing production
- Fewer incomplete fillage strokes increases efficiency and reduces failures

Acknowledgements/Thanks & Questions

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Sources

- Bonmmer, P.M. Benefits of Slow Speed Pumping. SPE-103359-JPT
- Kennedy, D.M. and Ghareeb, M. 2017. Ultra-Long-stroke and Intelligent Rod Pumping System for Producing Difficult Wells and/or Fluids. SPE-187028-MS.
- McCafferty, J.F., 1993. Importance of Compression Ratio Calculations in Designing Sucker Rod Pump Installations. SPE -25418-MS.

- Abdalla, R. (2007). *Downhole Problems of Sucker Rod Pumps*. Researchgate.net. https://www.researchgate.net/figure/Downhole-problems-of-sucker-rod-pumps_fig1_332763026.

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