Autonomous Control of Well Downtime to Optimize Production and Cycling in Sucker Rod Pump Artificially Lifted Wells (SPE-209743-MS)

GPC Workshop – Brown Fields Rejuvenation

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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

What are Setpoints?

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CONTROL SET POINTS

Control Setpoints often have a “sweet spot”

Control setpoints:

- **Primary control**: fillage setpoint, idle time, fill base line
- **Secondary control**: malfunction point, peak and min load limits, pump-off strokes, startup time/strokes, VSD setpoints (5-10 key ones), fluid load limit, etc.
- **Other:** equipment data (~50 setpoints), fluid properties, alarm configurations, etc.

Example:

100 wells x 100 setpoints per well = 10,000 points to manage!

Setpoints are any parameter in a remote device that can be modified by a user

Why downtime occurs in rod pump wells

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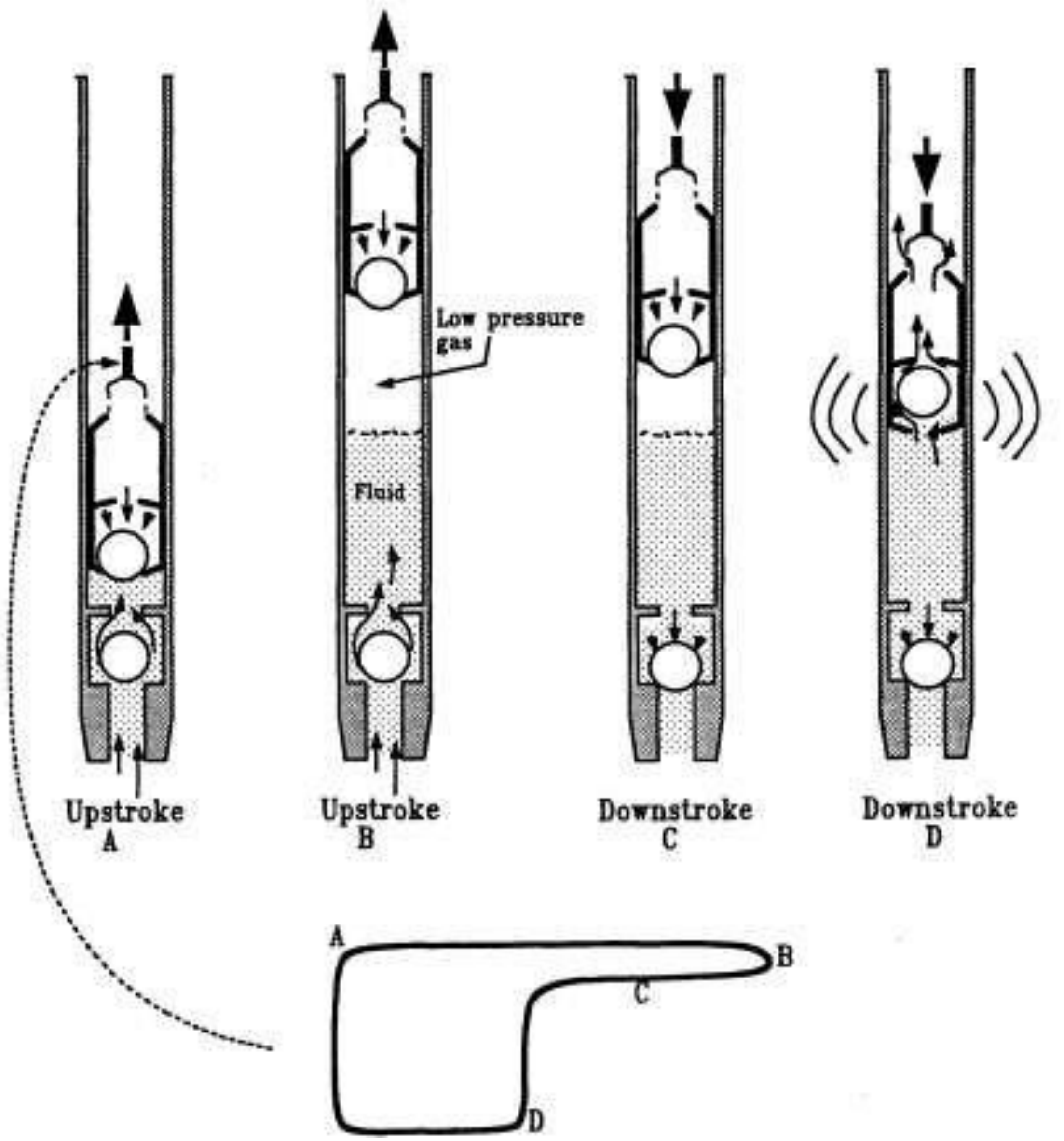
- Allows wells to maximize production without running 24 hours a day with incomplete fillage
- When downtime is too short wells cycle more frequently than necessary
- When downtime is too long wells lose production
- Downtime should be as long as possible without losing production



GOALZERO YOU LEAD

THETA AUTOMATION AND OPTIMIZATION

Rod Lift Autonomous Control Objectives

Leverage industry standards and trusted setpoint optimization strategies to develop methods for making automatic setpoint changes in the controller using the host system to mitigate unsafe operating scenarios, protect equipment, and reduce unnecessary downtime.

Achieve fully closed-loop control in XSPOC software without requiring additional hardware to be installed onsite in the field.

Idle Time Setpoint Optimization

Objective

- 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

Solution

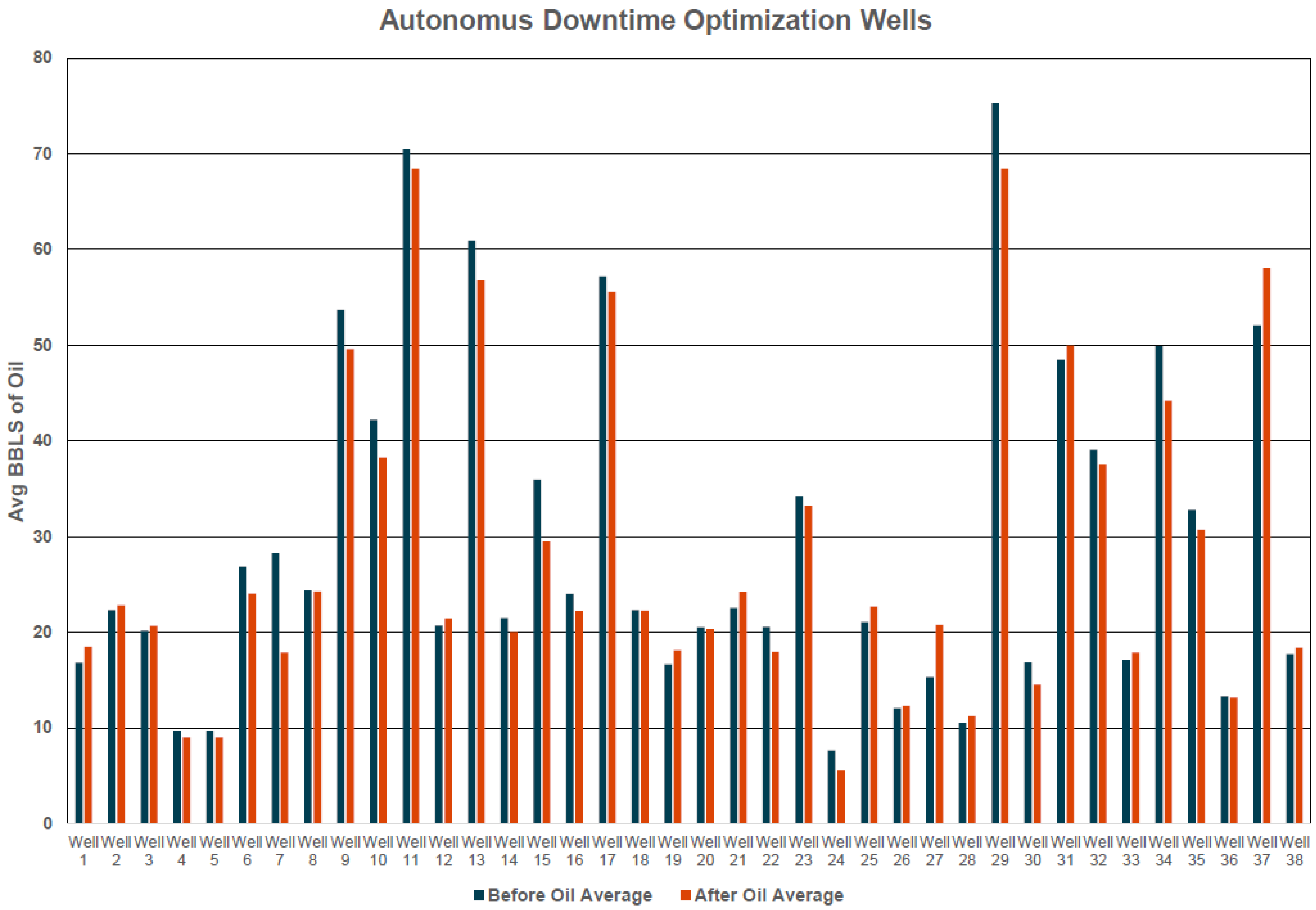
- Develop algorithms that vary the well's downtime and self asses if the setpoint changes have helped or hindered production
  - **Reduce cycles:** reduce bad pump strokes
  - **Increase runtime:** capture production by reducing backpressure on reservoir

Methods

- Developed algorithms that vary the downtime and analyze the effect on operations
  - If downtime increases, are we actually reducing cycles? Are we losing production?
  - If downtime decreases, are we increasing production? Are we adding unnecessary incomplete fillage strokes?
  - Algorithm has to constantly change downtime to accommodate for changes in production
  - Using historical data, we validated changes to ensure production was always maximized

Case Study Bakken SRP field

- ~100 SRP wells operated in Bakken area
- Majority of wells were able to increase idle time and reduce number of cycles
- Production consistent throughout trial
- No wells identified as under-producing
- Cycles reduced by avg. 15% on trial wells



Case Study Bakken SRP field

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Autonomous idle time

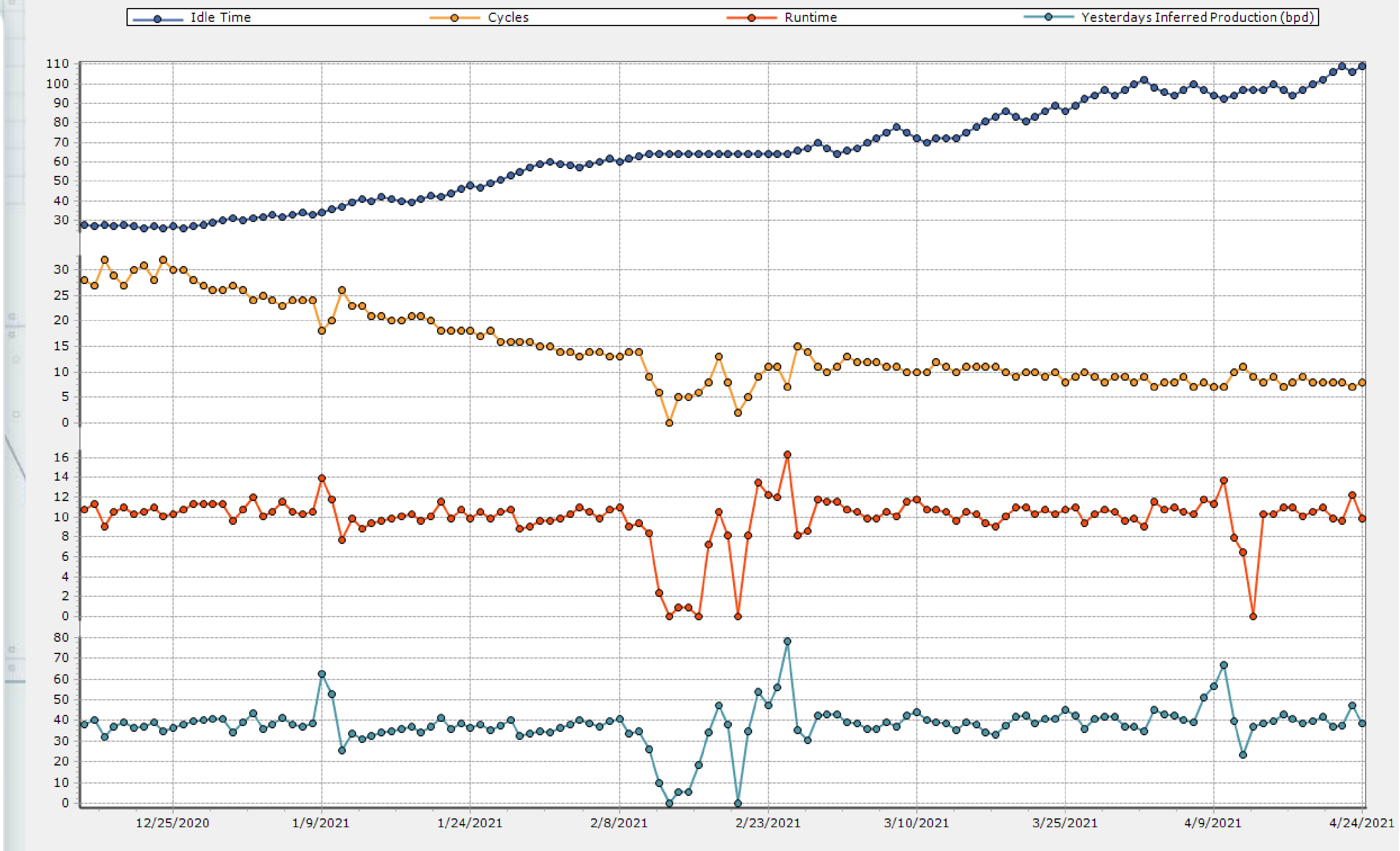
CASE STUDY 1

CHALLENGE

Fluid pound well cycling with standard POC control

RESULTS

- Idle increase from 30 to ~110 minutes
- Cycles reduced from ~30 to ~8
- Runtime and inferred production were maintained
- Reduced incomplete fillage strokes by 40,000 per year



Case Study Bakken SRP field

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Autonomous idle time

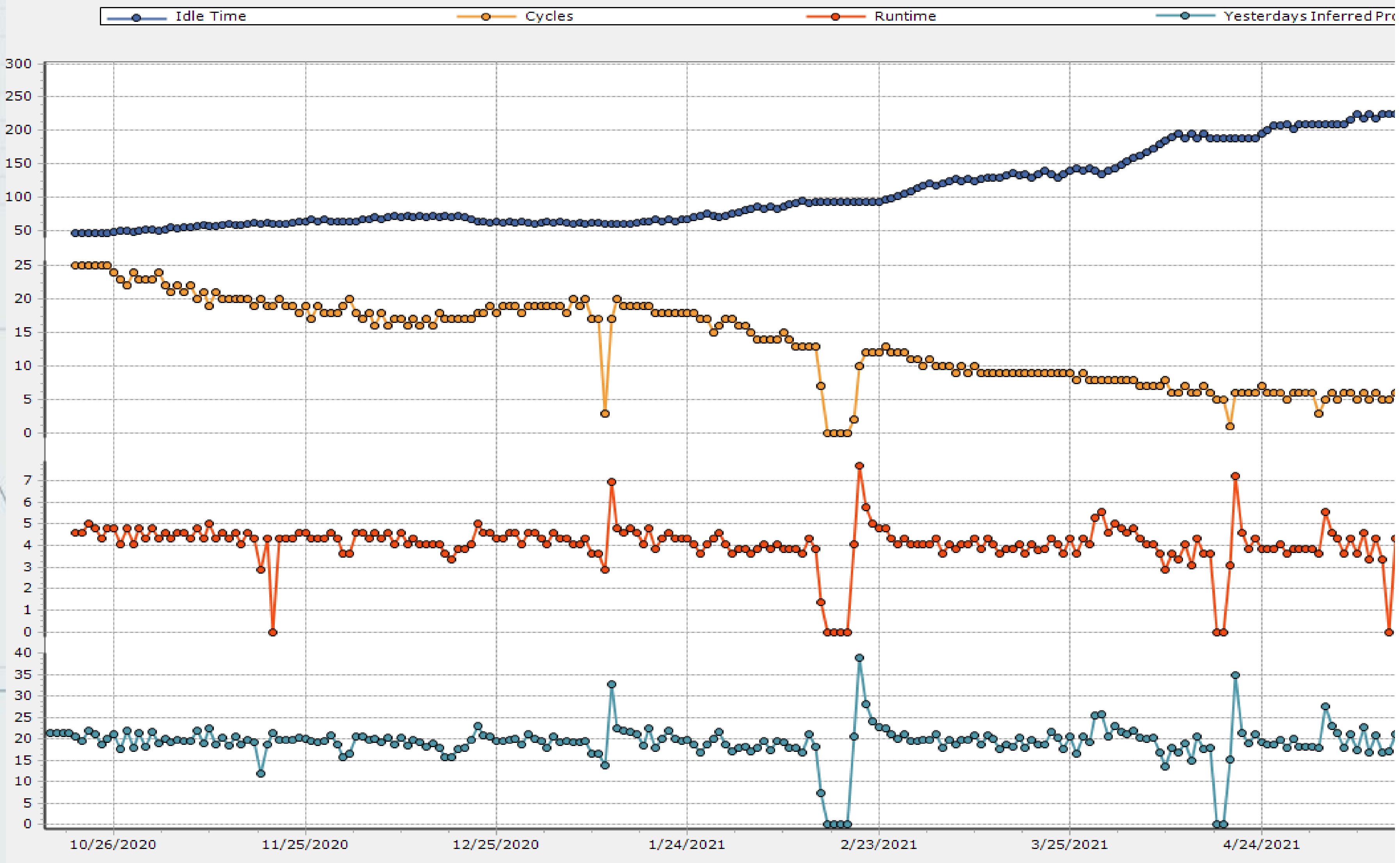
CASE STUDY 2

CHALLENGE

Fluid pound well cycling with standard POC control

RESULTS

- Idle time increased from 50 to ~270 minutes
- Cycles reduced from ~25 to ~5
- Runtime and inferred production were maintained
- Reduced incomplete fillage strokes by 36,500 per year



Case Study Bakken SRP field

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Autonomous idle time

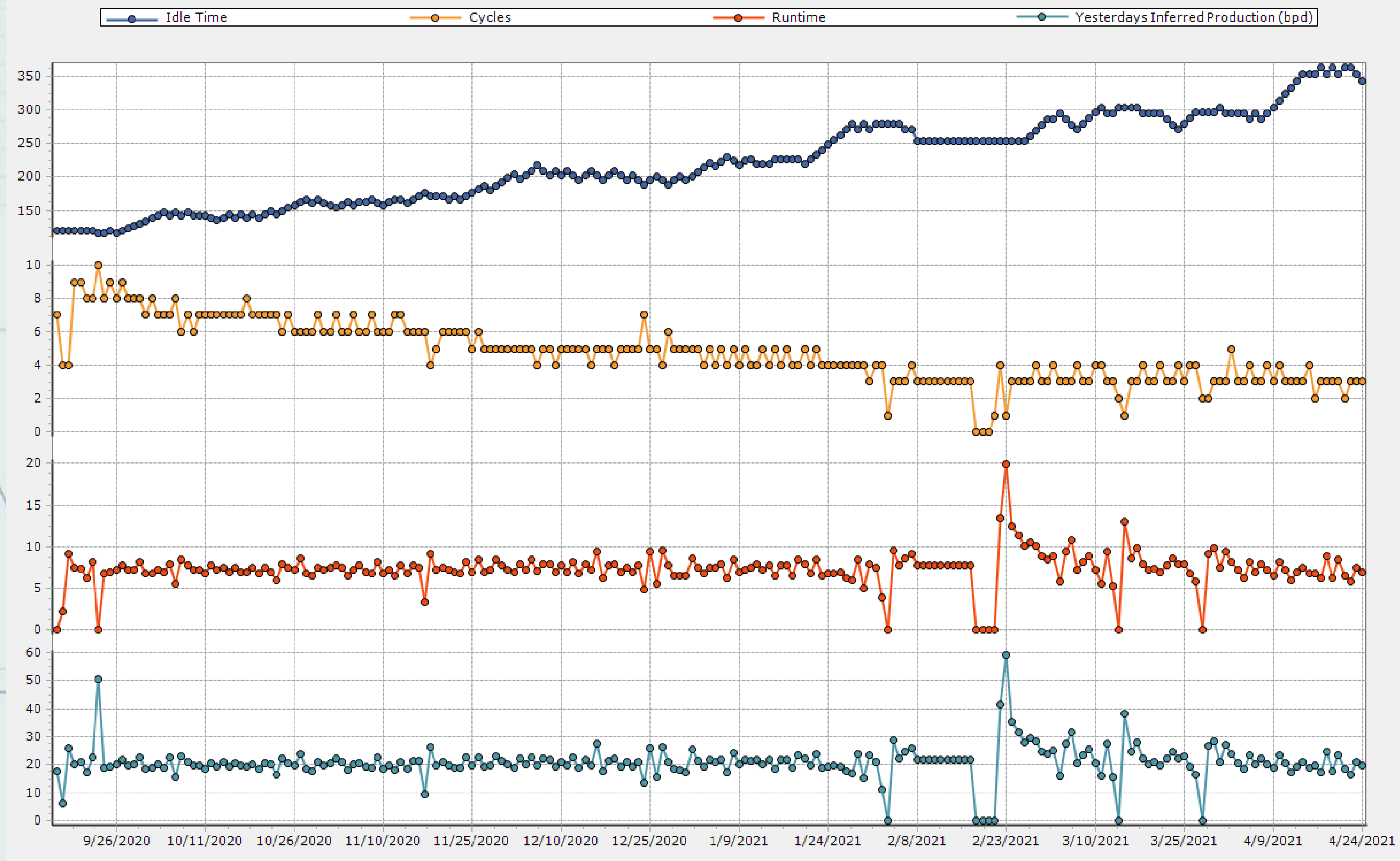
CASE STUDY 3

CHALLENGE

Fluid pound well cycling with standard POC control

RESULTS

- Idle increase from 90 to ~350 minutes
- Cycles reduced from ~8 to ~4
- Runtime and inferred production were maintained
- Reduced fluid pound strokes by 20 per day (over 7,000 FP strokes / year)



Case Study Bakken SRP field

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Autonomous idle time

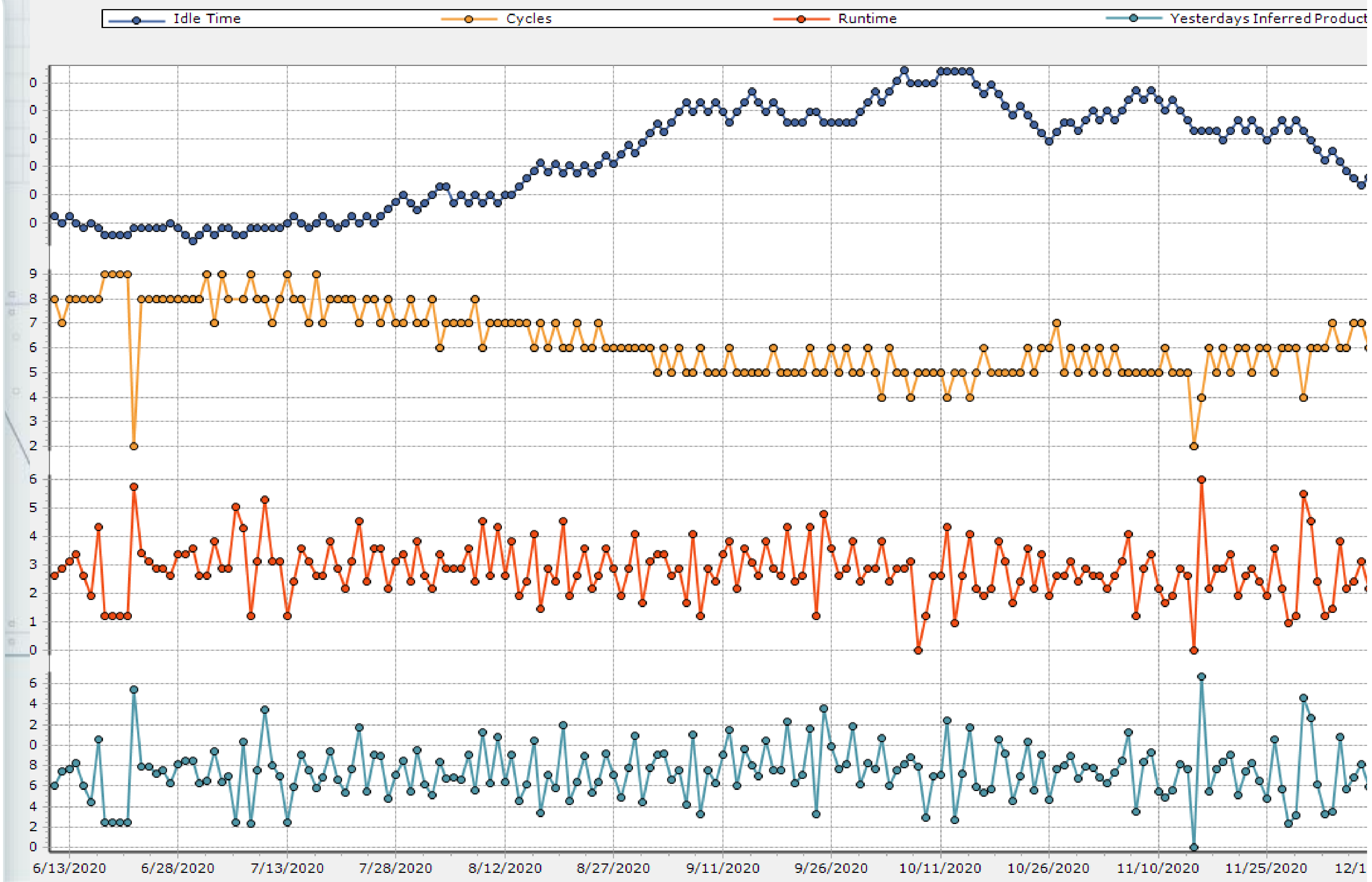
CASE STUDY 4

CHALLENGE

Gas interference well cycling with standard POC control

RESULTS

- Idle time increase fluctuates constantly looking for optimal idle time based on well conditions, average increase from 160 minutes to 215 minutes
- Cycles reduced from ~8 to ~4 per day
- Runtime and inferred production were maintained



Conclusions

- 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
- Reducing number of daily cycles and idle time periods translates to energy savings and extended equipment runlife

Acknowledgements & Sources

- Acknowledgements
  - Carlien Worley –Theta automation & optimization, ChampionX
  - Kevin Lo –Theta automation & optimization, ChampionX
  - Terry Treiberg –Theta automation & optimization, ChampionX
- Sources

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Thank you for your attention

Questions & Answers