

Rod pump monitoring and optimization: New physics for today's problems

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Agenda

- Objectives and goals
- ► System presentation
- ► Case studies
 - Horizontal well slug flow control
 - Diagnosis using high resolution water leg monitoring
 - Virtual test battery and flow meter
- ► Conclusion



Objectives and goals

Show the benefits of high-resolution field-wide monitoring, control and optimization

Streamlining SCADA through widespread IoT



Augment traditional dynacard approach with novel sensing



Deploy real-time AI for analysing large streams of highresolution sensor feeds

Initial target: large stripper fields

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Market conditions accelerating adoption of automation

- Lower oil prices in recent history mean producers are still focused on running leaner operations
- Higher and more stable oil prices encourage adoption of new technologies in the field
- Tighter regulations tend to enforce new monitoring requirements and better practices
- With a stronger focus on ESG topics than ever before, the industry's environmental footprint has to be continuously reduced, especially gas emissions and liquid leaks



Our approach: A field wide solution

Upstream

- Underground pump monitoring and real-time optimization
- Pumpjack surface issue detection

Midstream

- ► Tank monitoring & leak detection
- Production allocation/virtual flow metering

Control

- ► Well runtime adjustments and automatic fail-safes
- Routing and workflow optimization



System presentation: IoT for all

- Bringing stripper fields into the 21st century
- No infrastructure required for telemetry
 - ► New long range 5G network
 - ► High resolution 100Hz data 24/7
- Lowering sensor and automation cost
 - ► New, affordable sensor technologies
 - ► Fully wireless with years of battery life
 - Everything is recorded simultaneously: Rod load, current, vibration, acoustics, pressures,...
- Al in the cloud and on the edge





High quality data collection, made simple





Advanced signal processing of sensor feeds

- ► High res signals require significant processing
- Al analyses every individual stroke on 10+ signals simultaneously!





Stroke-by-stroke fillage analysis

- AI processes continuous signals (pump card included) and identify well pump-off condition while optimizing runtime
- Backbone of active control algorithms

Pump fillage over timer cycles Pump fillage (%) Time (s)

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Case study 1: Slug flow in horizontal wells

- Dynamic problem difficult to diagnose on the field with traditional tools
 - Pumper: "One day the well is pumping fine and the next the pump is empty"
- Difficult to know the well's true potential output





Case study 1: Slug flow in horizontal wells

- Cards are all over the place, 100% fillage to 40%
- Traditional controller confused





Case study 1: Slugging damages the well

- Average pump fillage appears reasonable, but actual fillage range is huge!
- 50% of runtime is with <60% gas in pump!</p>
- Gas pounding well





Case study 1: Slugging stabilized with the smart controller



Strokes reduced by 30%, production unchanged!



Case study 2: High resolution monitoring of oil AND water leg

- Water leg is 90% of flow yet not accurately measured
- Water is most of LOE including electricity cost to move
- Raw data is unreadable by a human



System uses controller information AND tank measurements



Case study 2a: Detection of abnormal conditions

- Oil production collapses
- Water production unaffected
- Alert for operator
- Casing leak diagnosis







Case study 2a: High resolution monitoring of water flows to monitor changes in product composition

Oil/water cut constantly changing





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Case study 2b: Merging wellhead and inventory to perform production allocation

- Average lease with 3 wells and 1 separator + tank battery
- Runtime change because of maintenance downtime + system control



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Case study 2b: AI used as a virtual flow meter

- ► AI able reconstruct system flow without flowmeters with high accuracy
- Works on oil and water legs with many wells per tank battery
 - ► Helps with billing, pump wear calculation,....



Total cumulative production



Case study 2b: Live dual phase flowmeter on every well



- Real time oil and water flow on each well
- Identify troublesome wells
- Potential to optimize control scheme between wells producing from the same formation
- Enables triage for well pulling & maintenance



Next steps

- Advanced control of slug flow wells to increase production
- Reservoir scale control
- ▶ Gas wells



Conclusions

- With 5+ high resolution sensor streams per well, we are able to get a complete picture of well & pump conditions
- Advanced algorithms are necessary to process and apply this amount of data 24/7
- Slugging can be mitigated using control and not just gas separators and downhole tools
- Amount of required hardware on sites can be reduced using virtual flow metering that leverages the right advance data

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Thank you

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