New Snapped Shaft Tool for PADs 101-104

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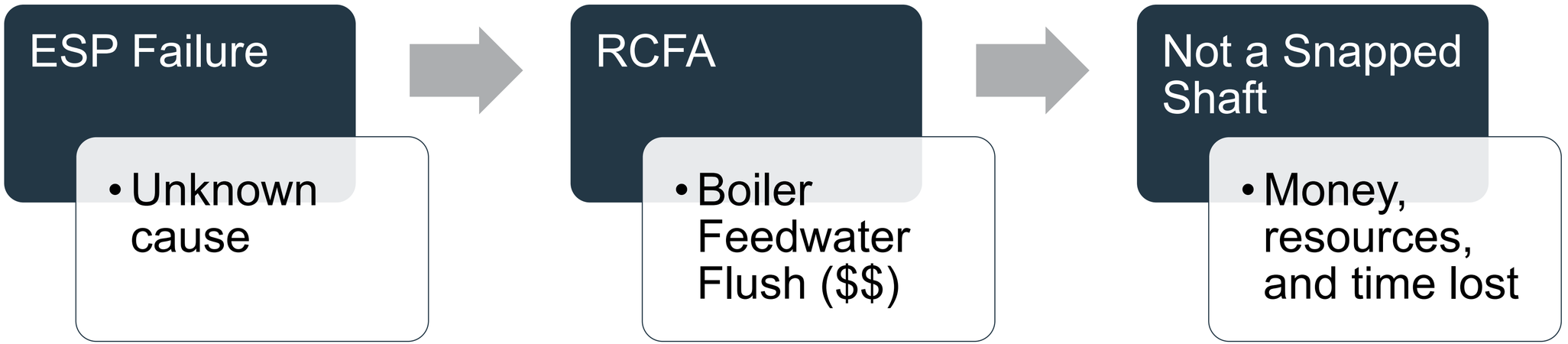
Problem

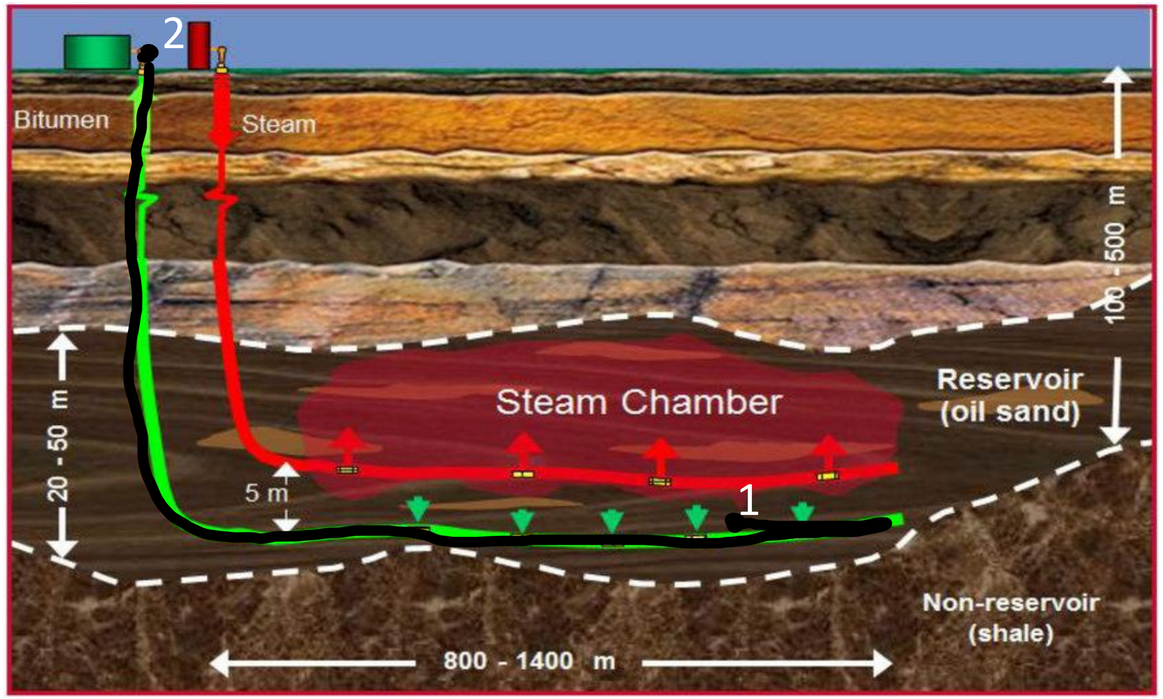


How can we identify a snapped shaft without expending resources?

Generate a Theoretical Model of Downhole ESP

Limited data provided by the legacy variable frequency drives (VFD)

- From fluid mechanics principles we can calculate the ideal head, and thus ideal power for the ESP at each time step
- Since current is directly proportional to power in P=IV, we can use it as a proxy to determine actual power consumption
- Using the ABSA voltage (~1000V) we can approximate power consumption at each time step
- The ratio between the actual and ideal power should always remain constant unless ESP hardware changes
- Snapped shafts can happen suddenly, thus the sampling rate is 1 minute



V = Q/A

Tubing Pressure

ESP TVD

$$h_p = P_2 + \frac{1}{2}\rho V_2^2 + \rho g z_2 - \left(P_1 + \frac{1}{2}\rho V_1^2 + \rho g z_1 \right)$$

Chamber Pressure

Surface of liquid level approximation V~0

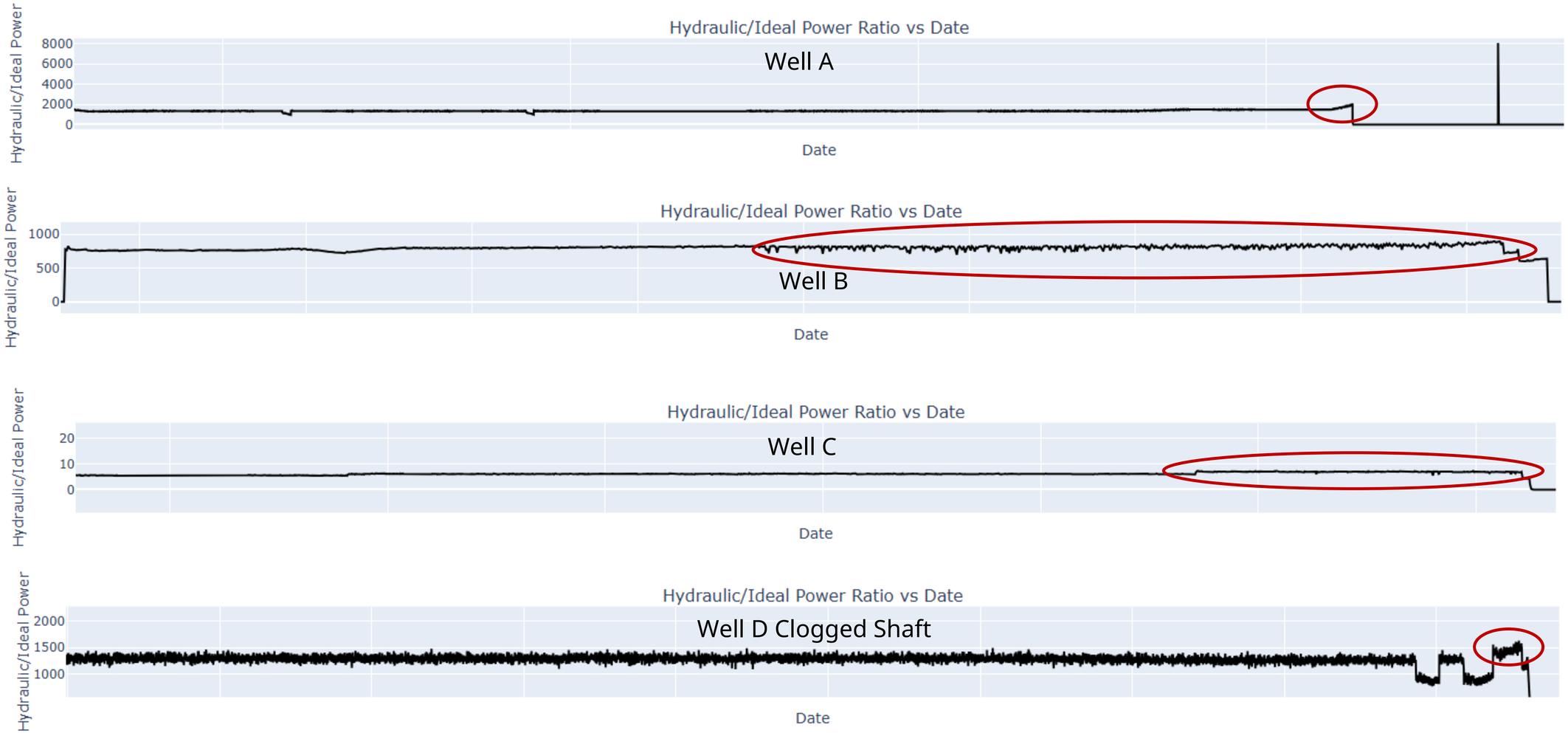
Code Review

Purpose: Calculate ideal power for SAGD downhole ESP and plot metrics for snapped shafts

- Input data
  - PI Data in .xlsx files
- Processing
  - Pandas
    - Data cleaning
  - Numpy
    - Physics model
  - Plotly
    - Plotted on local server
- Output
  - Plots of key ESP characteristics

- Modular
  - Functions for data aggregation and plotting
- Optimization
  - I did not spend time optimizing the code as I was looking for an MVP
  - Takes approximately one minute per well
- Error Handling
  - Error arises in input data, if data is NaN then it is coerced to 0

Testing the Solution



On confirmed shaft failures, the ratio suddenly increases and becomes unstable. This usually spans 4-12 hours before failing. It depends on a well x well basis but usually a 5-10% difference warrants a shaft failure. Only limitation is clogged vs snapped differentiation.

These are not the only case studies, there are many more.

SOP Implementation

This will work within the existing snapped shaft page where PADs with legacy drives are missing

- Like the current snapped shaft tool where data is shown for a specified range
- Since it varies well x well, there is no “threshold” for snapped shaft
  - Set a 5% limit in variation and flag the well for manual review
- Test against cases for current snapped shaft tool

Thank You