geoconvention
Calgary • Canada • May 7-11 2018

Three Approaches to Predicting ESP Pump Failures during SAGD Operations

Leon Fedenczuk, Gambit Consulting Ltd

Summary

Modeling of pump failure is difficult due to the low frequency of 'failure' events and requires looking at events on different time scales. This paper proposes modeling approaches for predicting ESP pump failures. Our study proves that such models can benefit SAGD processes. Specifically models can be used to formalize failure predictions, prevention, and lead to optimizing the ESP's replacement and/or maintenance.

Method

Predictive models were built using different data sets, different target parameter definitions, and different statistical model types. Three different approaches were tested that correspond to different resolution/scale of events. The first two deal with a large time scale. Specifically they predict overall time to failure and corresponding active time to failure. The third approach predicts high resolution events and estimates a probability of a failure at a specific time using the most recent or all wellhead data. The second and third model type exclude well's no-active time periods related to workovers and other non-productive time periods.

Results, Observations, Conclusions

The first two model sets were based on multivariate models that predicted the number of days to pump failure (Total Time to Failure which is Production Period) using only geology or/and trajectory based metrics. These models were developed with data from all well pads. A combined trajectory and geology based model showed acceptable and stable performance (R-Square equal to 0.41). The final model was built using only the most important subset of parameters from both sets.

In the next step we built a second set of regression models for Total Time to Failure using only well parameters. These models used pre-processed wellhead data from select wells on a few different pads. Well data required pooling large amounts of data and developing parameter summarization using Motor Current Periods, which were discrete time periods characterized by continuous electric motor current values above zero (no stopping). A modified set of models was built for predicting the motor active time to failure (Hours-on to Failure). In this model type the well-head predictive parameters had to be pre-processed in each motor current period. The modeling process included a regression model characterized by R-Square equal to 0.75 and a decision tree model characterized by R-Square=0.82.

The third set of models predicted probability of pump failures based on ESP Motor Current Periods using logistic regression.

Novel/Additive Information

This paper presents a novel approach to a time scale discretization when predicting pump failures at different scales. Model predictions can be presented inside a pop-up window in the current field monitoring applications to display expected 'Total Time to Failure', 'Hours-on to Failure', and 'Probability of Failure'. All three model types should be used to understand all risks.