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Please fill in your manuscript title.	Planning for Well Integrity Jobs Using Multifrequency Electromagnetic Tools

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Abstract

Electromagnetic techniques are commonly used to monitor the condition of the pipe in oil & gas wells with multiple tubulars. A typical well completion includes tubing and casings and it varies from well to well, because of different tubular sizes, weights, and start and end depths. Therefore, it is important to customize the tool configuration and logging speed to obtain optimal data quality for each job. In this paper, we introduce a job planner for an electromagnetic pipe inspection tool based on efficient modeling techniques to generate realistic synthetic logs that are used in predicting tool performance (e.g., accuracy, sensitivity, and operational parameters).

A job planner was designed to efficiently generate synthetic electromagnetic logs for a given well. Because of computational efficiency, a radial one-dimensional (R1D) electromagnetic forward modeling is used to quickly compute approximate response for the electromagnetic tool. However, the R1D model is less accurate due to lack of consideration of 2D features, therefore a two-dimensional (2D) electromagnetic forward modeling is used to generate accurate tool responses. However, it takes a long time to yield a complete log through 2D modeling. In our approach, the tool responses based on 1D and 2D forward modeling are calculated once for each different pipe zone of a well, which are defined as pipe sections with the same pipe configuration. Then a non-linear mapping function between the R1D model-based log and 2D model-based log can be constructed. For any given non-nominal pipe configuration, the R1D model-based log can be computed and mapped using the non-linear mapping functions to obtain R1D log with non-linearity included. Then a pre-computed impulse response due to a small defect is convolved with the non-linear R1D log to obtain a quasi 2D model-based log. Additionally, a noise with a certain level is applied to mimic realistic conditions.

Processing the quasi 2D log through model-based inversion, one can obtain estimates of the pipe parameters and analyze the tool performance metrics for a given well. Finally, logging parameters are adjusted to optimize the performance metrics.

This approach has been applied to a yard mockup model, which shows that the fast numerical simulation is comparable to the experiment. The estimated metrics can be used to determine the tool parameters for each specific well. For example, an array of transmitters and/or receivers can be determined prior to running the job based the proposed digital realization of this tool.

The job planner is a good alternative to time consuming and costly experiments, providing precise tool specifications estimation for each individual well section. It provides the optimal tool configuration for the field engineer to plan the job for each well, minimizing operations time and cost.

Keywords
Job planning; Fast electromagnetic modeling; corrosion monitoring; multi-tubular inspection; electromagnetic corrosion detection; well integrity; model-based inversion; performance prediction; logging parameters adjustment.