INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Real-Time Monitoring and Optimization of the Oil and Gas Well Drilling Process

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SHORT ABSTRACT

Fossil fuel has been serving the world's energy needs for a century. The depletion of fossil fuels from conventional resources has forced the drilling industry to explore complex oil fields. Multiple downhole complications could arise during the drilling operation. Few of them are contagious to the life of the drilling floor workers, such as kick events, oil spills and blowouts. In addition to the above risks, techno-economical sustainability also hampers the process of exploring unconventional reservoirs. A typical drilling plan is made based on the geotechnical survey report and historical data of the exploratory well of the same oil field. However, the uncertainties and deviations from the anticipated downhole conditions are often encountered during drilling, leading to complications in drilling. In such situations, the new process parameters suggested by the experts may not be the optimum for the newly encountered downhole condition. The sub-optimal drilling process may often result in more energy consumption and time for the completion of the well. Therefore, optimization of drilling parameters and monitoring of downhole conditions should work parallelly to achieve energy-efficient drilling of oil and gas wells. This approach is demonstrated by developing a decision support system (DSS) for oil and gas well drilling. The developed DSS can 1) detect critical drilling problems in real-time and take preventive measures, 2) suggest the best search range of process parameters for optimal drilling operation from the historical data, and 3) do real-time optimization for the dynamic wellbore conditions, 4)The developed model can predict the spatial variation of cutting concentration, which was required for real-time root cause analysis. Two case studies were conducted to validate the model, and the model was able to predict drill string washout, cutting accumulation, and mud pump failures before they occurred.

The above method helped in reducing drilling time by 27.1 % and energy consumption during drilling operation by 55 %. Further, formation-wise energy analysis was also conducted and inferred that depth, dogleg, and drilling process parameters but not formation lithology are the most significant parameters that affect energy consumption. An optimization problem was formulated by combining energy consumption terms and ROP to minimize the energy requirement per meter of drilling. The optimization results were found to be increasing ROP by 32%. for a well drilled in the northeast part of India