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## **Automatic Evaluation of Near-Well Formation Flow Interaction during Drilling Operations**

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### **Abstract**

Within the next few years wired drill pipe telemetry is expected to revolutionize the ability to measure and transmit downhole pressure, temperature, mechanical forces and formation parameters in real-time during drilling operations. Bandwidth, reliability and availability will improve dramatically and lead to better premises for developing new technology for more advanced drilling methodology. Downhole real-time measurements are expected to be utilized in a broad range of applications compared to today's drilling procedures. Among these are real-time analysis systems, decision support systems or advanced drilling control systems, e.g. for Managed Pressure Drilling or Underbalanced Operations that will be improved and adapted to this new window into the well.

The understanding of interaction between the mud column in the well and the near-well formation is of major importance especially in Managed Pressure Drilling, Underbalanced Operations, or in any drilling operations with narrow pressure window. In this paper, improved methodology for better understanding of well flow, and near-well formation interaction based on this step change in availability of downhole measurements is presented.

Model based real-time decision support systems and drilling control systems requires advanced calculation modules that calculates well pressures and flow conditions. For drilling operations with narrow pressure margins where influx from the formation or loss to the formation is likely, it is crucial that such hydraulics models give a good approximation of the physical behavior and the state of the well at all time. The models should therefore be calibrated based on available surface and downhole measurements from the drilling operation. Methodology for automatic calibration of advanced well flow models with formation interaction is presented in this paper and results are given. A more comprehensive real-time hydraulics model constantly calibrating itself against available measurements is a better basis for advanced real-time decision support systems or drilling control systems. Especially for challenging wells with narrow pressure window, such as in depleted reservoirs or deep-water wells this methodology can be useful.

### **Introduction**

The hunt for hydrocarbons from more “inaccessible” reservoirs has automatically driven the drilling technology towards more advanced techniques and equipment. Drilling operations in deep (and ultra deep) water and in formations with low (even negative) pressure margin are no longer showstoppers for the industry in order to find and produce hydrocarbons. Both economical and environmental issues have emphasized the necessity of developing and implementing new technology in an industry that to some extent has been seen as conservative when it comes to application of new methodology and technology.

The request for more information from the well and direct access to down hole tools during the drilling operation has enforced the development of the wired drill pipe telemetry system. Bi-directional real-time drill string telemetry at high speed is now available and may be capable of transmitting data of up to 2 Megabits/sec in the near future [1], [2]. High speed bandwidth from sensors down hole during the entire operation (not only when circulating) and two-way communication with down hole tools is expected to revolutionize drilling operations. In addition, wired drill pipe telemetry enables distributed measurement nodes along the drill string. Altogether, this technology will open up for more extensive use of real-time or quasi real-time systems for automation and decision making. In this context the term automation implies adding intelligent software agents into the control systems that handle downhole tools (e.g. rotary steerable) or rig equipment (e.g. mud pumps, draw-works, top drive or chokes) [3], [4].

When it comes to faster and better decision making the increased amount of data will enforce a development towards software products with more intelligence for monitoring and analysis of the drilling operation in order to sort out and present