AdrillTech Non-Stop Drilling Technologies: Continuous Circulation System All the Way to TD

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INTRODUCTION

AdrillTech Non-Stop Driller (NSD) is a sub-based constant circulation system that enables the continuous circulation of drill fluids downhole while making or breaking drillpipe connections. The system has been designed with a specific focus on the operator's needs by improving drilling efficiency, operational safety, hole condition, and equipment integration.

Among the main advantages of drilling a well with NSD include management of equivalent circulating density (ECD), improvement of hole cleaning, reducing the wiper trips, improvement of wellbore stability, prevention of stuck pipe, enabling continuous mud logging, and reduced near-wellbore temperature for high-pressure, high-temperature (HPHT) wells.

In this new technology article, we will focus on the last application, especially in geothermal wells. Using NSD in geothermal wells allows the circulation of drilling mud throughout drilling of the entire section, maintaining the wellbore at a manageable temperature for operations like logging. If losses are encountered, then circulation can be continued. This means that the drilling mud will continue to be pumped at the same time, and the pumps will not be switched off. Maintaining a dynamic mud circulation regime throughout the drilled section prevents the applied pressure on the formation from dropping below the pore pressure and below the collapse pressure of the formation. Additionally, it allows the management of the pressure in the wellbore, preventing increases of pressure beyond the fracture gradient, which in less consolidated sediments is very low (Petrie and Doll, 2021).

AdrillTech NSD TECHNOLOGY

Let's discuss in more detail how AdrillTech NSD technology works. We need to clarify that although continuous circulation systems have been around for more than 10 years, their application in geothermal projects is recent. The utilization of this technology in geothermal projects was specifically in response to drilling inefficiencies due to wellbore stability issues, which are commonplace when drilling surface or intermediate sections through volcaniclastic sediments (Petrie and Doll, 2021). Most of the high enthalpy geothermal projects occur in locations where there is a great deal of recent volcanic activity; this is not by coincidence. As such, when we come to drill surface sections, we encounter losses and wellbore stability issues due to poorly consolidated and cemented rocks. Because losses are expected, mud systems are designed generally with fresh water from a local source with little weighting additives or rheological property adjustment whatsoever. Wells drilled in these conditions are likely to encounter problems while drilling directionally, as hole cleaning will be problematic (Nazari et al., 2010).

AdrillTech NSD technology improves drilling performance and safety by maintaining constant circulation of drilling fluid in the wellbore when adding or removing drillpipe stands. A schematic of the NSD system is presented in Fig. 1.

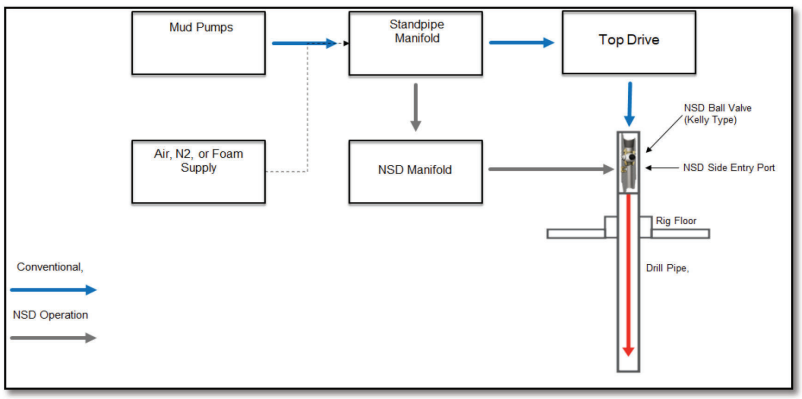

Fig. 1—NSD flow schematic and systems overview.

Each stand to be drilled down requires a pre-installed sub (Fig. 2). When the stand is drilled, the sub is used to create an access point to the drillstring for circulation. AdrillTech NSD technology uses a high-pressure mud hose with an integrated quick-connect mechanism to connect to the side of the drillstring. A remote-controlled manifold is used to redirect the flow path of the drilling mud from the mud pumps through the side entry valve in the NSD sub. Closing the valve at the top of the side entry valve isolates the drillstring pressure, allowing constant circulation during connections. When the connection is completed, the flow of drilling mud is redirected through the top drive, and drilling continues with the NSD sub, which is now an integral part of the drillstring downhole.

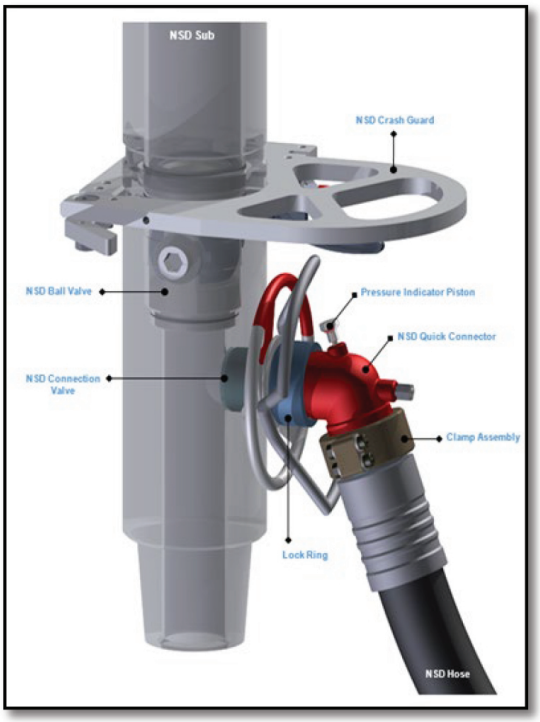

Fig. 2—NSD sub and hose.

RESULTS OF THE GEOTHERMAL PROJECT

Example 1

AdrillTech NSD technology was utilized on a deepwater drillship to mitigate the temperature fluctuations in the drilling bottomhole assembly (BHA). The operator had a need for formation evaluation to determine rock type, mineral composition, and other petrophysical properties. A complete study was conducted on the drilling process, and it was determined that the maximum temperature allowance of the drilling tools would be exceeded during the connection process timeline. Normal deepwater connection time takes up to 15 minutes or more. The study, presented in Fig. 3, confirmed that the near-wellbore temperature would exceed the maximum temperature of the tool in less than 5 minutes, where the worst conditions encountered during no pumping events and hydrothermal fluid influx would bring the downhole temperature up to 350°C, whereas the maximum temperature at the BHA while circulating would be 114°C.

Assessed Hydrothermal Influx **350degC** at 60mbsf
- Pumping
  - 8-1/2″hole:
    - Influx Flow-in: 350degC x 200gpm at 60mbsf
    - 38-114degC @ 600gpm
    - 21-95degC @ 800gpm
    - Annular BP: 40psi @800gpm x 100mbsf
  - 12-1/4″hole:
    - Influx Flow-in: 350deg C x 200gpm at 60mbsf
    - 26-74degC @1200gpm
    - Annular BP: 20psi@1200gpmx100mbsf
- Pumps Off
  - 8-1/2″hole:
    - Influx Flow-in: 350deg C x 400gpm at 60mbsf
    - Max 182degC @ 2min
    - Max 212degC @ 3min
  - 12-1/4″hole:
    - Influx Flow-in: 350deg C x 400gpm at 60mbsf
    - Max 128degC @2min
    - Max 168degC @3min
    - Max 196degC @4min

Temperature control modeling was performed before the start of the project. Results show that drilling an 8.5-in. section with 530 GPM and ROP of 3 m/h with 8.4 ppg seawater without NSD technology will have a temperature in the drillstring around 170°C. The use of NSD technology with the same drilling parameters will allow a cooling effect, bringing the temperature down to approximately 130°C.

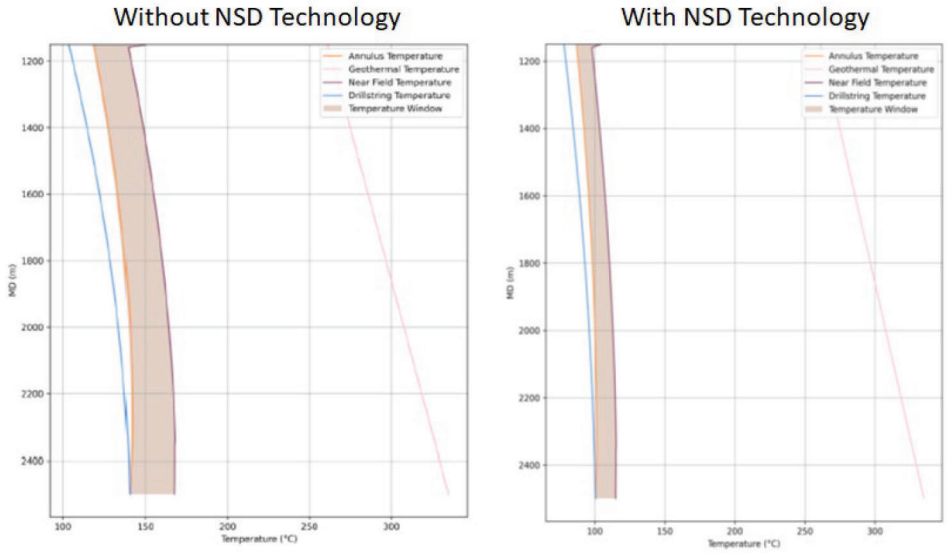

Fig. 3—Temperature control modeling.

Example 2

AdrillTech NSD technology was used in an integrated project management project to drill two wells as a part of the second phase of the project covering the 17.5-, 12.25-, and 9.875-in. sections (Pinkstone et al., 2018). Over 300 connections were performed on the two wells, and a total of 2,015 m of open holes were drilled using NSD technology. During both wells, continuous circulation was maintained at all times, which ultimately prevented any stuck pipe incidents during connections and helped to keep the BHA at operating temperature.

Hole Section (in.)	Total No. Connections	No. Successful Connections	No. Unsuccessful Connections	Success Rate	Distance Drilled Using NSD (m)	Time Drilled Using NSD (hrs)
17.5	107	98	9	91.6%	460	72
12.25	60	55	5	91.7%	624	96
9.875	134	132	3	97.7%	932	72
Total	*301*	*285*	17	*94.4%*	*2016*	*240*

CONCLUSIONS

AdrillTech NSD technology allows the continuous circulation of drilling fluids while drilling, which helps to manage the downhole pressure, ECD, improves the hole cleaning, and, specifically for geothermal projects, helps to keep the downhole temperature within operating rates for the BHA.

Both examples presented clearly show the advantages of keeping the circulation of the drilling fluids all the time, helping to maintain a hole clean, keeping the ECD constant, preventing any wellbore collapse, and substantially decreasing the risks of getting stuck.

REFERENCES

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