Prospective Study on Managed Pressure Drilling Technology of an Ultra-Deep Complex Well

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Extra-deep wells are an important direction of future petroleum exploration and development. However, extreme environments in ultra-deep formations provide severe challenges to drilling operations such as unpredictable problems of ultra-high pressure, complex pressure system and ultra-high temperature. The unusually narrow window of safe pressure operation, and conventional drilling cannot effectively deal with such problems, which easily lead to various complex risks of downhole, such as well kick, well loss, collapse and pipe stick, to increase drilling and completion costs greatly. Therefore, we established a new high precision micro-flux controlled pressure drilling method and system in this paper, which can cope with the problem of pressure and flow feedback lag to solve bottom-hole pressure accurate control in extremely deep and complex wells. Firstly, a new monitoring method of drilling fluid inflow and outflow was established, which can accurately measure and analyze the high and low pressure levels of drilling fluid inflow and outflow and judge the stable state of wellbore pressure in real time. Secondly, a drilling fluid inflow and outflow monitoring system was constructed, which is composed of a low-pressure inlet flow measurement system, a high-pressure inlet flowmeter, a high-pressure outlet flowmeter and a low-pressure outlet flow measurement system of accurate monitoring. Thirdly, a set of precise and real-time flow difference analysis method for the inlet and outlet of drilling fluid circulation system was established. According to the variation of drilling procedure, such as drilling ahead, run in hole and pull out of hole, rotation drilling tools, pump on or pump off, the instantaneous and cumulative parameters calculation are estimated, and the variation characteristics are analyzed. Combined with the total volume change of mud pits, it is to call out danger warning, such as well kick, well loss, collapse and pipe stick, and take corresponding measures in time. Finally, a set of field experiments and test methods were formed to test the characteristic control parameters of wellhead pressure and flow rate according to the characteristics of different wellbore, working conditions, drilling fluid types and downhole string combination, and form a safe operation range. The above three methods form the core of managed pressure drilling technology for ultra-deep and complex wells, which is still in the process of further research and improvement. However, compared with conventional drilling methods, they have shown strong technical advantages and we believe that the technology will play an important supporting role in future ultra-deep well drilling.