Global modelling of drill string dragging and buckling in 3D curvilinear bore-holes

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Enhancement of technology and techniques for drilling deep directed oil and gas bore-wells are of essential industrial significance because these wells make it possible to increase their productivity and output. Generally, they are used for drilling in hard and shale formations, that is why their drivage processes are followed by the emergency and failure effects. As is corroborated by practice, the principal drilling drawback occurring in drivage of long curvilinear bore-wells is conditioned by the need to obviate essential force hindrances caused by simultaneous action of the gravity, contact and friction forces. Primarily, these forces depend on the type of the technological regime, drill string stiffness, bore-hole tortuosity and its length. They can lead to the Eulerian buckling of the drill string and its sticking. To predict and exclude these states, special mathematic models and methods of computer simulation should play a dominant role. At the same time, one might note that these mechanical phenomena are very complex and only simplified approaches ("Soft String Drag and Torque Model") are used for their analysis. Taking into consideration that now the cost of directed wells increases essentially with complication of their geometry and enlargement of their lengths, it can be concluded that the price of mistakes of the drill string behavior simulation through the use of simplified approaches can be very high and so the problem of correct software elaboration is very urgent. This paper deals with the problem of simulating the regimes of drilling deep curvilinear bore-wells with prescribed imperfect geometrical trajectories of their axial lines. On the basis of the theory of curvilinear flexible elastic rods, methods of differential geometry, and numerical analysis methods, the 3D "Stiff-String Drag and Torque Model" of the drill string bending and the appropriate software are elaborated for the simulation of the tripping in and out regimes and drilling operations. It is shown by the computer calculations that the contact and friction forces can be calculated and regulated, providing predesigned trouble-free modes of operation. The elaborated mathematic models and software can be used for the emergency situations prognostication and their exclusion at the stages of the drilling process design and realization

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