Research on the Output Performance Model of a Turbodrill Used in a Slim Borehole

Junjie Sha[1,2], Yu Wang[1,2,*], Zhiqiao Wang[1,2], Qin Zhou[1,2], Bairu Xia[1,2], Baolin Liu[1,2]

[1]School of Engineering and Technology, China University of Geosciences, Beijing 100083, P.R. China, 2865457661@qq.com; wangyu203@cugb.edu.cn; zqwang@cugb.edu.cn; zhqtg@cugb.edu.cn; brxia@cugb.edu.cn
[2]Key laboratory on Deep Geo-Drilling Technology of the Ministry of Land and Resources, China University of Geosciences, Beijing 100083, P.R.China.

Small-diameter turbodrills used in slim boreholes have a great advantage because of their lower cost and high efficiency when applied to deep earth exploration. Multistage hydraulic components composed of stators and rotors are critical structures of turbodrills. This study aimed at completing research on turbine blade performance prediction based on a fluid-solid coupling method, so as to meet the needs of an accurate design of turbdrill. First, performance prediction models for single- and multi-stage blades were established using modified Bernoulli's Equation. The design requirement of the blade for high-temperature drilling in deep earth exploration was established. A Ø 127 blade was designed according to the dimensionless parameter method and Bezier curve; the parameters of the blade, including its radial dimension, geometric structure parameters, and blade profiles, were input into ANSYS and CFX to build a calculation model of the single-stage blade. Considering the high viscosity and high solid properties of a high-temperature drilling fluid, a multistage turbine simulation model was established, and the output performance of the whole turbodrill was predicted. The results of the flow field and numerical simulation show that with the increase of viscosity of the drilling fluid, the torque, pressure drop and efficiency of the turbine stage increases, and the velocity of the drilling fluid at the turbine stage decreases. The increade of the drilling fluid density causes a velocity and pressure drop in the turbine rotor rise and improves the turbine efficiency. The results demonstrate that the design can meet the turbodrill's requirements and the multistage model can effectively improve the accuracy of the prediction.