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HYDRODYNAMIC ANALYSIS OF SUCK-IN PULSED JET IN WELL DRILLING*

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Abstract: The development of new drilling methods is important for the exploration and production of oil fields. The pulsed jet is a drilling technology of high potentiality. This article proposes a new concept of suck-in pulsed jet with self-excited oscillation, by which a full use of the hydraulic power can be made in the annular space. A hydrodynamic analysis of suck-in pulsed jet with self-excited oscillation is carried out by numerical simulations and rock-breaking experiments. It is shown that with the jet, a negative pressure zone will be formed in the oscillation cavity to ensure automatic sucking of enough annular fluids and the formation of an efficient pulsed jet. The rock-breaking and pressure testing results have verified the reliability of the numerical simulation. The research provides a basis for the development of the pulsed jet drilling technology.

Key words: drilling methods, numerical simulation, pulsed jet, rock-breaking, suck-in

Introduction

The pulsed jet drilling technology has attracted more and more attentions, and with remarkable achievements in applications. It has become an effective way to improve the drilling efficiency. The pulsed jet formed by the self-excited oscillation nozzle has a large instantaneous energy, thus it can reduce the chip hold down effect, create a partial pressure in the bottom-hole, and help to remove drilling cuttings[1,2]. The numerical simulations and the experimental researches of the pulsed jet show that the pulsed jet drilling technology can improve the drilling efficiency significantly, and it can also promote the development of the oil fields[3].

Compared with the overburden pressure and the fluid column pressure, the pulsed amplitude and the pulsed peak produced by the pulsed drilling fluid are limited in a deep well with large frictional-loss. Therefore, the pulsed jet drilling technology is more effective in shallow wells. The deeper the layer is, the more the hydraulic power loss wil be, and the pulsed effect would weaken gradually. In the exploratory development of a deep or ultra deep well, it is not quite effective to enhance the hydraulic power in the bottom-hole only by improving the equipment capability, and there are also practical restrictions in adding bottom-hole booster pumps.

Since the drilling fluid column pressure is high, if this hydraulic power of annular fluids is used in an appropriate way, to supplement the power loss of drilling fluid and to adjust the hydraulic pulse to affect the bottom rock, a new and effective drilling method can be envisaged. Therefore, the concept of the suck-in pulsed jet with self-excited oscillation is proposed in this article, with an analysis of the flow field and dynamic characteristics. The results can be used as a guidance for the development of the actual drilling tools, and also as a reference for current pulsed jets.

1. Pulsed structure

The suck-in pulsed jet tool is designed as shown in Fig.1. The collision wall in the oscillation cavity is linearly arranged. Based on the previous experiments, the taper angle of the collision wall is 120^{o}, and the

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