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The research of post-buckling about slender rod string in wellbore based on energy method and experiment

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Abstract

The buckling behavior of rod strings in wellbore is one of the most phenomena in petroleum engineering. The slender rod strings in wellbore were selected as research objects. Based on the energy method, the critical load of sinusoidal and helical buckling were derived for the string with the wellbore pressure at the bottom. According to the sinusoidal and helical buckling's geometry of the pressurized string, the contact friction state of post-buckling between rod strings and the wellbore was considered. In this paper, Lagrange multiplier method was adopted to describe the sliding displacement boundary conditions of wellbore and the gravitational potential energy and friction resistance dissipated energy were introduced in the energy method. The contact forces and friction resistances between rod string and wellbore were derived in the inclined and vertical wells. And the post buckling experimental apparatus was also developed in this paper. The results indicate that the sinusoidal and helical buckling critical loads and the friction resistances were derived under different loads. The experimental results are consistent with the theoretical results. Therefore, this article would provide an effective method for buckling string, such as drilling, coiled tubing.

Keywords：sinusoidal buckling; helical buckling; friction resistance dissipated energy; contact force; friction resistance

1. Introduction

The buckling problem of slender rod string within the wellbore is one of most phenomena in engineering, seen as fig.1. It has many adverse effects for petroleum engineering jobs, particularly in drilling and workover jobs. Because of the friction forces surge after bucking, the weight of rod string cannot be added to the drill bit, which will cause the failure of drill and workover jobs. Thus, it will limit the application of coiled tubing and the drill depth for large displacement wells [1,2].

Fig.1 The picture of rod strings' buckling

The buckling behavior of slender rod string in wellbore has been a hot topic of concern by researchers at home and abroad. In 1953,

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