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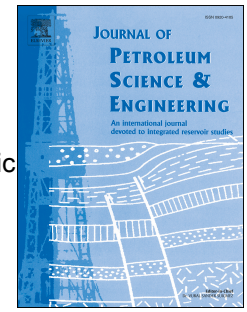

Analysis of wellbore stability considering the effects of bedding planes and anisotropic seepage during drilling horizontal wells in the laminated formation

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Analysis of wellbore stability considering the effects of bedding planes and anisotropic seepage during drilling horizontal wells in the laminated formation

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Abstract

With the exploration and development of gas shale in recent years, layer structures (bedding planes) of laminated rock and its effects on mechanical properties of rock and wellbore stability have arisen great attention. In this paper, we mainly concerns the wellbore stability during drilling horizontal wells in the laminated formation with horizontal bedding planes, meanwhile, the effects of anisotropy of permeability paralleled to bedding planes and that perpendicular to bedding planes are taken into consideration as well. Models of pore pressure distribution and seepage stresses under anisotropic seepage are established. Combining the effects of anisotropic seepage and bedding planes, we have investigated the equivalent collapse density (ECD) around horizontal wellbores. The results based on the input data in this paper reveal that the ECD considering the weakness of bedding planes is far higher than that without considering bedding planes, and the shape of zones where surrounding rock is relatively easier to collapse is similar as two couples of cat ears. The point where ECD reaches its maximum value tends to move from wellbore wall to internal rock if drilling close to the direction of minimum in-situ stress, and the higher anisotropic permeability ratio is, the more obvious the phenomenon is. The effect of anisotropic seepage can be ignored if the weakness of bedding planes is omitted, it otherwise can not be left out and the maximum ECD around wellbore instead of the maximum value at wellbore wall should be used to design for drilling operation. This study simultaneously investigates the effects of anisotropic seepage and weak bedding planes on wellbore stability during drilling horizontal wells，it is promising to provide a theoretical basis and practical guidance for the further researches on wellbore stability in future.

Keywords：anisotropic seepage; bedding plane; weak plane; horizontal well; wellbore stability;

1 Introduction

Shale gas, as a kind of increasing important unconventional resources, is undergoing thriving exploration and development in recent years. Horizontal well drilling technology is one of the important supporting technologies during development process of shale gas, because it is dramatically effective in enhanced the capacity of single-well production when combined with other subsequent stimulation treatments like hydraulic fracturing. However, serious wellbore instability problems are frequently encountered largely as a result of laminated structure of shale, therefore wellbore stability issues related to rocks with layering structure, like shale and bedding sandstone, has drawn great attention around worldwide. Mechanical property of laminated rock on the direction vertical to its bedding planes is obviously different from that parallel to its bedding planes, this discrepancy or