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沁水盆地南部煤层气储层压裂过程数值模拟研究

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Numerical simulation study of fracturing process in coalbed methane reservoirs in southern Qinshui basin

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摘要

储层改造是煤层气井提高产能的重要措施,水力压裂是煤层气储层改造的重要方法.为研究煤层气储层压裂过程及其天然裂缝对煤储层压裂时破裂压力的影响,本文以山西沁水盆地南部高煤级煤矿区为研究区,运用有限元数值模拟方法,计算不同地应力条件下、裂缝处于不同位置时煤储层的破裂压力.结果表明:(1)不同类型地应力场对破裂压力的影响不同.对于均匀应力场,破裂压力随着围压的增大而增大,其增幅约为围压的两倍;对于非均匀应力场,当一个水平主应力不变时,破裂压力会随着水平主应力差的增加而减少;(2)如果地应力条件不变,煤储层破裂压力随着天然裂缝与最大水平主应力方向夹角的增加而增加,水平主应力差越大煤储层破裂压力增幅也越大;(3)在有天然裂隙的地层中进行压裂,当天然裂缝的方位不同时压裂裂缝既可能是沿着天然裂缝扩展的裂缝,也可能是压裂过程中产生的新裂缝,因此天然裂缝的方位对破裂压力具有一定的影响.

关键词 煤层气开发, 煤储层, 压裂过程, 天然裂缝, 数值模拟

Abstract:

Reservoir reconstruction is a significant approach to enhance productivity of coalbed methane (CBM) wells, and hydraulic fracturing is an important method to reconstruct CBM reservoirs. The primary objective of this study is to analyze the effects of fracturing process and the natural fractures in CBM reservoir on the fracture pressure. This article takes the high rank coal mining area in the south of the Qinshui basin in Shanxi province as the study area, using the finite element numerical simulation method to calculate the coal fracture pressure under different in-situ stress and different natural fracture position. The results indicate: (1) the different types of in-situ stress field show distinct mechanism in affecting fracture pressure. As for uniform stress field, the fracture pressure increases with the confining pressure, and the rate of increase is about twice of the confining pressure; To non-uniform stress field, when a horizontal principal stress is constant, the fracture pressure decreases with the increase of horizontal main stress difference; (2) If the in-situ stress remains invariant, the more the angle formed between the natural fracture and the direction of the maximum principal stress is, the higher the fracture pressure of CBM reservoirs is, and the greater horizontal principal stress difference implies a bigger increase amplitude of fracture pressure; (3) When formation fracturing in the stratum contained different natural fractures, the new fractures either extended along the pre-existing natural fractures or are formed in another different orientation, which indicates the effect of natural fracture orientation on fracture pressure.

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