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论文

低透气性煤层脉动注水增透机理研究及数值分析

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摘要：

为了有效提高低透气性煤层渗透率，提出脉动注水增透技术，从微观机理上对脉动注水原理和疲劳裂纹起裂扩展过程进行了研究。在充分考虑有效应力以及滑动摩擦力的基础上，结合Ⅰ-Ⅱ型裂纹断裂判据，首次计算得到考虑影响因素较全面的煤体原级裂纹起裂的临界裂隙水压计算公式；通过将分支裂纹力学模型简化为悬臂梁模型，计算得到适合分支裂纹起裂扩展的裂隙水压范围。通过FLAC3D内嵌FISH程序语言编写脉动注水函数，实现了对裂纹尖端裂隙水压变化趋势以及裂纹扩展规律的数值模拟，模拟结果表明原级裂纹起裂扩展临界裂隙水压为13.1 MPa，分支裂纹初次起裂扩展水压为12.91 MPa；裂纹扩展半径在水平方向为3.6 m，竖直方向为2.3 m。现场试验表明脉动注水压裂增透效果明显优于普通注水压裂增透效果。

关键词： 低透气性；脉动注水；增透；原级裂纹；分支裂纹

Permeability enhancing mechanism and numerical analysis on pulsating water injection in low permeability coal seams

Abstract:

In order to improve the permeability in low permeability coal seams，a pulsating hydraulic fracture technology was proposed.The process of fatigue crack initiation and propagation，and the theory of pulsating water injection were studied from microscopic mechanism aspect.Based on the full consideration of effective stress and sliding frictional force，combining with the Ⅰ-Ⅱ type crack fracture criterion，the formula for calculating the critical water pressure of the coal’s original level crack initiation was first time derived with a full incorporation of all factors.The water pressure range of branch crack was calculated by simplifying its mechanical model as cantilever beam.Through the FLAC3D’s embedded FISH programming language，the pulsating injection function was programmed and a numerical simulation on the crack tip fissure water pressure change trend and the crack propagation law were achieved.The simulation results show that the fissure water pressure of the original level crack propagation is 13.1 MPa，the water pressure of the branch crack is 12.91 MPa when it extends for the first time.The crack propagation radius of the horizontal direction is 3.6 m and the vertical direction is 2.3 m.The results of field application show that the pulsating hydraulic fracture technology is superior to the general hydraulic fracture.

Keywords: low permeability；pulsating hydraulic fracture；permeability enhancing；original level crack；branch crack

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