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论文

径向水平钻孔直旋混合射流喷嘴流场特性分析

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摘要：

为解决高压水射流径向水平钻孔时孔径和孔深相互矛盾的问题，设计了一种兼具直射流和旋转射流特点的直旋混合射流喷嘴。运用数值模拟方法，采用RNGk-ε湍流模型对所设计喷嘴的内外流场进行了三维流动特性分析，运用高速摄影对射流结构和破岩特征进行了对比。结果表明，直旋混合射流喷嘴所形成的射流具有直射流和旋转射流特征，比锥形直射流喷嘴扩孔能力强、比旋转射流喷嘴钻孔深度大。直旋混合射流的轴向速度与直射流相比不存在等速核，与旋转射流相比轴心速度高，能够形成一定的钻孔深度，不会形成孔底锥起；切向速度沿喷嘴径向呈现“M”型分布，能形成较大的孔径；径向速度呈轴对称分布，存在明显的漫流层，有助于岩屑的脱离。流场特性模拟结果与实际破岩钻孔特征基本一致。

关键词： 直旋混合射流；冲击流场；径向水平井；RNGk-ε湍流模型

Flow field study on integrating straight and swirling jets for radial horizontal drilling

Abstract:

In order to solve the contradiction between the diameter and the depth of borehole during high pressure jet drilling laterally radial horizontal wells，a new type of nozzle design was proposed which both advantages of round jet and swirling jet.Three dimensional flow fields inside and outside the nozzle were simulated in terms of RNG k-ε turbulent model，also the flow structure and rock breaking characteristics with different nozzles were compared by the use of high-speed photography.The results show that the jet by the new designed nozzle has both features of round straight jet and swirling jet，with larger hole diameter than a conical round jet nozzle and deeper depth than a swirling jet nozzle.Axial velocity of the jet formed by the designed nozzle has no potential core compared with round jet，and higher speed to a certain depth of drilling with no protrusion from hole bottom compared with swirling jet.Tangential velocity along the nozzle radial showing “M” type distribution can form a large aperture.Radial velocity distribution is symmetrical with an obvious cross flow layer helping cuttings out from rock matrix.Flow field simulation results and the actual rock-drilling features are basically the same.

Keywords: integrating straight and swirling jets； impact flow field； radial horizontal well； RNG k-&epsilon turbulence model

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