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含夹层盐岩双重介质耦合损伤模型研究

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STUDY OF COUPLED DAMAGE MODEL OF DUAL MEDIA FOR SALT ROCK WITH INTERLAYER

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摘要 针对中国地下油气储库建设中所出现的含夹层盐岩问题，考虑夹层和盐岩层之间存在地质界面，采用以节点位移和孔隙压力为自由度的界面单元来模拟水力损伤造成的地层界面的开裂、扩展和流体渗漏；并基于多孔介质流－固耦合理论，建立含夹层盐岩双重介质耦合损伤模型。该模型克服了等效连续介质模型不能正确反映地层界面的渗流问题，又克服了双重介质模型不能考虑地层界面开裂问题。在此基础上，采用数值模拟技术，研究高压流体在泥岩夹层与盐岩的界面渗透及其开裂扩展特征，结果表明，高压流体沿腔体围岩渗漏过程中，含夹层盐岩界面呈扇形状张开，沿界面通道流体压力逐步降低。因此，在层状盐岩储库运营过程中，要严格控制腔体压力，避免在含夹层盐岩分层界面上产生油气渗漏，保持腔体的致密性及稳定性。

关键词： 岩石力学 层状盐岩 储库 夹层界面 裂缝渗流 有限元

Abstract： According to the reality of bedded rock salt and clay interlayer for underground oil or gas storage carven in China，considering the existing interface element between salt rock and weak interlayer，the interface element taking nodal displacement and pore pressure as degree of freedom，is used to simulate the initiation，propagation and fluid seepage of weak layers resulted from hydraulic damage. Based on the fluid-solid coupling theory of porous fluid diffusion and deformation，the coupled damage model of dual media for salt rock with formation interlayer is established. This model can depict the crack propagation process and reflect the seepage flow of interface. Then，some numerical simulations are carried out to analyze the seepage and crack propagation characteristics of high pressure fluid on interface between salt rock and clay. The results show that the fluid pressure decreases along the interface element direction and the aperture of the opened fracture is fan-shaped during the leakage process of high-pressure fluid along cavity surrounding rocks. It is concluded that the effects of interface seepage on pressure distribution are very important. For the tightness and stability of the oil and gas repository，the inner pressure of oil or gas repository should be controlled to avoid the oil and gas leakages on the interface for salt rock with interlayer.

Keywords： rock mechanics salt rock with interlayer storage cavern interface of interlayer crack seepage finite elements

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