

基于可靠度方法的盐岩地下储气库腔体收缩风险分析

井文君¹, 程林², 杨春和^{1, 3}, 徐玉龙¹, 张玉军¹, 施锡林^{1*}

(1. 中国科学院武汉岩土力学研究所 岩土力学与工程国家重点实验室, 湖北 武汉 430071; 2. 中国石油西气东输管道公司, 上海 200122; 3. 重庆大学 西南资源开发及环境灾害控制工程教育部重点实验室, 重庆 400044)

VOLUME SHRINKAGE RISK ANALYSIS OF SALT ROCK CAVERN GAS STORAGE BASED ON RELIABILITY METHOD

JING Wenjun¹, CHENG Lin², YANG Chunhe^{1, 3}, XU Yulong¹, ZHANG Yujun¹, SHI Xilin^{1*}

(1. State Key of Geomechanics and Geotechnical Engineering, Institute of Rock and Soil Mechanics, Chinese Academy of Sciences, Wuhan, Hubei 430071, China; 2. Petro China West East Gas Pipeline Company, Shanghai 200122, China; 3. Key Laboratory for Exploitation of Southwestern Resources and Environmental Disaster Control Engineering, Ministry of Education, Chongqing University, Chongqing 400044, China)

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摘要 由于腔体收缩导致的储气库可用体积减少是盐岩地下储气库在运营阶段的常见风险类型之一, 严重时会造成腔体围岩破损甚至坍塌破坏, 引发重大事故灾害。针对盐岩地下储气库在运营过程中可能发生的腔体收缩事故, 通过力学分析推导出无限、理想盐岩体中恒定内压下球形腔体在盐岩稳态蠕变阶段的体积收缩率公式, 并结合腔体收缩风险的分级标准建立盐岩介质中球形腔体的体积收缩的极限状态方程; 然后通过可靠度分析法计算各参数为正态随机分布时腔体收缩各级风险的发生概率, 分析地应力与腔体内压差值与各级风险发生概率之间的变化规律; 最后讨论若将围岩的弹性变形、初始蠕变变形以及加速蠕变变形考虑在内时对计算结果的影响, 为我国盐岩储气库的运营管理提供理论参考。

关键词: 岩石力学 风险分析 盐岩地下储气库 腔体收缩 可靠度

Abstract: Effective volume reduction resulted by cavern shrinkage is one of the common risk types in the operation phase of salt cavern gas storage. Cavern shrinkage risk will lead to damage or collapse of cavern wall rock, even serious accidents. Aimed at the possible cavern shrinkage risk during operation phase of salt cavern gas storage, volumetric shrinkage formula of steady state creep phase is derived on the condition of spherical cavern with constant internal pressure in the limitless and ideal salt rock. Combined with the cavern shrinkage risk classification of salt cavern gas storage, the limit state equation of cavern volume shrinkage is created. On the assumption that every random variable in the limit state equation follows normal distribution, probability of risk occurrence under different levels is calculated using reliability analysis. Then the change regularity of stress-difference between grostress and internal pressure and risk probability of every level is analyzed. Lastly, the elastic deformation, initial creep deformation and accelerated creep deformation are taken into consideration and the calculations result is discussed. The research results can provide theoretical reference for the operation management of salt cavern gas storage.

Keywords: rock mechanics risk analysis underground salt cavern gas storage cavern volume shrinkage reliability

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