SOLUTION MINING
RESEARCH INSTITUTE
3336 Lone Hill Lane
Encinitas, California 92024, USA

Telephone: 619-759-7532 ◆ Fax: 619-759-7542
www.solutionmining.org ◆ smri@solutionmining.org

Meeting Paper

Feasibility Study for Lowering the Minimum Gas Pressure in Solution-Mined Caverns Based on Geomechanical Analyses of Creep-Induced Damage and Healing

by

Kerry L. DeVries
Joe D. Nieland

RESPEC
P.O. Box 725
Rapid City, South Dakota 57709

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1.0 INTRODUCTION

1.1 BACKGROUND

The economics of compressed natural gas (CNG) storage in salt caverns are largely dependent on maximizing the ratio between the working gas and the cushion gas volumes. This ratio depends directly on the relative values of the maximum and minimum gas pressures permitted in the storage cavern. The maximum storage pressure is limited to a fraction of the weight of the overburden (typically 0.75 to 0.85 of the vertical stress) in order to prevent fracturing and loss of containment. The minimum pressure required to ensure the structural stability of the cavern is much more difficult to determine, and numerical simulations of cavern response during typical gas service cycles and conservative design criteria are used to evaluate the cavern stability at the minimum gas pressure (e.g., Ratigan et al. [1993]).

In recent years, considerable improvements in the ability to predict the deformation and deformation rate around underground openings in salt deposits have been obtained as a result of research efforts in various countries. Much of this research was driven by the need to develop the technology for the safe disposal of radioactive waste. Most of the constitutive models formulated have assumed that during creep deformation, the volume of the rock salt is constant and driven by deviatoric stresses induced by the excavation, independent of mean stress. The coupling of creep deformation and damage on the creep response of rock salt is treated by only a few constitutive models (e.g., Cristescu and Hunsche [1992]; Aubertin et al. [1993]; Chan et al. [1996a; 1996b]; and Lux et al. [1998]). Constitutive models for salt that incorporate damage accumulation and healing have not typically been used in the simulations to evaluate cavern stability of CNG storage caverns. Application of these advanced constitutive models may indicate that the minimum gas pressure can be decreased in many CNG storage caverns without compromising the stability of the surrounding salt. If this proves to be the case, the working gas capacity and the economics of CNG storage in salt caverns can be improved.