SOLUTION MINING RESEARCH INSTITUTE
105 Apple Valley Circle
Clarks Summit, PA 18411
USA
Country Code: 1 ◆ Voice: 570-585-8092 ◆ Fax: 570-585-8091
E-mail: smri@solutionmining.org ◆ www.solutionmining.org

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IMPROVEMENTS IN MECHANICAL INTEGRITY TESTS FOR SOLUTION-MINED CAVERNS USED FOR MINERAL PRODUCTION OR LIQUID-PRODUCT STORAGE

prepared by

Leo L. Van Sambeek
RESPEC
P.O. Box 725
Rapid City, South Dakota 57709-0725

Pierre Bérest
École Polytechnique
Post 2252
91128 Palaiseau Cedex, FRANCE

Benoit Brouard
Brouard Consulting
101 rue de Temple
75003 Paris, FRANCE

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EXECUTIVE SUMMARY

E.1 INTRODUCTION

Underground caverns in salt can be used to provide chemical plants with brine (mineral production) or for storage of hydrocarbons (both gaseous and liquid), compressed air, and waste products. For almost all applications, tightness of the cavern and external well components is a fundamental requirement. Tightness ensures that a leak does not cause contamination of drinking water resources or allow the uncontrolled escape of storage products to the surface.

Almost all solution-mining wells and storage caverns in rock salt are tested on a regular basis to prove their mechanical integrity, typically upon commissioning and then again every 5 years. Although technologies for Mechanical Integrity Tests (MITs) for caverns filled with a liquid are reasonably well advanced and established, potential improvements in the MIT technology were investigated by reviewing aspects of MIT methods and protocols, test results interpretation, and formulation of cavern tightness conclusions.

E.2 CURRENT INDUSTRY-STANDARD MECHANICAL INTEGRITY TESTS

Basically, two MIT methods are currently used, the Nitrogen Interface Test (NIT) and the Liquid-Liquid Interface (LLI) tests such as Pressure Observation Tests (POT) or Pressure Difference Observation Tests (PDO), as depicted in Figure 1. In both cases, the cavern is emptied of product before the test (wellhead pressure is removed) and the well is equipped with a central tubing or string.

The Nitrogen Interface Test (NIT) consists of injecting nitrogen to form a gas column in the annular space to below the last cemented casing. The central string remains filled with brine, and a logging tool is used to measure the brine/nitrogen interface location. Two or three measurements, generally separated by 24 hours, are performed; an upward movement of the interface is deemed to indicate a nitrogen leak. Pressures are measured at ground level, and temperature logs are performed to allow precise calculation of nitrogen leakage.

The Liquid-Liquid Interface (LLI) tests consist of injecting liquid hydrocarbon (instead of nitrogen, as for the NIT) to form a column in the annular space. During the test, the evolution of the brine and hydrocarbon pressures are measured at the wellhead. A significant pressure drop is a clear sign of poor tightness–particularly when the pressure decay is linear with no indication of stabilizing of a slower decay. Changes in the difference in pressure between the annulus and tubing can also be used to monitor movement of the liquid-liquid interface.