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AN APPROACH TO INTEGRITY TESTING STORAGE OF HYDROCARBONS IN UNDERGROUND FORMATIONS IN CANADA

Jug Manocha, P.Eng., Operations Engineer, Petroleum Operations Section,
Ontario Ministry of Natural Resources, London, Ontario, Canada

ABSTRACT

The underground storage of natural gas and liquefied petroleum products in geological formations provides economic and environmental benefits for the companies and consumers. There are approximately 160 salt caverns in Canada with a combined storage capacity of approximately 12.3 million m3 (80 million barrels). All caverns are in bedded salt formations and many provide high pressure storage of petrochemicals and natural gas liquids.

The Canadian Standards Association Standard Z341 (2014 6th edition) Storage of Hydrocarbons in Underground Formations provides requirements for the salt cavern storage. This standard incorporates life cycle considerations and requires inherent safety features to be built into the well design, construction, operations and maintenance to ensure long term mechanical integrity of the salt cavern storage system.

The approach requires the consideration of the well life cycle including the design, the construction, operation and maintenance of the salt cavern storage system. The standard requires safety instrumented systems including emergency shutdowns. As these salt caverns store high pressure and high volume hydrocarbons, integrity of the surface and subsurface systems are critical. The standard also requires demonstration of well mechanical integrity at the wellhead, casings, casing seat and cavern cavity. In addition to testing of caverns prior to the initial storage of hydrocarbons, this standard requires routine maintenance and testing. Additional testing should be conducted whenever operational or other data, such as unexplained product losses or high pressure in the brine string, indicate that a condition might exist that could adversely affect cavern integrity.

In mechanical integrity tests (MIT) operators are required to confirm that calculated leak rates are below the minimum detectable leak rate (MDLR) as calculated and measured. This paper discusses the experiences of operators where potential integrity concerns were detected during the mechanical integrity testing of the salt cavern systems. This has included areas such as potential concerns on the production casing, the washout of the casing seat, excessive corrosion near the surface casing, and leaking primary wellhead seals. Finding these concerns during testing likely prevented significant incidents and provided an opportunity to address and deal with the issues on a preventative basis. This included installing casing liners, or plugging the old well and re-drilling new entry wells and installation of new primary and secondary seals on the wellheads.

The defined mechanical integrity tests provide preventative information, and additional assurance, that ensures salt cavern hydrocarbon storage systems are operated effectively. Examples from the province of Ontario are included in the analysis.

Key words: Mechanical Integrity Test, Well Casing, Minimum Detectable Leak Rate, Well Cement Evaluation Caverns for Liquid Storage, Cavern Testing, Instrumentation and Monitoring, Instrumentation and Monitoring, Testing Frequency, CSA Z341 Storage of Hydrocarbons in Underground Formations, Canada.