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Numerical Simulation of Salt Cavern Dynamics and Flow-Induced Vibration

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Abstract

The present paper details the development of a numerical model for the study of flow–induced vibrations of brine or production strings in salt caverns, and presents the progress made in the simulation of an idealized, scaled, salt-cavern and pipe-string model. The examined flow–induced vibrations are oscillations arising from the interaction of the flexible structure, namely the hanging string, with counter-current internal and external axial flows relative to the hanging string. The numerical model was constructed in the ANSYS Workbench simulation platform. The developed model predicts the onset of flow–induced vibrations and the occurrence of limit cycle motion as the flow velocity is increased beyond a certain critical value. Further study involving spectral analysis of the predicted brine-string displacements, gives information regarding the characteristics of the system dynamics. The predicted behaviour is in very good agreement with existing experimental results in terms of the critical flow velocity, and in good to moderate agreement with experiments in terms of the amplitude and frequency of the vibrations. The simulation gives control over a wide range of physical parameters, and provides a better insight into the dynamics of the string. Benefits, practical applications, and limitations of the numerical simulation approach are discussed.

Key words: Flow-induced vibrations, Pipe-string instability, Fluid-structure interactions, Numerical simulation, Caverns for Liquid Storage