Solution Mining Research Institute Fall 2020 Virtual Technical Conference

22-24 SEPTEMBER 2020

Effect of fluid pressure on the leakage through wellbore cement fractures

Mahya Hatambeigi[1], Ishtiaque Anwar[1], Kirsten Chojnicki[2], Mahmoud Reda Taha[1], and John C. Stormont[1]

[1]University of New Mexico, Albuquerque, NM, United States

[2]Sandia National Laboratories, Albuquerque, NM, United States

Abstract

The flow rates through leaky wellbores associated with hydrocarbon storage facilities, which can result in pressure buildup in the cemented annulus at the surface, depend on the permeabilities of the leakage pathways, including cement fractures and microannuli. Similar to rock fractures, the permeabilities of these flow paths are expected to be a function of the external stresses acting on the fracture and the fluid pressures within the fracture. To determine how fractures respond to changes in confining stress and fluid pressures in a wellbore annulus comprised of fractured cement, fluid (nitrogen and silicone oil) flow tests were performed on fractured wellbore cement samples. The tests were conducted under a wide range of confining stresses and pore pressures, representing the various hydrostatic and fluid (gas and oil) pressures acting on the cement casing. Test results were corrected for non-linear (i.e., visco-inertial) flow as necessary and interpreted in terms of permeability and hydraulic aperture of the fractures. A strong correlation of increasing permeability with an increasing fluid (pore) pressure was found for both oil and gas flow. Results confirm the hypothesis that elevated fluid pressure props fractures open and significantly increase their permeability. The increased permeability, in turn, will result in increased flow (leakage) rates through the wellbore. The experimental results were incorporated into a numerical model that estimates the wellhead pressure response for a wellbore system with a thoroughgoing annular cement fracture. Results from the numerical simulations show that the wellhead response is substantially affected by the fluid pressure in the fracture system. Further, gas flow at the wellhead can be strongly affected by visco-inertial flow.

Key words: Wellbore leakage, Cement fracture, Fracture permeability, Pore pressure, Visco-inertial flow

©2022 – Solution Mining Institute

Full Paper is Available in the SMRI Library(www.solutionmining.org)