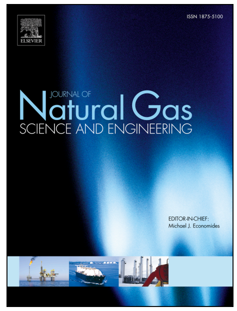
Accepted Manuscript



Identification and evaluation of well integrity and causes of failure of well integrity barriers (A review)

Raj Kiran, Catalin Teodoriu, Younas Dadmohammadi, Runar Nygaard, David Wood, Mehdi Mokhtari, Saeed Salehi

PII: S1875-5100(17)30218-4

DOI: 10.1016/j.jngse.2017.05.009

Reference: JNGSE 2178

To appear in: *Journal of Natural Gas Science and Engineering*

Received Date: 15 December 2016

Revised Date: 30 March 2017

Accepted Date: 4 May 2017

Identification and Evaluation of Well Integrity and Causes of Failure of Well Integrity Barriers (A Review)

Raj Kiran, PhD Student, University of Oklahoma; Catalin Teodoriu, PhD, Associate Professor, University of Oklahoma; Younas Dadmohammadi, Research Associate, University of Oklahoma; Runar Nygaard, PhD, Associate Professor, Oklahoma State University; David Wood, Consultant, DWA Energy Limited; Mehdi Mokhtari, PhD, Assistant Professor, University of Louisiana at Lafayette; Saeed Salehi, PhD, Assistant Professor, University of Oklahoma

Abstract

Volatile markets and harsh locations and downhole conditions pose severe challenges for ensuring safe and long-lasting intact well conditions. Well integrity is a crucial issue in the life cycle of all sub-surface boreholes. Failure of wellbore integrity leads not only to negative financial consequences, but also potentially to significant environmental impacts, such as groundwater contamination, gas leakage to the atmosphere, and fluid spills and seepage at the surface. Many studies have specifically focused on well integrity issues related to particular types of conventional and unconventional oil and gas reservoirs. Specific types of wells and well operations (e.g., high pressure high temperature, enhanced oil and gas recovery, deepwater, water and gas injection, geothermal, and plugging and abandonment) pose their specific issues. To understand the barriers to well integrity, and what is required to sustain it, a holistic study encompassing a wide range of issues is highly required. From a practical point of view, there are several factors affecting well integrity issues which can be classified based on chemical, mechanical, and operational factors. The consequence of these well integrity issues is mainly the fluid migration over time within or escaping from the wells. Past studies reveal that well integrity barriers are highly impacted by cement carbonation and casing corrosion processes, fluid migration, in-situ conditions, cement and casing mechanical properties.

Cement is the main physical barrier able to seal fluid flow into unintended zones from the wellbore. The sealing efficiency of cement is highly dependent on in-situ environment conditions and cement chemical compositions, influencing the time-dependent stress geometry in the vicinity of wellbores. Casing corrosion is another challenging issue which is often unavoidable due to acidic environments imposed mainly by CO_2 and H_2S “sour” gasses. Modern studies have also shown the importance of cement fatigue degradation.

Pressure regulation during production and temperature variation are the most common influencing variables impacting the mechanical aspects of well integrity. These variables induce extra stresses on the established barriers which can initiate and/or promote fluid migration. In addition, to chemical and mechanical aspects of well integrity, operational interventions can play crucial roles in improving well integrity. This aspect contributes to establishing zonal isolation, not limited to, but specific requirements of plugging and abandonment operations.

Continuous evaluation and monitoring using different logging techniques and tests during drilling, completion, and production are required to address the issues that compromise the robustness of the well integrity. Nuances of the interpretation of multiple well logs must be understood in order to effectively respond to the potentially damaging situation, without risking the amplification of negative downhole conditions. Well integrity compensatory factors such as