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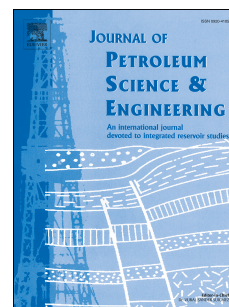
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Effects of Magnesium Oxide on Carbonic Acid Resistance of Oil Well Cement

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Abstract

This paper presents the results of an experimental study on the effects of magnesium oxide additive on the performance of oil well cement under a high-pressure high-temperature (HPHT) carbonic acid environment. Magnesium oxide (MgO) is a well-known expanding agent that improves sealing performance of cement. However, the performance of MgO-based cement has not been tested in a carbonic acid environment. Therefore, to investigate the impact of MgO on carbonic acid resistance of cement, two cement slurry formulations: Class H cement with 35% silica (baseline or HS) and baseline cement with MgO (HSMG) were compared after exposure to an acidic environment. To evaluate their performance, cylindrical cores and shear bond strengths (SBS) samples were prepared and aged in HPHT autoclave containing brine (2% sodium chloride solution) saturated with mixed gas containing CH₄ and CO₂. Six aging tests were conducted varying CO₂ concentration, temperature, and pressure. After aging for 14 days at constant pressure and temperature, the samples were recovered, and their physical (bond and compressive strength, porosity and permeability) and mineralogical composition were measured and compared with those of unaged samples. The results suggest that addition of 5% MgO reduces the carbonation of cement and could potentially prolong the operational life of cement by protecting its binding components (calcium hydroxide and calcium silicate hydrate).

Keywords

Oil well Cement, Magnesium oxide, Carbonation, Degradation, Expansion, Porosity

1. Introduction

Cement is extensively utilized in various industrial applications. In the petroleum industry, it is applied in well construction applications. Cement is mainly required to support steel casings and seal the annular space between the casings and wellbore. As a result, it isolates different formations from one another and the surface. Cement also protects casing from corrosion. Zonal isolation is maintained by preserving the original sealing performance of cement. Porosity, permeability, and SBS are properties that have major impact on its sealing performance. Cement degradation can be caused by mechanical or chemical process or both. Mechanical degradation happens due to excessive loads resulting from casing ballooning, thermal expansion and volume change during hydration. In addition to mechanical deterioration (reduction of compressive strength and SBS), cement is prone to chemical attack. Cement exposed to acidic fluids undergoes a combination of physicochemical reactions. Depending on the composition of the surrounding fluid, various level of cement degradation can occur. The degradation often substantially changes the sealing and structural performance of cement.

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