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An Assessment of the Permoporosity of Composite Cement-Silica-Polymer Oilwell Slurries

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Abstract – A large variety of natural and chemical admixtures is currently available to adapt conventional Portland cement to adverse oilwell applications, where safety and long-term reliability are required. In the present study, composite cementing slurries were prepared using Portland cement, polyurethane and silica aiming at reducing the porosity and permeability of the cement sheaths of gas-producing oilwells. Additionally, the permoporosity of composite slurries was also evaluated. The results revealed that the combination silica-polymer reduced the permeability of the material compared to conventional Portland slurries. Moreover, the permeability of the slurries is inversely proportional to the concentration of silica in the formulation.

Portland-based cement slurries are pumped into the sheath of oil and gas wells to isolate their producing zones [1]. Oil wells are submitted to high-temperatures especially during steam injection. This technique is widely used to improve the production of heavy oils by lowering their high viscosity and therefore, increasing its flowing behavior. However, the injection of steam imposes thermal cycles and severe stress concentrations to the inherently brittle cement sheath. Different admixtures can be used to adapt conventional Portland to adverse oilwell applications, where safety and long-term reliability are required. In particular, polymeric solutions are known to improve toughness and reduce gas permeability of hardened slurries [2]. Silica can be used to prevent cement retrogression caused by high-temperature exposure and also reduce gas permeability. The addition of 5 wt.% silica can reduce as much as 100 times the permeability of the slurries to the flow of gas [3].

The scope of the present study was to evaluate the effect of the simultaneous addition of silica and polyurethane on the permeability of Portland-based cement slurries for oil and gas well applications. Samples were cured in thermostatic bath during 7 days at 47 ^{o}C and subsequently oven dried during 24 h at 100 ºC. Permeability and porosity measurements were carried out using a Core Lab Ultra Perm 500 permeabilimeter and a He-operated Core Lab Ultra Pore 300, respectively.

The results showed that both the porosity and permeability of the composite slurries decreased with increasing the concentration of silica. Silica reacted with calcium hydroxide to form small particles of crystalline C-S-H that improved the compaction of the material by filling the pores present in the hardened composite slurries. As the capillary pores of the material reduced both in number and diameter, the composite slurries depicted lower gas migration, thus resulting in environmentally safer and improved compositions for oil and gas well applications.

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