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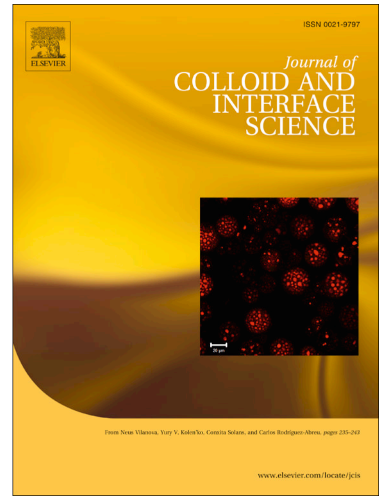

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Synthesis, characterization and working mechanism of a novel sustained-release-type fluid loss additive for seawater cement slurry

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ABSTRACT: Synthetic polymer fluid loss additive (FLA), an important type of admixture, was broadly applied in modern well cementation. However, the filter loss volume and fluidity of cement pastes containing polymer-FLA would deteriorate remarkably when sea water was used in mixing slurries instead of fresh water. In this study, a novel sustained-release-type fluid loss additive(S-FLA) was synthesized by means of anion-exchange intercalation reaction between an anionic type-copolymer and a calcium/aluminum type-Layered Double Hydroxide (Ca/Al-LDH). Based on the fluidity and compressive strength of experiments, it was found that in seawater mixing conditions, this composite material not only utilized its sustained release effect to significantly improve retention fluidity performance, but also the seed crystal effect of the Ca/Al-LDH effectively alleviated the declining in compressive strength of the slurries caused by the carboxyl group in the polymer. More interestingly, the realization of the slow release function increased actual adsorption capacity of the anionic polymer on the surface of cement hydrated particles, which made its controlling water loss effect was also better than that of the conventional FLA. The above advantages of this hybrid materials created the possibility to surmount the negative effect of electrolytes present in seawater, so as to provide some useful references for its practical application in the offshore well cement.

Keywords: Fluid loss additive; Sustained-release; Anion-exchange intercalation reaction; Seed crystal effect; Adsorption capacity; Offshore well cement

1. Introduction

As a kind of fluid loss additive(FLA), the synthetic copolymer is widely used in the field of cementing well. Their main working mechanism is based on adsorption of FLAs on the surface of hydrating cement particles and the formation of a complex network structure between polymers, which can enhance the compactness of the filter cake, resulting in decline of cement slurry filtrate [1,2]. Therefore, FLA is indispensable to produce high-performance cement such as low filtration and self-compacting properties. However, with a decline in easily extractable oilfields, most of oil firms move their wells from the land to offshore and even deep ocean locations. The reservoir fluids in these areas normally contain plenty of electrolytes including sodium, potassium, magnesium and calcium salt. The existence of these metal ions seriously affects the rheological property of the cement slurry, usually results in forming a large number of agglomerated cement particles, which perturbs the effectiveness of most conventional polymer-FLA [3-5].

Generally speaking, to make sure the FLA has excellent abilities in controlling water loss, salt tolerance and rheological property, the structure of polymer generally contains carboxyl, sulfonic acid and long side chain groups [6-10]. Even though such FLA still have two distinct drawbacks: Firstly, the introduction of carboxyl group has a negative effect on the development of the early strength of cement with the increase of adsorption amount; Another problem is that although the long side chain group in the copolymer has been well adjusted for the initial rheological property of cement paste, the fluidity of the slurry gradually deteriorates with the consumption of the admixture.

To counter the problems above, the incorporation of polyanionic admixture guest molecules into Ca/Al-layered double hydroxides-like (LDHs) materials has received considerable attention in recent years [11-13]. That is partly because LDHs as a group of anionic clays possess a high capacity of anion exchange. On the basis of this mechanism, polyanionic admixtures can intercalate into the interlayer of LDHs as well as inorganic anions and form a slow