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Recent advances and prospects on retarder application in oilwell cement: A review

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ABSTRACT

Retarders are used to prevent hydration of oilwell cement by prolonging thickening and setting time for cement slurry application under deep and high-temperature conditions. However, at higher temperature, abnormal gelation and thickening time reversal occur. Hence, an adequate understanding of the factors influencing retarders mechanisms is required for effective application in deep oilwells. Therefore, this review presents vital information on the formulation, mechanism, and factors influencing the application of retarders in oilwell cementing. Herein, the formulation methods were discussed. Thereafter, the different types of retarders and their corresponding mechanisms were pinpointed. Similarly, the factors influencing these mechanisms were revealed. Moreover, the application of retarders in oilwell cementing was reviewed. Finally, the challenges prevalent during the application of retarders in oilwell cementing have unlocked new prospects for research with proffered solutions. Experimental results indicate that the concentration of a retarder is related to the setting time of the cement. Likewise, the consistency of the cement slurry should be less than 30 Bc to ensure that it can be pumped into oilwell. Hence, to achieve a very low consistency, the retarder should be added after the cement past has been prepared rather than premixing with cement (dry blending). But for high-temperature reservoirs (>150 °C), it is advisable to use multiple retarders.

1. Introduction

The success of all oil well completion operations depend on good cement (Biernacki et al., 2017; Brufatto et al., 2003). Oilwell cement is used as a mechanical support for casing string to restrict fluid movement between permeable zones, protect the casing from corrosion by sulfate-rich formation waters, and support wellbore walls to prevent the collapse of formations (Guo et al., 2019). However, with the increase in energy demand coupled with improved drilling technology, there's a significant rise in drilling deep and ultra-deep oil wells (Blkoor et al., 2022; Davoodi et al., 2024; Ismail et al., 2020; Oseh et al., 2020). Deeper wells result in longer sealing intervals with cement slurry, posing significant challenges to cementing operations (Gaurina-Međimurec et al., 2021; Guo et al., 2016). Hence, retarders are needed to increase the thickening time (Chen et al., 2021; Qi et al., 2022; Zhang et al., 2021; Zihan et al., 2021). Retardants are known to attach to calcium ions and can prevent the formation of ettringite crystals (Aspiotis et al., 2021; Chen et al., 2021). Likewise, retarders can influence viscosity and extend pumping time (Broni-Bediako et al., 2016; Mohan et al., 2021). The use of retarders does not diminish the cement's compressive strength. However, the concentration and curing conditions are factors that affect the degree of retardation (Broni-Bediako et al., 2016; Huang et al., 2020). Therefore, it is essential to accurately forecast the bottom hole circulation temperature (BHCT) to apply the proper retarder concentration and prevent flash setting or a lengthy set-up time caused by an overly retarded cement slurry (Bett, 2017). Jinhua et al. (2023) investigated the effects of poly-AAMD® retarder on the stability, thickening time, compressive strength, and rheological properties of oilwell cement. They reported that the thickening time of cement slurry with 1.2 and 1.5 wt% retarder was 312 and 316 min at 220 °C, the

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