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Silica Enhanced high temperature oil well cement systems based on particle packing theory

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As the oil and gas exploration moves towards deep wells and ultra-deep wells, the operators are increasingly demanding high temperature stability of the cement. This presentation mainly focuses on investigating the high temperature strength stability of set cement. Oil well cement systems suitable for high temperature applications were produced by adding silica admixtures with different particle sizes, whose dosages were optimized based on particle packing theory. Set cement samples cured under high temperature and high-pressure environment at 200°C and 50MPa for different durations of 7, 14 and 30 days were prepared and analyzed. The engineering properties of different formulations were evaluated based on standard API testing methods, such as thickening time, fluid loss, sedimentation stability, compressive strength and permeability etc. Additionally, continuous ultrasonic strength testing and XRD phase analysis were conducted to study the cement strength evolution as a function of time and the mechanism of strength retrogression under high temperature and high-pressure conditions. Test results indicate that the addition of fine silica particles such as silica fume helps to improve particle packing of the cement mixture and thereby improve engineering properties of the formation such as fluid loss and strength stability. Research outcome from this paper may help provide scientific ground for improving cementing quality in deep wells, ultra-deep wells and other complex conditions and achieving long-term zonal isolation in oil and gas wells.

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