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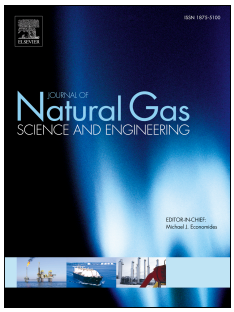

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Thermal Wellbore Strengthening through Managed Temperature Drilling – Part II: Chemical System Design and Laboratory Testing

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Abstract

This paper is the second part of a two-part series introducing a new and innovative managed temperature drilling technique for thermal wellbore strengthening of challenging oil and gas wells. It describes the development of heat-releasing ("exothermic") coated particles designed to release heat at exactly the right circulating time to increase near-wellbore formation temperature and thermal stress in potential lost circulation zones, such as depleted reservoir zones in deepwater wells. The increase in thermal stress directly elevates the near-wellbore tangential stress, which translates into an increase in the effective fracture gradient. This may lower the risk of lost circulation, and also improve the chance of successfully cementing casing and achieving zonal isolation. In the latter application, a treatment can be executed as an integral part of the cement job by using it in an extended spacer train for mud displacement, pumped directly prior to cement placement to thermally strengthen a formation.

The coated exothermic particles, which were based on the hygroscopic calcium and magnesium salts with chlorine and bromine, were designed such that they could release their "payload" via an extended time-release mechanism, to ensure that the heat release reaches the appropriate target location in the wellbore at exactly the right time. The chemical candidate systems were found to effectively heat up the wellbore and increase temperature up to 90^{o}C. This, in turn, will elevate the fracture gradient by several hundred psi, depending on formation properties. The particles need to be transported to the target formation and their reaction products need to be carried away from the target formation by a suitable carrier fluid that can handle the exothermic dissolution of a large amount of salt without any instability. Details regarding the formulation and testing of non-coated and coated particles and their carrier fluid are discussed here, as well as considerations for field application of thermal wellbore strengthening. The developed managed temperature drilling technique, enabled by the chemical system described here, can be used to minimize lost circulation events and associated well trouble time and cost during drilling, cementing and completion operations.

Keywords: Thermal Wellbore Strengthening, Managed Temperature Drilling, Exothermic Chemical Reaction, Near-Wellbore Heating, Thermal Stress, Delayed Activation Mechanism, Lost Circulation Prevention, Narrow Drilling Margin, Deepwater Wells