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Application of Polyglycolic Acid to Self-Degradable Downhole Tools

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The time and cost for a well completion has increased in association with growth of stage count of hydraulic fracturing. To eliminate time consuming milling-out process of downhole tools for multi-stage fracturing after use, degradable tools are increasingly used; however, their usage is still limited because of their narrow applicable range against various well conditions. Expanding the range of the degradable tools is greatly demanded to save the time and cost for the well completion.

Polyglycolic acid (PGA) is a hydrolyzable and biodegradable polyester that offers high mechanical strength. We have established an industrial manufacturing technology for high-molecular-weight PGA and have begun commercial production of the material. Based on the characteristics of PGA, we have also developed the use of PGA in gas and oil field. PGA is a material suitable for components of degradable downhole tools and has already been used in some applications including frac balls. However, in low-temperature wells close to the glass transition temperature of PGA, there are problems with tool breakage during installation or stimulation because of the changes in the mechanical properties of PGA at low temperatures. In addition, the prolonged isolation periods due to slower than desirable degradation rates at low temperature may be considered as a potential risk.

This paper focuses on the improvements of impact strength and also the acceleration of degradation of PGA. A study of modifiers identified the additives that are highly compatible with PGA. Morphological studies of mixtures showed finely dispersed additive domains within a PGA matrix and the impact strength of the mixture was twice as high as that of neat PGA. Also, we found an acidic additive which can accelerate the degradation rate of PGA through a comprehensive study. The average degradation rate and lag time for initiating degradation at low temperatures were accelerated by a factor of several times. These techniques will open the way to apply PGA downhole tools to the multi-stage fracturing at low temperatures, and will contribute to the time and cost saving for the well completion.

Keywords: PGA, downhole tool, fracturing, impact strength, degradation