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Different Methods To Avoid Annular Pressure Buildup by Appropriate Engineered Sealant and Applying Best Practices (Cementing and Drilling)

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Abstract

Many wells that have been successfully cemented initially are showing annulus pressure buildup due to damaged cement sheath integrity by post-cementing operations/conditions. This has been a concern by many operators where wellbores may be exposed to severe conditions and/or production regimes over a period of time. Sometimes this problem can be temporarily dealt with by releasing the annulus pressure, if environmental conditions and well type will allow. However, this method of annular gas production relief is not a long-term solution to the problem. In addition, it is not always possible to reduce the annulus pressure by releasing the trapped pressure into the environment on a regular basis, even if all other conditions permit this operation. An engineered cement slurry system can save the operator from facing this situation by applying a lifetime zonal isolation remedy through the proper cement job design.

Gas injection in specific areas in the United Arab Emirates is performed to help maximize the production from these development fields. This paper will discuss the process of engineering a cementing system for these gas injection wells and the development of a solution that has successfully protected wellbores in gas injection areas where high pressures are applied to the wellbore. By treating the cement under defined wellbore conditions and studying the mechanical behavior of the cement sheath, it was possible to design a cement slurry system that could withstand the high pressures applied through gas injection operations. The mechanical behavior was evaluated using three-dimensional finite element analysis that considers mechanical properties such as Young's modulus, Poisson's ratio, and tensile strength in addition to confined compressive strength. The importance of complete zonal isolation is of high order. Elastic cement designs have provided a resilient nonfoamed, or conventional,

system that successfully isolated the wellbores for more than a dozen gas injection wells.

Introduction

The long-term integrity of a cement sheath essentially indicates how well the sheath withstands (1) changes in temperature, (2) changes in pressure, (3) toleration of mechanical shocks as drilling continues or when certain other secondary drilling operations are conducted, and (4) possible repetitive loading and unloading of the well over time. Cement sheath integrity is influenced by the effectiveness of the slurry placement in the annulus and the effectiveness of the slurry as it goes through the hydration process as well as the long-term compressive strength/yield strength of a cement system.

In many cases, wells that were successfully cemented initially utilizing cementing best practices (Crook 1999) eventually begin to show annulus pressure buildup caused by damage to the cement sheath integrity from post-cementing operations or conditions. It is also important to note that even if the cementing operation is performed satisfactorily, it is still possible for formation fluid/gas to move into the unset cement column. This fluid or gas flow potential is an event that can be easily dealt with in advance stages of the cement job design (Benge 1996). This often occurs when wellbores have been exposed to severe conditions over time. These conditions could occur shortly after the cementing operation or they may occur over an extended period. Environmental concerns and regulatory directives limit releasing the annulus pressure into the atmosphere as a long-term solution. Additionally, it is not always possible to reduce the annulus pressure by releasing the trapped pressure into the environment. Offshore wells with subsea wellheads (commonly used in deeper water operations) do not provide access for pressure relief. An engineered cement slurry system with the appropriate mechanical properties can prevent this situation.

In more than a dozen gas injection wells in the United Arab Emirates (UAE), where complete zonal isolation is essential, elastic cement designs are providing a resilient nonfoamed (conventional) system that is succeeding in isolating the wells subjected to high pressures. This paper will discuss the process of engineering the cementing system for these gas injection wells in the UAE and the development of a solution that has successfully protected wellbores in gas injection areas. By treating the cement under defined wellbore conditions and studying the mechanical behavior of the cement sheath, it was possible to design a resilient cement