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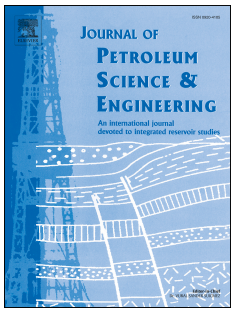

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ACCEPTED MANUSCRIPT

Influence of the Initial Loaded State on the Stress Distribution of a Wellbore System

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Abstract: Designing and maintaining the long-term integrity of an entire wellbore system is important to all its operations and to prolonging the service life of the oil and gas well. Some analytical finite-element mechanical models have been built to calculate the stress distribution of the wellbore system, but most models ignored its loading history and took no account of its initial loaded state. Due the shrinkage effect, nonexpandable cement systems likely induce tensile radial stresses on the cementing faces and aggravated cement-sheath failures, yet due to the expansion effect, expandable cement systems likely produced compressive radial stresses on the cementing faces and repressed cement-sheath failures. Now, more and more researchers have realized the importance to consider the initial loaded state. Some researcher have presented multistage methods to simulate the overall process before drilling, during drilling, and after drilling. However, because it is more complex and difficult to simulate the cement solidifying stage, some researchers tried to skip the simulation of cement solidifying process. To simplify the multistage method reasonably and accommodate the importance of the initial loaded state, we propose a new analytical mechanical model with a vertical wellbore and isotropic horizontal in-situ stresses. The model is derived according to the elastic mechanics theory, which can consider the loading history of the entire wellbore system and take account of its initial loaded state. The influences on stress distribution due to the initial state are discussed using a real-life example. We determined that considering the initial loaded state can cause substantial differences in the estimated stress distribution of the entire wellbore system. Taking the initial loaded state into account is essential for accurate design and examination of wellbore integrity.

Keywords: analytical mechanical model; cement-sheath; initial loaded state; living example; stress distribution; wellbore integrity

1 Introduction

In the life of an oil and gas well, maintaining the long-term integrity of the entire wellbore system, comprising the casing unit, the cement-sheath unit, and the near-wellbore formation unit, is important to all operations and to prolonging the service life of the well.

Some researchers have built classic analytical or finite-element mechanical models to calculate the stress distribution of the wellbore system due to downhole pressure variations, temperature variations, or both, and then design and maintain the long-term integrity of the

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