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Modeling of Expandable Slotted Tubulars

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Abstract

Advanced technologies are implemented for successful completion of wells and have become paramount objective especially in high-risk, high-cost environments, such as ultra-deep water extended reach wells. Challenges are associated not only with complex well architecture but also completing the wells successfully using slotted tubulars, slotted liners and etc. Expandable slotted tubulars have been found to improve well production, reduce sand production and thereby reduce well costs compared with conventional approaches to sand control. While performing these completion operations the maximum running hook loads and static drag encountered during pre and post expansion process are indispensable for making appropriate well-completion decisions. Comparatively little research or modeling has been done to estimate these operating parameters. Traditionally, operating parameters such as torque and drag are estimated using the traditional torque and drag calculations with adjusted friction factors. This will result in under estimation of the values and pose problem in successfully completing the zone. Unduly conservative design or under estimation may pose poor result and lead to undesirable increase in the well cost and may be significant in challenging wells. To avoid this, a simple mathematical model has been developed and presented in this paper. Several simulations were carried out with synthetic as well actual data and have been found that the model prediction is very good as compared to the actual data. This paper documents the comparison between the predicted mathematical simulation results with the actual data.

Introduction

During the process of oil production, a large amount of sand can be produced with crude oil. It will require additional processing on the surface for separation, in addition leaving empty pore spaces in the producing reservoir that will result more troubles for the follow-up jobs. Ultimately the sand production may result in casing failure. Expandable slotted tubulars or expandable slotted liners/casings have been designed to help reduce sand production and they show excellent results in practice. Few papers have been published on the selection of the optimum slot size and types. Makestad *et al.*(1996)[1] presented a numerical model based on the fractal method to estimate the critical slot width for the reservoir conditions expected. Kaiser *et al.*(2000)[2] studied the optimized slot selection based on the inflow analysis and skin factor and suggested an expression for the calculation. There are few studies on the mechanical properties of the slotted liners also. Dall'Acqua *et al.* (2005)[3] presented a study on the thermal effects on the post yield properties and slot configuration of the slotted tubulars. Abbassian *et al.* (1998)[4] described a simple method of evaluating the collapse strength and post-collapse behavior of the slotted pipes subjected to external pressure. They also presented a simple analytical solution for the collapse reduction. Other studies (Roque *et al*, Stewart *et al,* Mehta *et al,* Hara *et al,* Avitzur)[5-9]brought new insights to the properties and material degradation of the slotted tubulars after expansion. At the very beginning, after the tubulars are being placed into wells, the estimation of axial tensions during expansion process and contraction when retrieving the tubulars are very much required (Li *et al*) (2002)[10,11].

There has been little research done to estimate and analyze the optimized slot size based on the pre and post expansion deformation. This work aims at characterizing the process effectively. The present study presents the calculation of the expanding screen analysis of the expansion and unloading process. To reduce the laboratory work and optimize parameters of expandable slotted tubulars, this theoretical work has been carried out. The objectives are to describe post-expansion deformation, build an analytical model to calculate axial tensions while initiating expansion process and unloading process, with important intervening parameters of the expandable slotted tubulars. The methodology enables completion engineers to estimate the risk of occurrence of problems not only during well planning procedure but also during completions process.

Deformation of the Expandable Slotted Tubulars

The mathematical model developed for the expansion and contraction process is based on flexural deformation principle (Roque *et al*, Stewart *et al*)[7,8]. This paper describes a simple method of evaluating the pre axial force to initiate expansion process, post-expansion deformation and unloading process based on the established expansion process with expansion cones. Principal component analysis presented includes the