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Towards a Novel Approach to Consider Casing Wear in Well Designs

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Abstract

This paper deals with an in-depth evaluation of the collapse pressure of a worn pipe (due to the casing wear) using a reliability-based approach (based on a 2D finite element analysis) combined with physical tests. In addition, a novel approach to evaluate the performances of a worn connection is proposed combining 3D FEA and physical tests.

The first step is to determine the maximum wear, due to the contact forces between the drillstring and the inner wall of the pipe while drilling. A stiff-string torque and drag model with contact management allows a very accurate estimation of these forces at each step of the well construction process, and the cumulative mechanical work is calculated at each cross section of the well. A wear model is then applied: the induced 3D wear is calculated, and a predicted maximum wear profile is obtained.

This maximum wear is incorporated in the pipe collapse reduction factor evaluation (referred to as CRF) and in the worn connection evaluation envelope (referred to as worn CEE) assessment. For the pipe, a 2D model has been developed. This model is fully parametric, and a variety of parameters can be changed such as: the ovality, the eccentricity, the pipe OD/t ratio, the tool joint diameter, the position of the wear groove, etc. A large DoE has been launched to evaluate the CRF of each individual pipe. This cloud of points allows for determining an equation to give a CRF in function of the casing wear level. This equation integrates the scattering that will be found in the reality considering a pipe population. Some physical tests were performed to cross-check with the equation. The equation shows a less severe CRF than the one computed with the API uniform wear model. For the connection, a 3D FEA model including the casing wear groove is created to evaluate the local stress gradient in the groove. The connection studied is a VAM® SLIJ-II. In addition, some physical tests (based on the API RP 5C5:2017) were performed to check the remaining performances of the connection and to correlate with the FEA. Through the test, the VAM® SLIJ-II 14" 115.00# 125ksi has demonstrated that the initial CEE was maintained during multiple rounds of a Series A with both 5% and 10% wear.

The litterature is centered on the casing wear of pipes comparing the API uniform wear model to other approaches such as analytical formulation or finite element analysis. In this paper, a casing wear profile is estimated with a stiff string model, and the CRF for the pipe is calculated thanks to a reliability-based approach. The important novelty is the assessment of a worn CEE on the VAM® SLIJ-II using a 3D FEA model and some tests.