Evaluating Connection Performance in Multifractured Horizontal Wells

API RECOMMENDED PRACTICE 5SF
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Introduction

The well designs and completion strategies associated with hydraulic fracturing have a unique set of challenges. During well construction, the long lateral sections of extended-reach wells may require the production or intermediate casing to be rotated and pushed through build sections of relatively high curvature (i.e., greater than 10°/30 m [10°/100 ft]). Furthermore, some operators rotate the casing during cementing to improve cement placement quality. This rotation may subject the connections in the build section to a high number of rotating/bending load cycles, and the high stresses associated with these cycles could lead to localized yielding of the material, loss of sealability, or potential structural failure. The hydraulic fracturing process itself subjects the casing to rapid increases in pressure (and potentially significant changes in temperature); consequently, wells with multiple stimulation stages will be subjected to cyclic pressure-loading. Given these considerations, connections used in hydraulically fractured wells may be subjected to significant and varied loads, and this loading may have an impact on the overall connection-sealing integrity and structural capacity later in the service life of the well when the combined pressure, temperature, and axial loads during production are acting on these connections.

API 5C5 outlines a process for experimentally validating a connection performance envelope. While this standard addresses galling resistance, sealability, and structural integrity, the primary focus is validating the sealability performance of a connection under various combinations of pressure, axial force, and temperature.

The primary focus of this standard is to evaluate connection performance under the structural loads that typically occur in multifractured horizontal wells (MFHW). This standard may be used in conjunction with API 5C5 to subject the connection to structural loading before subsequent sealability evaluation.

This standard will provide a means to evaluate connection performance under a consistent method of discrete test program elements developed to replicate the cyclic, rotating/bending loads of well construction and the pressure cycling of multistage hydraulic fracturing. This standard will not follow a prescriptive approach but rather allow the evaluator to customize a test program from the test program elements that are most representative of the well application. While evaluators following the guidelines of this standard should employ sound engineering judgment when devising test programs, it is ultimately the responsibility of the end user to determine the level of applicability of a given test program to the design loads of interest.

Evaluating Connection Performance in Multifractured Horizontal Wells

1 Scope

This standard defines tests that may be used to determine the performance of threaded casing or tubing connections for use in multifractured horizontal wells (MFHW). This standard defines experimental loading conditions intended to simulate the various stages of MFHW construction and use—installation of casings, stimulation of surrounding formation, and production of hydrocarbons. Dynamic effects from such factors as thermal shock, vibration during running/rotating, and hydraulics are beyond the scope of this standard.

This standard does not address erosion or metallurgical impacts such as corrosion or hydrogen embrittlement. This standard also does not establish a singular testing program or acceptability criteria. Not all the test program elements (TPEs) presented in this standard may apply to all MFHWs; consequently, this standard provides flexibility in tailoring a testing program for the specific, anticipated field loads of a given well (or group of wells). End users are ultimately responsible for determining whether an evaluation program assembled from the TPEs presented in this standard is appropriate for a given set of field conditions. This determination will likely be based on historical practice, local regulatory requirements, and specific well conditions.

It should be noted that since the casing down which stimulation fluids are pumped is typically casing in MFHWs, this standard will henceforth only use the term “casing” instead of “casing or tubing”. This nomenclature is solely for the sake of convenience and concision; the testing protocols in this standard are equally applicable to casing and tubing connections.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API Recommended Practice 5C5:2017, *Procedures for Testing Casing and Tubing Connections, Fourth Edition*

3 Terms, Definitions, Abbreviations, and Symbols

3.1 Terms and Definitions

For the purposes of this standard, the following terms and definitions apply.

3.1.1
connection
A tubular product, either threaded and coupled (T&C) or integral, that is tested according to this standard.

3.1.2
dogleg severity (DLS)
The amount of curvature built up in a casing string over a length interval, typically measured in degrees per 30 meters or degrees per 100 feet.

3.1.3
end user
The party who expects the connection to perform (an “end-user operator” is a party that has operations where the connection will be used in the field).

3.1.4
evaluator
The evaluator is the party creating and executing a test program following the guidelines of this standard. In some instances, the evaluator will be one entity (e.g., a connection supplier selecting the TPEs and executing