Successful Development of Coiled-Tubing Connectors Using Virtual Testing

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Abstract: Since its introduction in the 1960s, coiled tubing (CT) has evolved from smaller sizes and a few cleanout jobs to larger diameters and heavier grades with higher flow rates. Some of the limiting factors, especially on offshore platforms, are limited crane-weight capability and poor weather conditions, which severely limit the size of the reel that can be lifted. With offshore crane capabilities as low as eight tons on some platforms, a CT reel is often transported in two or more sections, requiring offshore assembly. A conventional method of joining the two strings was to butt weld them, which reduces fatigue life to 35%. Most recently, spoolable connectors, also called cold connections, have gained popularity because of their easy and safe installation. A nonlinear, FEA-based, virtual-test method was developed to quickly and cost effectively design spoolable connectors. Using the virtual test extensively in the development of the spoolable CT connectors, and guided by engineering mechanics principles, we have successfully developed a CT connector tool that exceeds the fatigue life of field butt weld. This CT connector tool has an industry-leading fatigue life and requires a fraction of the developmental cost and time that the conventional procedure of using trial-and-error physical tests requires. The virtual test, selected virtual- test results, physical results from a fatigue machine test, and a full-scale yard test are discussed in this paper.

Keywords: coiled tubing, connector, fatigue, virtual testing

1. Introduction

As the offshore industry accesses deeper reserves, the CT workstrings required for intervention operations have become longer and heavier. By far, the largest and heaviest component of a CT unit is the CT itself and the reel on which it is handled. In offshore applications, weight handling limitations presents a big challenge because many platforms were not designed to lift the heavy CT reels off the workboats and onto the platform. Because of this, CT must be placed on multiple reels before being transported to a worksite. The CT workstring must be assembled before a job is initiated Joining the CT sections together into a continuous string is a major design challenge. Until recently, the preferred method has been to connect the CT sections by butt welding the ends of the CT; however, this can be an expensive and time-consuming proposition. First, welding specialists are required to complete the operation and, in most situations, a special work permit is required and a discrete area on the rig must be used. Second, in many instances, the well(s) must be shut in for the duration of the welding job for safety reasons. Finally, the welds have to be x-rayed by other specialists with more equipment. Because of these factors, development of a spoolable, mechanical, CT connector is of great interest