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Analysis of Thread Engagement Requirements for Studs and Nuts

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Summary

This paper addresses the issue of fastener systems (studs and nuts) lacking full thread engagement. Various industry standards, including API 6A, *Specification for Wellhead and Christmas Tree Equipment*, indicates studs should have thread engagement equal to the stud diameter to preserve design stud tensile strength. This is commonly accomplished by selection of a nut with height equal to the stud diameter and specifying several stud threads should protrude above the nut once assembled. Studs may be discovered not made up to this standard and the decision to continue operation versus conducting remediation activities needs to be evaluated.

The ANSI and SAE literature provide equations relating to thread shear capacity and stud tensile strength. This allows calculation of the amount of lack of thread engagement (“shortfall”) allowed before the stud-nut thread shear strength falls below the tensile strength of the stud and fastener system strength begins to decrease. We defined shortfall as the distance the end of the stud is below the side of the nut. These equations indicate full stud tensile strength is retained up to a thread shortfall of approximately 0.27 inch (~2 threads) for 1.25 inch grade L7 studs. To validate these equations, a pull test of 1.25 inch studs was conducted. This pull test validated the predicted values given by the equations. Allowable shortfall was then calculated for other common oilfield stud sizes and a field inspection practice was adopted requiring two or more stud threads be exposed above nut face, but allowing up to 0.25 inch shortfall on existing installations. Remediation activities are conducted on fastener systems with greater than 0.25 inch stud shortfall.

Discussion

The issue of nut thread engagement surfaced when a well was reported with partially engaged threads in the nuts attaching the master valve to the tubing head adaptor. Two to three threads were not engaged on each nut. The tubing had been recently replaced, and a review of the tree installation procedure indicated an RX style ring was installed where an R ring gasket had previously been used. The RX ring gasket is 0.30 inch thicker than the R ring gasket, resulting in the nuts not being fully threaded. A decision was made to remove the tree and install longer studs to accommodate the thicker RX-style ring gasket. Figures 1 and 2 show before and after pictures of the master valve-tubing head adaptor connection. A subsequent field equipment inventory identified a number of wells with at least one stud bolt in a flange on the tree or wellhead assembly having less than 100% thread engagement.

Various codes and standards regarding fastener systems are not explicit regarding how far a stud should extend through a nut, but they imply that there should be full-depth thread engagement for a distance equal to the stud diameter. API 6A, TR9501 and ASME B18.2.2 indicate thread engagement of a stud bolt should be equal to its diameter. This is achieved through the use of heavy hex head nuts. However, taking into account manufacturing tolerances for the nuts and the nuts’ internal chamfer, the resulting thread engagement in the nut is only about 7/8 of the stud bolt diameter. A standard field practice is to require at least one full thread on the stud extend past the side of the nut. The purpose of this requirement is to eliminate the variables associated with the unthreaded point on the stud, which may be as much as 1/4-inch, and the possibility that the first thread is not a full depth thread.