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Controlled residual stresses introduction to improve fatigue resistance of rotary shouldered connections used in oil drilling industry

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Abstract – With the aim of increasing the fatigue strength of rotary shouldered connections, an innovative technique is proposed. The objective is to generate controlled compressive residual stresses at the most stressed zones (i.e. the threat root areas), to delay fatigue crack nucleation. The residual stresses are generated through adequate application of the make-up torque of the joint. Two different testing programs were performed to show the suitability of the proposed method. Tests result showed that significant increases can be achieved in the fatigue life of joints applying this technique.

In the oil industry, threaded connections are one of the most critical components of the drillstring because they present more stiffness, and also because the threads roots act as stress concentrators [1]. As a consequence, a great number of failures in drilling operations take place in the threaded connections. The type of failure usually observed is the loss of integrity or twist-off, due to nucleation and grow of fatigue cracks [2]. These failures are difficult to predict and produce several economic damage.

Residual stress effect on fatigue is well-known, although interest has recently increased, especially to use them to increase life in fasteners [3]. In thread joints, cold rolling is a method widely used to increase the fatigue strength introducing residual stresses in the thread root and delaying the nucleation of fatigue cracks. The method presents the disadvantage that it can be used in medium to large diameters [4].

An innovative method to generate controlled residual stresses is proposed in this paper. Using an appropriate over torque, localized plastic strains at the thread root are induced (i.e. the highest stressed zone). When the applied torque is reduced to its nominal value, the surrounding elastic strain will tend to relax introducing compressive stresses in the plastically deformed zone.

Two different testing programs were performed to show the suitability of the proposed method. The aim of the first was to introduce residual stresses in specimens capable to represent the geometries of interest. The aim of te second experiment was to evaluate the introduction of residual stresses by means a proper control of the make-up torque. Tests results showed that significant increases were achieved in the fatigue life of the joints.

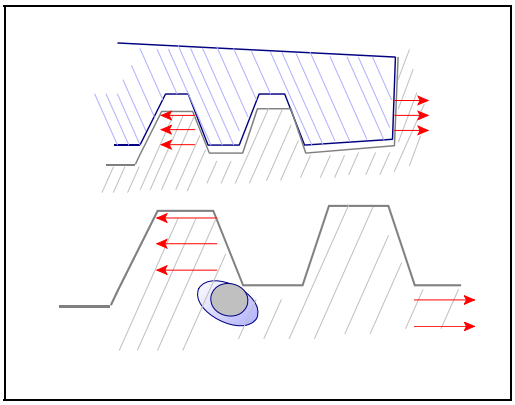

Figure 1: Residual stress scheme generation (gray zone: plastic strain, blue zone: elastic strain).

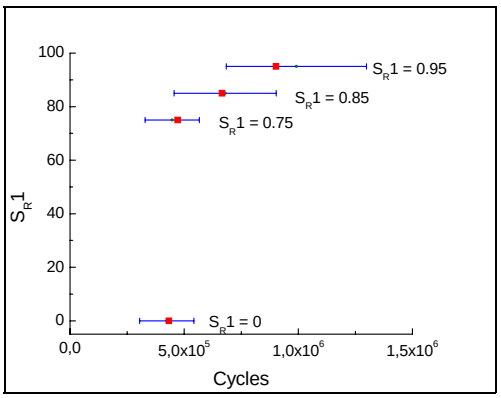

Figure 2: Fatigue life improvement. Sr1represents the over make-up torque respects to the nominal make-up torque

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