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VARIABLES AFFECTING NUT FACTORS FOR FIELD ASSEMBLED JOINTS

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ABSTRACT

A great deal of research has been done to determine how to ensure a reliable bolted flange connection. Using a proper bolt torque value during installation helps achieve this goal. Many of the variables used during the calculation of a bolt torque value are easily quantified, but the nut factor has yet to be accurately determined. This paper provides an overview of research recently completed to determine what the real world nut factor is in varying applications.

INTRODUCTION

In order to achieve a reliable seal of a bolted flange connection a proper bolt load must be applied to the gasket. This bolt load must be high enough to provide a seal, but low enough as not to cause the joint to fail. The bolt load applied has to be greater than the minimum stress required to seat the gasket. This minimum seating stress varies depending upon the gasket material. The proper amount of bolt load will overcome the separation force that will be created by the hydrostatic end force developed by internal pressure in the system. This will also provide the necessary clamping force to maintain the required gasket stress during thermal cycling and help compensate for any load loss due to relaxation. Therefore, it is imperative to be able to accurately determine the minimum bolt load for an assembled joint.

It is equally important to determine the maximum bolt load that should be applied. Based upon the grade of the bolt, it is possible to apply too much load and carry the bolt beyond its yield strength. Once a bolt has been yielded, it no longer provides the mechanical integrity needed to consistently maintain a seal. Special care must also be given as to not exceed the maximum gasket stress of the gasket material. As is the case with minimum gasket stresses, each gasketing material has a recommended maximum gasket stress that, when surpassed, will cause mechanical failure. This can be in the form of buckling in a spiral wound gasket or fracturing in an elastomer or PTFE based sheet gasket. Also, very high load levels can yield or otherwise damage the flange. Flange rotation and fracturing of plastic flanges can cause the gasket to prematurely fail. For these reasons, it is essential to be able to accurately determine the maximum bolt load for an assembled joint.

FIELD ASSEMBLED JOINTS

In most plants very few joints are assembled using any method of load control. Mechanics and pipe fitters are normally armed with open-end wrenches and sometimes air impact wrenches. The accurate load control methods of measuring bolt stress or strain are rarely used. A torque wrench is normally the best you can hope for and should be used to assemble any problem joints to ensure relatively accurate bolt load. The joint should be assembled using procedures found to be reliable through past research, such as the “star” rotational pass or PCC=1. In order for the torque wrench or the assembly procedure to be of any value the final torque value must be accurate.

An accurate final torque value is largely dependant upon an accurate nut factor. The dimensionless nut factor, sometimes referred to as the friction factor, describes the amount of effort required to overcome friction during a torque based bolting procedure. This friction occurs between the