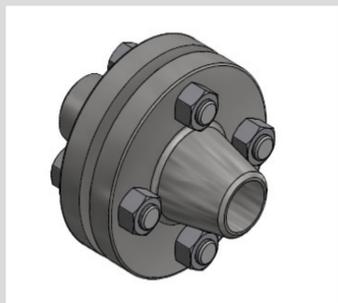
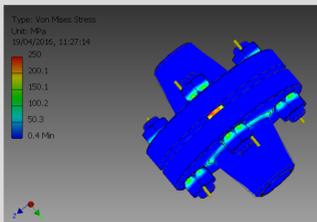


The Analysis of Bolted Joint Torque Calculation Methodologies for Critical Pipework Systems

Aim: to justify a preferred method of calculating bolt torque values for critical pipework systems

Process and piping systems are used to transfer fluid or gas mediums. Within critical systems, such as a nuclear process and piping system, it is imperative that the correct torque is applied to ensure the seal is formed and that the flanges, bolts and gasket have not been subjected to excessive stress; which can lead to failure of the joint.

$$T = F \left[0.16 \cdot P + 0.58 \cdot d_2 \cdot \mu_t + \left(\frac{D}{2} \right) \cdot \mu_n \right]$$

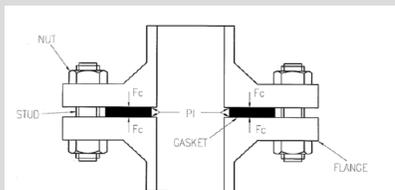


$$F = Wm_1 = \frac{(\pi \cdot G^2 \cdot P_r)}{4} + (2b \cdot \pi \cdot G \cdot m \cdot P_r)$$

$$F = Wm_2 = \pi \cdot b \cdot G \cdot y$$

$$F = \sigma \cdot A$$

$$F = \sigma_s \cdot Tsa \cdot Pf$$

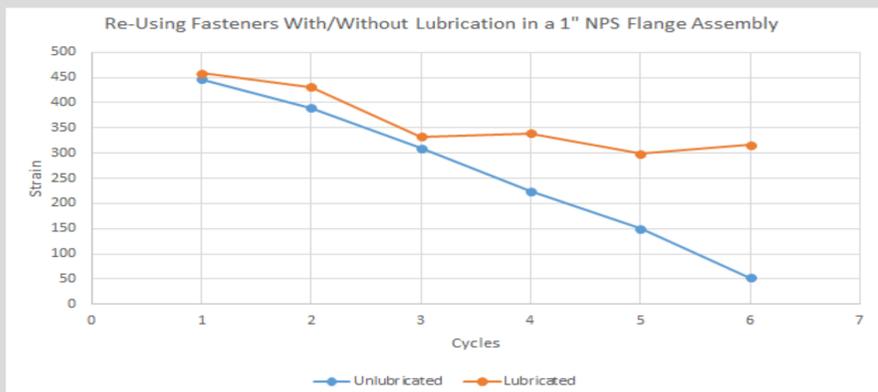


A literature review was undertaken to examine science/engineering theories as well as the extant research that has been carried out (within the field of bolted joint torque), in order to form the foundations of the investigation.

Calculations were undertaken to determine the minimum load required to compress two different gasket materials and the load required to withstand the internal system (fluid/gas) pressure; and to determine the maximum load that could be applied before bolt and gasket failure.

FEA was undertaken to determine the effect on the flanges of applying the maximum calculated torque value to a 1" pipe flange assembly.

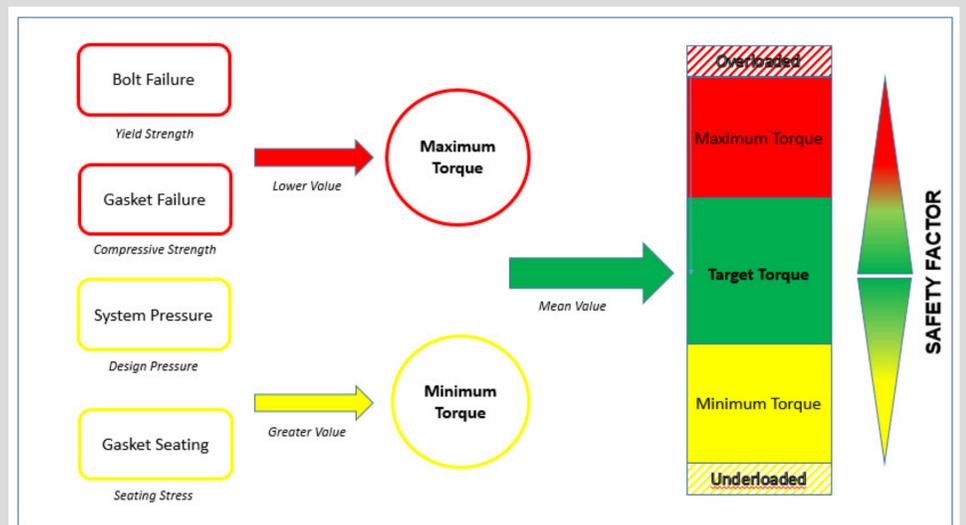
Testing was undertaken within a laboratory to explore the effect of re-using bolts with and without lubrication, in order to understand how friction affects the torque calculations in pipe flange assemblies.



Evaluation - A combination of calculations must be undertaken to ensure the flange assembly is not under loaded or over loaded.

Conclusion - Due to the risk associated with critical pipework systems the key requirement when identifying a torque methodology is to ensure the factor of safety is as great as possible, thus reducing the risk as low as reasonably practicable.

Recommendations - Undertake further analysis to explore the long term effects of high bolt loadings and conduct a value analysis of torque tightening against other tightening methods. e.g. torque angle.



Key Finding: Rubber gaskets are not suitable for use with raised face flanges as very low bolt loads could overstress the gasket due to an insufficient contact surface area; which could cause in-service rupture leading to an uncontrolled discharge.