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# A Survey Method to Optimize Bolted Flanged Joint Assembly Torques for ASME B16.5 Flanges

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## ABSTRACT

The three critical components within a bolted, flanged connection are the flanges, gasket, and bolts. Until recently, simplified flange assembly target torque values for ASME B16.5 flanges were routinely determined by considering just one or two of these primary components.

One approach considers only the gasket. Gasket-based target torque values are selected to optimize the gasket's sealing performance by ensuring compression between minimum and maximum seating stress ranges, or based upon achieving specific levels of gasket Tightness ($T_p$). Another approach, fastener-based torque values, simply targets a specific bolt preload during assembly, typically some percentage of bolt material yield stress. A third approach optimizes gasket seating stress or tightness within the specific preload stress range of particular grades of fasteners. None of these approaches consider the physical limitations and capabilities of the flange itself, which can result in flange damage due to excessive bolt preload or the lost opportunity to gain fatigue resistance and reliability when low fastener preloads are selected [1].

While detailed Finite Element Analysis (FEA) could meet this objective, cost and time constraints limit the number, size, and materials to be considered. The objective of this method to optimize target assembly torques for B16.5 flanges is to identify the likely maximum safe assembly bolt load not exceeding the compression, yield, or tensile limits of any of the three flange components. It is recognized that some localized yielding does occur. Existing industry efforts to study and optimize target torques are surveyed, reviewed, combined, and extrapolated to determine acceptable torque values that conform to selected component limits. The limits are chosen consistent with normal practice in the chemical, process, and power industries.

## INTRODUCTION TO BACKGROUND RESEARCH:

In an effort to identify Optimized Flange Component (OFC) torque values for standard piping flanges, the authors reviewed, evaluated, and assimilated a broad range of industry research and practices to determine target torque values for ASME B16.5 flanges. The various research and approaches each have specific advantages and limitations which restrict their broad application when used by themselves. However, through a focused assimilation process, elements of each research/analysis approach are utilized and combined with the authors' engineering judgment to form the basis of an Optimized Flange Component approach for assembling ASME B16.5 flanges. OFC target torque values are thus determined as the assembly torque value which simultaneously best optimizes (maximizes within prudent limits) the stress regimes for all three flange components, based upon the currently available research and certain engineering and experience-based assumptions.

Following is a brief summary of the data/reports/presentations that were utilized in the development of the OFC Target Torque Values:

**ASME Section VIII Division 1 Appendix 2 & FEA Analysis [2]:** Analysis is performed using ASME Section VIII Division 1 Appendix 2 with stress limits as noted below for Lap Joint flanges and 3D FEA for Weld Neck flanges. Gasket (sheet and spiral wound), bolt (A193-B7) and flanges (Carbon Steel (CS) SA105 material) are modeled using flange and bolt yield stresses at 400°F (204°C) temperature. These are applied to Class 150 and 300 flanges. Design conditions are the ASME B16.5 flange pressure rating at 400°F (204°C).