NTTC Tank Truck Week 2015

Awareness
Gaskets/Fasteners/Flanges

Prince George, VA I Kingsport, TN I Webster, TX I Parkersburg, WV I Lake Charles, LA
OVERVIEW

1. Flange 101
   • Flange Types Inspection & Assembly

2. Gaskets 101
   • Stress
   • Tightness

3. Fastener 101
   • Yield
   • Lubrication
Bolted Flanged Connection: A Complex Multi-Component System Involving Flanges, Bolting, Gasket
Reliable Connection = Balance of Force

- Negative Forces
  - Hydrostatic End Force
  - Gasket Creep/Relaxation
  - Improper Lubrication

- Positive Forces
  - Bolt Tension
The Bolted Flanged Joint System

• Bolted Flanged Joint consists of
  – Flange
  – Fasteners
  – Gasket Material
    • Chemical Compatibility
    • Mechanical Requirements
    • Assembly Considerations (assume controlled procedures are in use)

• All Three Must Work in Harmony
How Does a Gasket Work, Anyway?

• Gasket is softer than flanges
• Flows when compressed into flange imperfections
• Gasket material determines required flange load

\[
\text{Stress} = \frac{\text{Force}}{\text{Area}}
\]

\[
\text{psi} = \frac{\text{lb}}{\text{in}^2}
\]
The Sealing System
Reasons for a Gasket Leak?

Based on a Study by the PVRC
(Pressure Vessel research Center)

- Loose Bolts: 15.0%
- Gasket Defective: 22.0%
- Flange Misalignment: 12.0%
- Flange Damaged: 25.0%
- Improper Installation: 26.0%
Gasket Creep/Cold Flow
- Gasket Stress Decreases
- Loss of Fastener Pre Load
- Fasteners more susceptible to vibration loosening

DEMONSTRATION

Ideally it is preferable to choose a materials that does not relax
Common Gasket Materials & Failure Modes

- **Elastomers:**
  - Chemical Compatibility, Aging, Over-Compression, Torque Loss

- **Compressed Non-Asbestos Fiber:**
  - Thermal degradation, Under-Compression, Chemical Compatibility

- **Polytetrafluoroethylene (a.k.a. “Teflon®”):**
  - Chemical Compatibility (filled), Torque Loss, Over-Compression

- **Flexible Graphite**
  - Oxidation, Breakage/Handling Damage, Process Contamination

- **Teflon® Envelope**
  - Exhibits properties of both Non-Asbestos Fiber and Teflon®
Elastomer Disadvantages

Achilles Heel/Common Failure Modes:

- Over-Compression
- Identification / Chemical Compatibility
- Temperature Limits
- Shelf Life
- Load Loss
PTFE: Disadvantages

Achilles Heel/Common Failure Mode:

• Creep/Torque Loss

NPS 2 x 300 After Compression (ambient)

NPS 1 x 150 Before/After Compression & Temp.
# Minimum Required Gasket Assembly Stress

Gasket Stress (psi) = \frac{\text{Total Bolt Load (lb)}}{\text{Gasket Contact Area (in}^2\text{)}} = \text{psi}

<table>
<thead>
<tr>
<th>Gasket Material</th>
<th>Minimum Gasket Stress to Seal (psi)</th>
<th>Maximum Gasket Stress (psi)</th>
<th>Re-Torque Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8&quot; Thick Rubber (Elastomer)</td>
<td>500</td>
<td>1,500</td>
<td>YES</td>
</tr>
<tr>
<td>Expanded PTFE</td>
<td>2,800</td>
<td>15,000</td>
<td>NO</td>
</tr>
<tr>
<td>1/8” Thick Compressed Non-Asbestos</td>
<td>4,800</td>
<td>15,000</td>
<td>NO</td>
</tr>
<tr>
<td>1/8” Filled PTFE</td>
<td>4,800</td>
<td>10,000 - 15,000</td>
<td>YES</td>
</tr>
</tbody>
</table>
IMPROPER TIGHTING OF BOLTS CAN CAUSE FLANGE DAMAGE & COSTLY REPAIRS
# Basic Understanding of Fastener Specification

## Common Tank Bolt Grades

<table>
<thead>
<tr>
<th>Identification Grade Mark</th>
<th>Specification</th>
<th>Material</th>
<th>Nominal Size and Range (in.)</th>
<th>Yield Strength min (psi.)</th>
<th>Tensile Strength Min (psi.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B8</td>
<td>ASTM A193 Grade B8</td>
<td>AISI 304</td>
<td>1/4 and larger</td>
<td>30,000</td>
<td>75,000</td>
</tr>
<tr>
<td>B8M</td>
<td>ASTM A193 Grade B8M</td>
<td>AISI 316</td>
<td>1/4 and larger</td>
<td>30,000</td>
<td>75,000</td>
</tr>
<tr>
<td>B8</td>
<td>ASTM A193 Grade B8</td>
<td>AISI 304 Strain Hardened</td>
<td>1/4 thru 3/4</td>
<td>100,000</td>
<td>125,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over 3/4 thru 1</td>
<td>80,000</td>
<td>115,000</td>
</tr>
<tr>
<td>B8M</td>
<td>ASTM A193 Grade B8M</td>
<td>AISI 316 Strain Hardened</td>
<td>1/4 thru 3/4</td>
<td>95,000</td>
<td>110,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over 3/4 thru 1</td>
<td>80,000</td>
<td>100,000</td>
</tr>
<tr>
<td>B8</td>
<td>ASTM A193 Grade B7</td>
<td>AISI 4140</td>
<td>Up to 2 1/2</td>
<td>105,000</td>
<td>125,000</td>
</tr>
</tbody>
</table>

- **Tensile Strength**: The maximum stress in tension (pulling apart) which a material can withstand before breaking or fracturing.
- **Yield Strength**: The maximum stress at which a material exhibits a specific permanent deformation.

## Nuts and Washers

<table>
<thead>
<tr>
<th>Bolt Grade</th>
<th>Nuts</th>
<th>Washers</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7</td>
<td>A194 Grade 2H</td>
<td>F436</td>
</tr>
<tr>
<td>B8 Class 1</td>
<td>A194 Grade 8</td>
<td>SS304</td>
</tr>
<tr>
<td>B8M Class 1</td>
<td>A194 Grade 8M</td>
<td>SS316</td>
</tr>
<tr>
<td>B8 Class 2</td>
<td>A194 Grade 8</td>
<td>SS304</td>
</tr>
<tr>
<td>B8M Class 2</td>
<td>A194 Grade 8M</td>
<td>SS316</td>
</tr>
</tbody>
</table>
## Basic Understanding of Fastener Specification

<table>
<thead>
<tr>
<th>BOLT Description</th>
<th>Diameter Range</th>
<th>Yield Strength (ksi)</th>
<th>Tensile Strength (ksi)</th>
<th>3/4&quot; Diameter Fastener Maximum Torque (ft-lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BN EN ISO 3506 A2-70</td>
<td>All Diameters</td>
<td>65</td>
<td>101</td>
<td>225</td>
</tr>
<tr>
<td>ASTM A193 GRADE B8 Class 1</td>
<td>1/4&quot; and larger</td>
<td>30</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>ASTM A320 GRADE B8M Class 1</td>
<td>1/4&quot; and larger</td>
<td>30</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>ASTM A193 GRADE B8 Class 2</td>
<td>1/4&quot; thru 3/4&quot;</td>
<td>100</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Over 3/4&quot; thru 1&quot;</td>
<td>80</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>ASTM A193 GRADE B8M Class 2</td>
<td>1/4&quot; thru 3/4&quot;</td>
<td>95</td>
<td>125</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>Over 3/4&quot; thru 1&quot;</td>
<td>80</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>BN EN ISO 3506 A4-80</td>
<td>All Diameters</td>
<td>87</td>
<td>116</td>
<td>300</td>
</tr>
</tbody>
</table>
Fasteners
Lubricate Bolt/Stud Threads **AND** Nut Bearing Surface

- Demonstration
Flange Assembly

- Lubricate all threads and nut bearing surfaces with Jet-Lube
- Run all nuts down snug (finger tight)
- Using a calibrated torque wrench. Tighten bolts in a star / criss cross pattern sequence, in a Minimum of 3 passes increasing bolt load / torque after every pass
- Finish with at least one clockwise rotational pass to ensure all bolts are to maximum torque

[Diagrams showing different tightening sequences]

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Flange Assembly

Elements of Good Flange Assembly

- Inspect the sealing surface
- Clean and prep the sealing surface
- Have the correct design information
- Inspect the flange alignment
- Inspect the fasteners
- Properly install the gasket and fasteners
- Properly tighten the fasteners
- Quality check and record installation data for critical services

If any of these are missing, the joint is subject to leaks!
I Have A Question

- Does your company, or facility have a gasket program?

- You most likely have programs in place for tires, hoses, pumps, brakes, etc..

- Why would you not have a program in place for the most exposed part of your trailers -
I Have A Question

The Bolted Flange Connections