TSP
Fastener Resource Experts

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A Brief Overview of High Temperature Concerns with Regard to ASTM Bolting Grades

Stress Relaxation: Importance, Testing and Available Data

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Discussion Points

- Bolted Joints – Basic Behavior
- High Temperature Concerns
- Available ASTM Grades and Tests
- Existing Data

Bolted Joints – Basic Principles

- Effective function of a bolted joint is dependent upon proper clamping force.
- Clamping force is established by “preloading”.
- Various assembly methods are used to preload the bolt to achieve desired clamping force.
- The clamping force must be maintained during service.

High Temperature Concerns

- Preloaded clamping force decreases by about 10% after initial assembly.
- Additional clamping force decrease that occurs over time is normally negligible at room temperature.
- Bolt strength is reduced with increasing temperature.
- Additionally, significant loss of clamping force can occur over time at higher temperatures.
- This clamping force loss over time at higher temperature is due to stress relaxation.

Stress Relaxation

- Definition from ASTM Committee E28:

  stress relaxation—the time-dependent decrease in stress in a solid under given constraint conditions.

- Loss of too much clamping force over time can compromise bolted joint integrity. Therefore, it is important to determine stress relaxation.
- Determination is somewhat complex – long times involved, different starting stress.

ASTM High Temperature Grades Commonly Used in Oil and Gas

- Low alloy, carbon and stainless steels: A193 B7, B7M, A320 L7, L7M, L43, A194 2H, 2HM, 7, 7M.
- Special bolting grades: A453 660D, A1082 (New).
- Under jurisdiction of ASTM Committee A01 on Steel.
- Primary intended use is high-temperature, high pressure applications – B&PV Code.

Applicable Tests

- Room Temperature
  Tensile: A370, E8

- Elevated Temperature
  Elevated Temperature Tensile: E21
  Stress Relaxation: E328

A193 Supplemental Requirement

S8. Stress-Relaxation Testing

S8.1 Stress-Relaxation Testing, when required, shall be done in accordance with Test Methods E328. The test shall be performed at 850 °F [454 °C] for a period of 100 h. The initial stress shall be 50 M psi [345 MPa]. The residual stress at 100h shall be 17 M psi [117 MPa] minimum.

Available Data

- Stress Relaxation:

  ASTM DS-60 – Compilation of Stress-Relaxation Data for Engineering Alloys

Published in 1982 – Joint project of ASTM and the Metals Properties Council

References

- Fastener Technology Handbook 2010 Edition – Industrial Fastener Institute, 2010
- DS 60, Compilation of Stress Relaxation Data for Engineering Alloys, ASTM International, 1982
- Specification A193-12b, ASTM International, 2013

Lester Burgess, January 2014