

## High Temperature Stress Relaxation (Creep)

### Creep

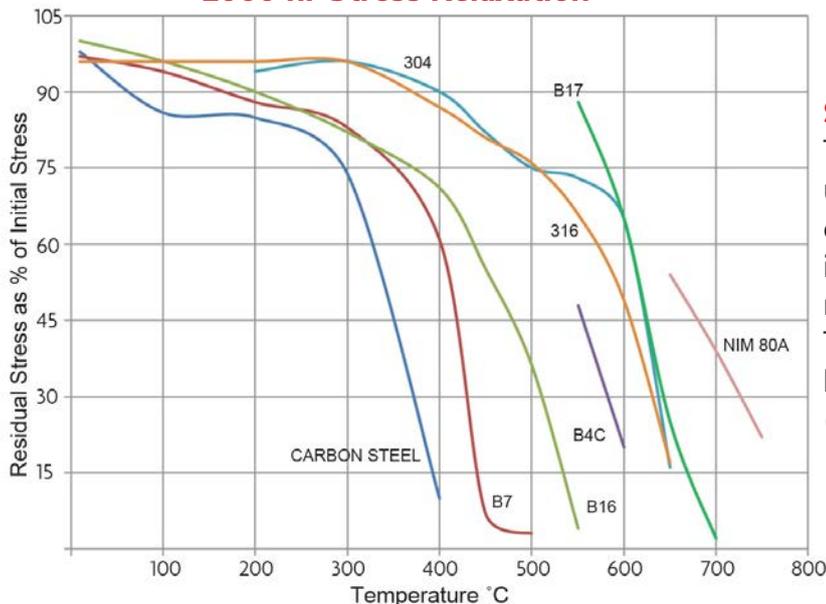
In materials science, creep is the tendency of a solid material to move slowly or deform permanently under the influence of persistent mechanical stress. It can occur as a result of long-term exposure to high levels of stress that are still below the yield strength of the material. Creep is more severe in materials that are subject to heat for long periods. For typical bolting materials Creep is not normally significant until operating temperatures >250°C.

### High Temperature Stress Relaxation

When a bolt material starts to creep, the bolt length increases without any increase in the bolt load. This is effectively a loss of elastic bolt extension and hence pre-load in the bolt. Creep is defined as continued extension under constant stress. The effect seen in a bolt is referred to as High Temperature Stress Relaxation, but the cause is the same.

- High temperature stress relaxation is "a reduction of bolt load with time".

### 1000 hr Stress Relaxation



### Stress Relaxation Graph

This graph is shown only for a general understanding of stress relaxation and comparisons between materials and is not to be used for accurate stress relaxation calculations.

Typically bolt performance will required bolt performance for over 10,000 hours (at elevated temperature).

### Tips for the Bolting Designer

For bolted applications at elevated temperatures it is important to consider the effect of stress relaxation, over time, if the joint is not to leak. Selection of the correct bolt and nut materials is an important and economic consideration. Materials which exhibit good stress relaxation at elevated temperatures are typically also more expensive.

Carbon Steel bolting material becomes less useful as the temperature passes 250 °C. B7 bolting material starts to exhibit increased relaxation above 350 °C and B16 above 400 °C. At higher temperatures stainless steel and super alloys are required. This relaxation must be taken into account at the design stage and sufficient allowance included in the initial bolt pre-load.

TensionPro designs, manufactures and rents hydraulic bolt tensioning equipment which is ideally suited to the tightening of bolts which are to be operated at elevated temperatures. Stress relaxation at temperature often requires bolts to be tightened to higher bolt stresses and hydraulic tensioning is the easiest way to achieve high and accurate pre loads in bolted joints.

Gaskets in high temperature bolted joints benefit from even compression. Any number of hydraulic tools can be connected together for simultaneous operation ensuring high and even bolt loading and gasket compression, in any bolted joint. TensionPro engineers can guide you through the bolted joint design and tool selection process.