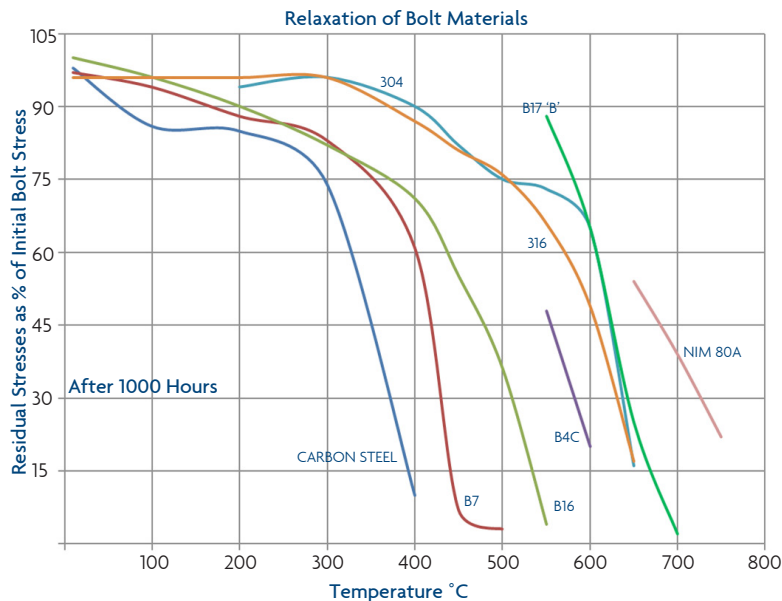


## HYDRAULIC BOLT TENSIONING

### High Temperature Stress Relaxation

Creep is defined as the continued extension of a material when subject to a constant stress. The rate at which the material will “creep” depends on a number of factors. Some materials are better at resisting creep than others. When a material is subject to high temperature the creep rate increases.

When a steel bolt and nut is tightened the material alloy from which they are made will be subject to the phenomenon of creep. At temperatures below 200 °C this is not normally significant. However, at elevated temperatures, creep has an effect which cannot be ignored.



When a bolt material starts to creep, the bolt extension increases without any increase in the bolt load. This reduces the bolt stress and hence the load retained in the bolt. Because creep is defined as continued extension under constant stress the effect seen in a bolt is not consistent with the definition of creep. It is therefore known by other terms such as high temperature stress relaxation or creep relaxation, but the cause is the same.

The effect of high temperature stress relaxation is :-

”reducing bolt load with time”.

The graph above gives only an indication of the stress relaxation behaviour of bolt materials after only 1000 hours. It is reproduced to demonstrate the effect of creep relaxation only and should not be used to predict the actual performance of a bolted joint which will depend on many other factors including the joint, nut, washer and gasket materials. Additionally high temperature applications will usually require bolts to operate at elevated temperature for over 10,000 hours.

In the case of flanged connections for pipelines and pressure vessels operating 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 increasingly expensive.

In the late 1960's and early 1970's GKN Bolts and Nuts Ltd performed test work on bolt and nut materials operating at elevated temperatures. The results of the work were placed in the public domain and were reproduced in an earlier version of BS 4882. A graph of the results is reproduced above.

From the graph, it can be seen that, Carbon Steel bolting material becomes less useful as the temperature passes 200 °C. B7 bolting material starts to exhibit increased relaxation above 400 °C and B16 above 500 °C. At higher temperatures stainless steel and super alloys are required and even these exhibit marked relaxation. This relaxation must be taken into account at the design stage and during the cold bolt tightening of the joint that is required to operate at elevated temperature for any period of time.

The combination of bolt and nut material has a significant influence on the degree of stress relaxation at temperature. Grade B7 bolts are normally used with Grade 2H nuts. B16 bolts with Grade 4 nuts. If a B16 bolt is fitted with a Grade 2H nut the benefit of the B16 bolt material will be lost. Likewise, if a B16 bolt is fitted with a Grade 8 nut the performance of the bolt and nut assembly will be improved.

Boltight 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.

Boltight Ltd will be pleased to receive details of your application to either design custom built tooling, or recommend suitable equipment from the standard range.



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