Temperature Deration

Doug Lehr, P.E.

This is the 4th in a series of articles on Critical Equipment design for offshore completions.

High temperature stress analysis of metallic components must account for an inevitable decrease in room temperature minimum yield strength **(S_y).** Linear-elastic stress analysis is the norm for nearly all downhole metallic components and accurate results depend upon the use of reliable temperature deration factors.

Below 300 ºF, there is a large database of temperature deration (TD) information available in the public domain for common structural metals. Guidance can also be found in the ASME Boiler and Pressure Vessel Code (ASME BPVC) for steels commonly used in fabrication. However, at higher temperatures, the amount of TD information in the public domain is limited. This is problematic for the steels commonly used in downhole completion equipment.

This data gap complicates the design of completion equipment for high-pressure high-temperature service (HPHT). It contributes to the design risk associated with this type of equipment, which is typically used in offshore applications. Adequate mitigations must therefore be used to manage this risk.

- To fill the data gap, OEMs and operators typically invest in extensive laboratory testing programs to establish proprietary databases of temperature deration factors for **S_y**.
- Other mechanical properties decrease at high temperatures and must be considered in some types of analysis.
  - A decrease in ultimate strength **(S_u)** will be consequential in an ASME Load and Resistance Factor analysis.
  - A decrease in Young's modulus **(E)** will be consequential for the behavior of components that must possess high rigidity.
- Conflicting data on deration factors may exist, so materials SMEs must decide which data is the most credible.

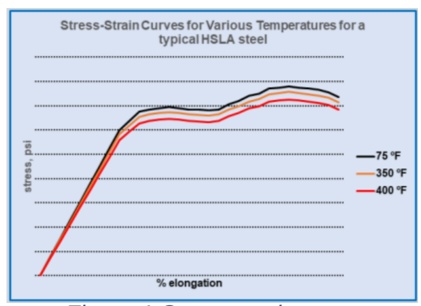

Figure 1 Stress-strain curves change as temperature increases. (not too scale)

Finally, high-temperature equipment must always be de-risked using a laboratory test program designed to assess not only for performance BUT ALSO FOR for the expected high-temperature behavior of critical components.

TRUTH: The use of reliable temperature deration factors minimizes design risk.