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ASTM A106 Gr. B Low Ambient Temperature Applications

Many older refineries located in northern regions were originally built without duly considering the effects of extreme low environmental temperatures. Though cold temperatures were recognized by both Canadian and American engineers, they did not fully appreciate the severity of the Canadian environment and other high latitude countries. Piping systems most often affected include flare piping, instrument air and various other uninsulated pipes. The consequence of this oversight has resulted in piping fractures and failures arising from cold induced brittleness.

Government regulatory agencies are useful from time to time in that guidelines are made available and followed for proper and safe design. The ASTM A106 Gr. B Low Ambient Temperature Specification for piping materials addresses this cold temperature effect. It is often referenced in the ASME B31.3 Process Piping Code for refinery design.

In ASME B31.3 1999 Edition, note (3) states in part, "Impact testing is not required if the design temperature is at or above -46C (-50F), and the maximum operating pressure of the manufactured components will not exceed 25% of the maximum allowable design pressure at ambient temperature, and the combined longitudinal stress due to pressure, dead weight, and displacement strain (see para.319.2.1) does not exceed 41 MPa (6 ksi)". The design temperature mentioned here is more commonly known as the "critical exposure temperature" or CET, and is often the coldest ambient temperature that the metal can experience.

The 6 ksi limitation is quite low. Flare headers in gas plants and refineries tend to run very long distances with minimal flexibility. The longitudinal stress due to displacement strain only, or due to dead weight only, can very easily exceed this limit.

If an existing system with ASTM A106 Gr.B is to be checked for compliance with this code requirement, or to satisfy the responsible govenment agencies, acceptable methods are:

- Check to see if the batch of carbon steel pipe was impact tested.
- Perform a computer analysis to insure combined longitudinal stressesare below 6 ksi.
- Insulate & steam trace.
- Replace certain components of the piping system with low temperature material.

Although verification of impact testing of existing piping is the best solution, it is very often impractical.

Failing impact test verification, the most economical approach is to analyze the system numerically to determine whether components in the system experience more than 6 ksi between installation and cold ambient temperatures.

For existing facilities, performing computer stress evaluation is the most economical way to achieve code compliance.

If the computer analysis shows that stresses are unacceptable, the next best alternative is often just a matter of economics.

Insulating and heat tracing can be expensive and impractical. Replacing a few fittings with low temperature materials is a more economical solution than insulating and heat tracing, redesigning, constructing new routing, or even adding loops or flexible expansion legs.

For new flare and instrument air system designs, meeting the 6 ksi requirement can be a simple selection of the right material, but if you are considering the use of ASTM A333 Gr.6 or stainless steel, it may be that the use of ASTM A106 Gr.B with computer analysis is a much less costly way to meet this code requirement.