from experience

Don't Crack Under Pressure: Designing Piping Systems for Thermal Expansion

When designing utility piping or process tubing systems, Hixson considers both the thermal expansion of the liquid in the pipe line, as well as the stresses created on the piping due to metal thermal expansion. (Liquid thermal expansion was considered in the Hixson FE article “Under Pressure! Pressure Buildup in Pipelines,” published in December 2007.) Piping thermal expansion is growth or contraction of the piping material due to the change in pipe metal temperature at operating conditions. The change in pipe or tubing length is governed by the equation:

$dL = (\alpha)\,(Lo)\,(dt)$, where…

- dL = piping or tubing length change (inches)
- α = linear expansion coefficient (inches growth/inch piping length/ degree F change)
- Lo = length of piping (inches)
- dt = change in piping temperature between installation temperature and operating temperature

For most food processing piping situations, good piping practices and piping bends in the system to accommodate piping layout, are sufficient to accommodate the change in pipe temperature or tubing length without rigorous analysis. However, some design cases warrant thorough analysis though, in particular when large changes due to hot water or steam occur, or piping runs are extremely long. To appreciate the change that can occur, see the examples below:

- 50 feet of 38°F cold milk tubing, 304 Stainless Steel: Contracts 3/16 inch
- 150 feet of 120°F hot HFCS pipe, 316 Stainless Steel: Expands 1 inch
- 100 feet of 100 PSI steam pipe, Carbon Steel: Expands 2 ½ inches

This excess pipe stress may result in leaks at flanges, excess nozzle stress on tanks or pumps, or eventual failure of the piping. To alleviate the stress, three options typically considered by Hixson are the use of expansion joints, pipe loops or extra-strong piping to accommodate the added pipe stress.

Piping conditions that favor each of these design solutions are outlined below:

Expansion Joint	• Limited space or structural limitation does not permit installation of pipe loop or elbows • Abrasive solids in the liquid would prematurely wear out loop elbows
Pipe Loop	• Expansion joint failure could result in operator exposure or environmental release • Piping design can be adjusted to reduce pipe stress or loop size
Extra Strong Pipe	• Space or structural limitations • Minimum pressure drop required

experience in brief

Two common linear expansion coefficients (α):

- 8×10^{-6} in./in. F for Carbon Steel
- 11×10^{-6} in./in. F for Stainless Steel and Copper

These values are generally applicable for a temperature range of 32^0F to 300^0F.

continuing education

Hixson associates regularly participate in continuing professional education events across the country. To learn more about the events listed below, e-mail Hixson at: info@hixson-inc.com

International Production & Processing Expo (IPPE)
Atlanta, GA
January 2018

"Keys to Successful Food Plant Renovations and Expansions"
A Hixson *Food Plant of the Future* Webinar
May 3, 2018, 2 p.m. Eastern
Register Now!

Direct Comments/Questions to:
Warren Green, Manager
Process Engineering
wgreen@hixson-inc.com

Phone: 513.241.1230
Fax: 513.241.1287
www.hixson-inc.com

Free webinar series! Go to www.hixson-inc.com/insights/foodplant-of-the-future/ to register or access the archives of Hixson's webinars.

A knowledge-sharing publication from:

HIXSON
ARCHITECTURE ENGINEERING INTERIORS