PENFLEX

ENGINEERING BULLETIN #157

Delay Work Hardening of Metal Bellows in High Vibration Applications

Oftentimes engineers use metal bellows to damp vibrations in a piping system. While they protect surrounding pipes and equipment from damage, bellows themselves are not impervious to damage.

Work hardening occurs with each cycle and, as a result, the bellows become increasingly brittle over time. The more brittle an expansion joint becomes, the higher the likelihood of stress cracking—seen within the valley or at the crest of a convolution—and subsequent failure.

In rare cases, resonance can cause near immediate failure. Given the challenges associated with vibration, it's a good idea to have a conversation with a Penflex sales engineer when designing components for these kinds of applications.

APPLICATIONS WHERE VIBRATION IS A CONCERN

The most common high vibration scenarios include exhaust and pump system applications.

High flow velocity can also lead to damaging vibration, though engineers take a different approach when designing bellows for applications where this is a concern.

DESIGNING METAL BELLOWS WITH HIGH VIBRATION IN MIND

A flexible, 5-ply design with a low spring rate is the "gold standard" for high-vibration applications.

Flexibility is a key characteristic as flexible bellows are slower to work harden. In delaying the onset of embrittlement, we can also delay the advent of stress cracking and thus prolong service life.

Stresses are distributed across the bellows in a multi-ply expansion joint. This also slows work hardening. And while many variables contribute to flexibility, adding plies helps to make an expansion joint more flexible as well. Finally, where pressure is a concern, the multi-ply design delivers a robust wall thickness to accommodate higher working pressures.

Low spring rates are desirable as they will keep the forces exerted on pumps by expansion joints low.

When high flow velocity is a concern, Penflex uses the EJMA guidelines for liners. Based on different flow velocities and diameters, the guidelines offer recommendations for smoothing media flow within an expansion joint.

INCONEL 625 LCF

Another consideration for expansion joints in high-vibration application is the material of construction. Inconel 625 LCF was specifically designed for the metal bellows industry. LCF stands for “low cycle fatigue.”

It is an excellent choice for high-vibration applications due to its better thermal fatigue resistance and better cycle fatigue properties when compared to other, similar alloys.

VIBRATION ANALYSIS

Penflex sales engineers can confirm an expansion joint will not operate within the resonant range, assuming system frequencies are known.

Work hardening and subsequent stress cracking is a common cause of expansion joint failure, but one that can be avoided through thoughtful bellows design. For more information, please contact us.