Optimal Designs for Fabric Expansion Joints

As fabric expansion joints have been used for decades several basic designs have proven to be suitable for various conditions and are commonly used.[1] When it comes to more severe conditions and/or special requirements even the best available materials will fail if they are not combined with a suitable design.

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Unique Requirements

Materials used in fabric expansion joints are unlike metal expansion joints not described in various standards. They can also have various frame designs depending on supplier and user requirements.

For example, expansion joints for gas turbine exhausts normally have special conditions which are taken into consideration when designing the frame.

High gas velocity (sometimes more than 100m/s) and turbulence are common in gas turbine exhaust. The soft parts need to be very well protected, otherwise the local vacuum and turbulence will cause their fibers to degrade quickly. The forces of the vibration on the steel parts as well as the ability to achieve a smooth flow must also be taken into consideration by the design team.

Stress Effects on Differing Designs

A rapid change in temperature, of more than 500°C, is a challenge for outside insulated frames; the temperature difference between inside and outside causes increased stress. Traditional frames that are perpendicular to the duct will suffer from this phenomenon as the stress level will be severe. While round frames will spread the stress along their circumference, distortion, and buckling are commonly seen. Square frames will concentrate the stress in their corners and cause fatigue cracks.

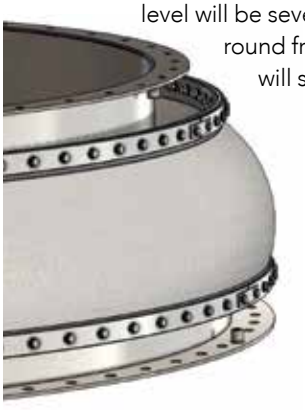

Figure 3: Round conical design.

Figure 1: Basic expansion joint design.

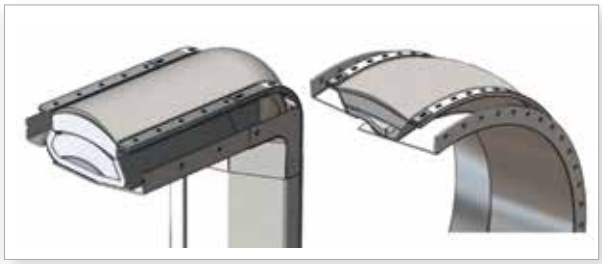

Figure 2: Design for gas turbines.

To avoid distortion and high-stress levels, the frame must be made to limit the maximum stress level. This can be done by the shape and design of the frame and/or by lowering the temperature difference. Various designs can be used; the challenge is to find a design without causing other disadvantages.

Suitable Designs

Figure 2 highlights a design which reduces the maximum stress level in the steel frames. When the temperature increases the sloped shape of the frame allows it to flex. By a square frame this will occur mid on the four sides while the round ones will flex more evenly around its circumference. The stress level will still be quite high but with some additional measures in the production and design of the frames, it will be within acceptable limits.

Figure 2 also shows an inside protection in the gap between inlet and outlet frame. A sliding steel plate could be a way to protect the gap but there is a risk of that it can jam and prevent the expansion joint to absorb movements. Another solution used here is a strong but flexible combination of various materials like wire meshes and fabrics which can protect the soft parts in the expansion joint.

Final Thoughts

The challenges associated with selecting the appropriate frame design for a fabric expansion should not be understated. Failure to accommodate the application sufficiently can result in damage, or in extreme cases failure of the expansion unit overall.

REFERENCE

1. ESA engineering guide https://www.esaknowledgebase.com/engineering-guide-english/)

ABOUT THE AUTHOR

Mikael Edvardsen is responsible for fabric expansion joint design at LBH International AS in Denmark and has worked with these products since 1996. LBH is a member of the ESA Expansion Joint Division.