Case Study

Key factors to consider when replacing expansion joints in a retrofit project

The colossus of Dubai

Production plant operators rarely pay much attention to expansion joints. Yet these are critical components that play a vital role in ensuring system functionality. Expansion joints must perform well under pressure, particularly when exposed to high temperatures, dynamic movements, stress or corrosive media. And precisely because an expansion joint must withstand so much stress, it is a wear part that must be replaced after a certain period. The replacement process requires thorough planning and the new expansion joint must be optimally adapted to the existing installation conditions. This case study presents a retrofit project of this kind that was carried out by Frenzelit GmbH.

A fabric expansion joint at the inlet of a waste heat boiler of a combined cycle power plant (CCPP) needed replacing in a Dubai aluminum plant. In extremely energy-intensive industries such as aluminum processing, operators in the Middle East frequently rely on CCPP plants to power their operations, because these plants generate an exceptionally large amount of energy. A gas turbine converts fossil fuels such as gas or oil into rotational energy; this drives a generator to produce electricity. This process releases hot exhaust gases as a waste product, which in turn drive a steam turbine as residual heat, thus also generating electricity via an additional generator. The 500 to 600 degree Celsius exhaust gases from the gas turbine transfer their energy to a water circuit via a heat exchanger. This causes the water to boil and the resulting steam generates rotational energy, which is converted into electricity via the steam turbine. Coupling both systems enables an efficiency factor of greater than one, i.e. significantly more energy can be generated using this method than with a single gas or steam turbine.

Expansion joints for area where hot gases accumulate

A fabric expansion joint serves as a connector between the two systems at the transition point from the gas turbine to the steam turbine. The energy is extracted from the hot gases in a waste heat boiler that is located there. The high temperatures at the inlet add significant stresses because the metal expands when heated. The expansion joint acts as an interface that absorbs and compensates for these stresses. The flexible component must withstand extreme conditions including high temperatures, major movements, significant stresses and expansions. At the same time, the expansion joint has considerable dimensions: 5.7 by 5.7 meters. It consists of insulated steel channels into which fabric layers are integrated via flanges. The right design and insulation are essential to protect the flange connections from excessive heat. A general rule for expansion joints in the area where hot gases accumulate is to achieve

a temperature that is tolerable for the fabric, particularly in the clamping, i.e. joint zone. The bellows in the center of the expansion joint is designed for high temperatures thanks to the various layers of fabric – in this case a total of 11 layers, 22 millimeters thick. Glass fabrics and insulating layers are used here that can withstand temperatures between 500 and 700 degrees Celsius. However, further out, the closer the flanges are, the temperature must be gradually reduced, because gas-impermeable PTFE layers follow to ensure the system remains sealed, and these are designed to withstand a maximum temperature of 250 degrees Celsius. The design must ensure that this temperature limit is not exceeded in the clamping zone between the steel channel and the fabric layers.

The expansion joint itself weighs approximately 380 kilograms. Moreover, there are additional insulating packings (pillows filled with insulating wool) inside that further reduce the application temperature and can weigh anywhere from 300 to 400 kilograms each. Replacing such a colossal component of an existing power plant is therefore extremely challenging.

Complex installation situation

Frenzelit, a company that specializes in gaskets, technical textiles, insulation and expansion joints, has deep understanding and expertise in the complex process of expansion joint replacement. Stefan Puchtler, General Manager Expansion Joint Division at Frenzelit, explains the key factors to consider: “An expansion joint of this size changes many aspects of the basic design: Foundations settle, shifts occur. So even in this case, it was not possible to duplicate the original expansion joint; instead, our experts had to examine the installation situation on site in detail. We prepared a new dimensional drawing, calculated the offsets and checked which material improvements were possible – as a manufacturer with our own textile development and production, we were able to offer the customer clear advantages thanks to our fabric combinations with high-temperature fibers.

No standards for fabric expansion joints

What makes fabric expansion joints so special is their uniqueness: There are no norms, dimensions and standards here. Instead, each fabric compensator is always customized to fit the respective application. This is compounded by the installation situation, which changes over the years, making retrofit projects nearly as extensive as new construction projects in terms of planning. But what distinguishes integrating an expansion joint in a retrofit project from a newly constructed plant is the challenging installation. Replacements must often be carried out at great heights, which is no easy feat given the dimensions and weight of the expansion joint. The available space is limited; service technicians must use ropes to hitch themselves to scaffoldings and install the expansion joint vertically. Installation crew members must be physically fit.

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Another unique aspect of this project was the nature of the flanges, which pointed inward. This required a convoluted round expansion joint. As long as it is not yet under pressure during installation, all of the packing systems need to be lined and properly bolted to the expansion joint to prevent thermal gaps. In addition, both the fabric expansion joint and the insulating packings had to be mounted over studs, some of which were corroded. First, they had to be removed with an angle grinder, rewelded and aligned. This project therefore involved a great deal of assembly work and steel construction to enable a functioning connection with the new expansion joint.

A Frenzelit supervisor, who is also based in Dubai, oversaw the on-site installation work. “It’s important for us to have service personnel on site to offer our customers the best possible support. Our supervisor either oversees the customer’s service staff or an external service team, but can also lend a hand, for example when it comes to professionally sealing the individual fabric layers. For our customers in the Middle East, it is very important for the service provider to also be able to supply an experienced supervisor for the retrofitting work,” Stefan Puchtler understands.

Rapid response times

Retrofit projects are usually scheduled during inspection periods when maintenance work is carried out on the entire plant on a rotational basis. These intervals are important in order to avoid unnecessary downtime due to wear-related malfunctions. “But we can respond quickly in emergency situations as well,” says Stefan Puchtler. “It depends on the type and materials, of course, but we are also able to install a new expansion joint within 24 hours. The fabric expansion joint may be formidable in size, but the good thing is: It is easy to transport it from our production sites in Germany to anywhere in the world, because it can be folded up like a pair of sweatpants.”

Frenzelit will replace six such expansion joints in the aluminum plant in total over the course of several years during the scheduled inspection periods.

Images:

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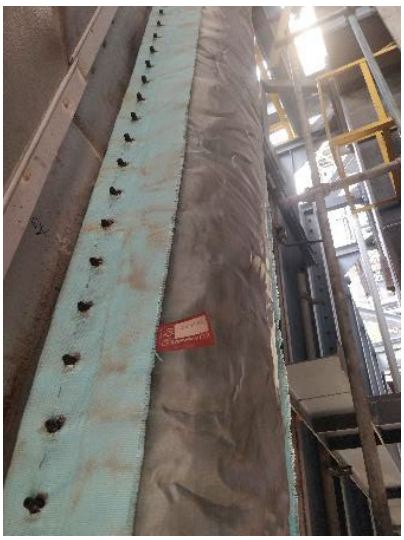
Precision-fit insulating packings are absolutely essential for the expansion joint at high temperatures because they lower the application temperature. *Image: © Frenzelit GmbH*



Challenging installation situation: The fabric expansion joint must be installed in a vertical duct. *Image: © Frenzelit GmbH*

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As flexible as a pair of sweatpants: A fabric expansion joint can be easily folded and transported to save space. Image: © *Frenzelit GmbH*

Ready for high temperatures, movements and expansion: The replaced fabric expansion joint with insulating layers made from high-temperature fibers by Frenzelit. Image: © *Frenzelit GmbH*

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