



Application of expansion joint in thermal power plant

Abstract: With the extensive application of expansion joint in thermal power plant, it's very necessary for users and manufacturers to have a more comprehensive understanding of expansion joint products for thermal power plant. This paper describes the characteristics of several commonly used expansion joint and some new practical structures for reference.

Key words: expansion joint; thermal power plant; application

1 Summary of thermal power plant

1.1 Characteristics of Pipeline in Thermal Power Plant

A thermal power plant is a plant that converts chemical energy stored in coal, oil, natural gas, or other fossil fuels into combustion energy, heat energy into mechanical energy, and generate electrical energy. Thermal power plant production process is mainly with the boiler, steam turbine, generator, and other auxiliary equipment composed of thermal and electrical systems. These systems have many pipelines, such as the main steam pipe, reheat pipe, the water pipe, smoke and air coal powder pipe. The characteristic of these pipes as below:

- (1) High temperature, for team pipe, the temperature can get to 400~450°C, the lowest to 200~300°C.
- (2) The section shape is varied. Steam pipes, gas pipes and water pipes are circular cross-section, the external flue are rectangular cross-section, while the section shape of air duct depends on the equipment structure of pipeline connection.
- (3) The medium flows fast. In order to prevent clogging of the coal pipeline, high speed win must be maintained in the air duct, and the maximum reach 80m/s.

1.2 Thermal expansion of thermal power plant pipeline

Thermal power plant pipeline from the cold state to the working state of its great temperature change, from tens of degrees to a few hundred degrees, resulting in thermal expansion of the pipeline, and because of these pipelines are long lines, the thermal displacement value will reach a great value.

The thermal displacement of the pipeline can be calculated by the following formula

$$\Delta L = \lambda L \Delta t \text{ (Unit: mm)}$$

λ —— linear expansion coefficient of pipe, mm/m °C;

L —— the length of pipe, m;

Δt —— temperature difference,

If the two ends of the pipe are fixed, then the expansion of the wall will produce





a huge stress, the stress value can be calculated according to the following formula:

$$\sigma = E \Delta \times 10^6$$

$$\sigma = E \Delta \times 10^6$$

σ —Stress, MPa;

E —Elastic modulus of pipes, MPa;

$\Delta L/L$ —The ratio of the thermal expansion of the pipe to the original length of the pipe.

Due to the thermal expansion of the pipe, the fixed point of the pipe ends will produce thrust, the thrust value can be calculated according to the following formula

$$F = \sigma A \times 10^6;$$

σ —Stress, MPa;

A —Sectional area of a pipe, m²;

Finally, $F = E \lambda \Delta t A$

If we treat Elastic modulus of steel pipe $E = 0.18 \times 10^6$ MPa, Coefficient of linear expansion $\lambda = 12 \times 10^{-6}$ m/m°C, the inner diameter of pipe is 300mm, out diameter is 326mm, the temperature difference is 350°C, thus, the thrust of the fixed point: $F = 0.18 \times 10^6 \times 12 \times 10^{-6} \times 350 \times (0.326^2 - 0.30^2) \pi / 4 \approx 9.6 \times 10^6$ N

From the above example, the thrust by thermal expansion generated is great.

2 The application of fabric expansion joint.

In order to reduce the thrust generated by thermal expansion in the pipeline, compensation for thermal expansion of the pipeline must be taken into consideration of the design and installation of the piping, and compensating of the thermal displacement is done by expansion joint. The normal expansion joint: slip-type expansion joint, fabric expansion joint, corrugated metal expansion joint, Π -shaped and Ω -shaped expansion joint.

Pipe bending make to be Π -shaped and Ω -shaped expansion joint (Pic 1).

Good ability to compensate, easy to manufacture, reliable operation, suitable for the pipeline of any pressure and temperature. The disadvantages: large size, occupy large space, with the development of the slip-type expansion joint and corrugated metal expansion joint, the consumption of Π -shaped and Ω -shaped expansion joint has been less and less. This paper is mainly introducing other expansion joints.



Π -shaped expansion joint Ω -shaped expansion joint

Pic 1





2.1 Slip-type expansion joint

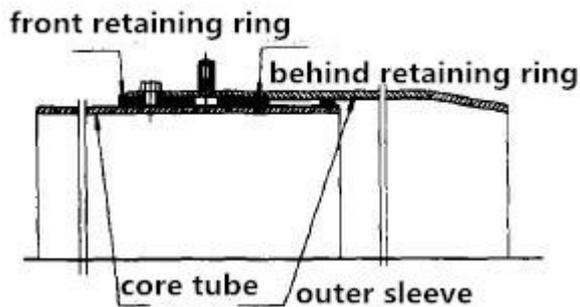
Slip-type expansion joint, also named filler-type expansion joint (Pic 2), because of its sealing structure using packing seal. Filler seal is contact seal, in the outer sleeve and the core tube filled with elastic sealing material, the axial pressure in the packing can be close to the surface of the core tube, the elastic deformation of the sealing material to compensate the wear of the sealing surface to prevent the media leakage. Taking the retaining ring composed of sealed stuffing box on the front and behind of core tube, outer sleeve, filled into the packing and filling into the graphite flexible filler, their combined effect can ensure that the sleeve expansion joint has a better sealing effect, and can be achieved online maintenance. In case of leaks, maintenance worker block the leak with special tools, and the pipeline system does not stop running.

With the development of technology, the compensation development of slip-type expansion joint is from single direction axial to two way direction, force balance type, horizontal type and other forms. The advantages: large compensation, small fluid resistance, low cost, long service life. Thus, the Slip-type expansion joint is widely used in boiler pulverized coal pipeline of the thermal power plant.

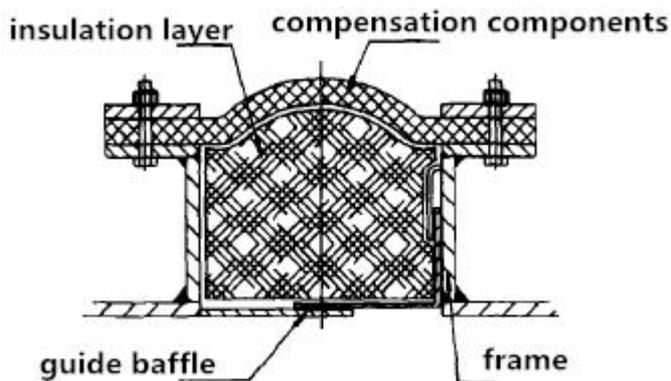
2.2 Fabric expansion joint

The fabric expansion joint used in the thermal power plant is fiber fabric expansion joint (Pic 3), mainly composed of non-metallic band, heat insulation material and steel structure. The compensation element is generally made of fiber fabric and coated with resin or rubber and other materials fabric. There are many types of fiber fabrics, commonly used asbestos fiber, glass fiber, polyester fiber, ceramic fiber and other fabrics. Coating materials include fluorine rubber, plastic, silicone and so on. Characteristics of fabric expansion joint: ① Fabric expansion joint can compensate for axial and lateral displacement; ② Muffler damping: fiber fabrics, cotton insulation itself has a sound absorption, vibration transmission function, can effectively reduce the boiler, fan and other systems of the noise and vibration; ③ The main material is fiber fabric, powerless transmission, there is no anti-thrust exists. Fiber expansion joint can simplify the design, avoid the use of large bearings, save a lot of materials and labor; ④ Fiber fabrics, fluorine rubber, silicone resin and other materials, high temperature and corrosion resistance determines the fabric expansion joint has good resistance of high temperature, corrosion; ⑤ The cross section shape of fiber fabric expansion joint is varied, suitable for all types of special-shaped pipe; ⑥ light weight, simple structure, easy installation and maintenance. Fabric expansion joint commonly used in the air duct, flue gas exhaust system, dust removal system of thermal power plant.





Pic 2 Diagram of sleeve expansion joint structure



Pic 3 Diagram of fiberglass fabric expansion joint

2.3 Corrugated metal expansion joint

Corrugated metal expansion joint installed in thermal power plant pulverized coal transportation system, turbine generator, pneumatic ash system, heat pipe and other parts.

2.3.1 Expansion joint for steam turbine generating set

Because the radial clearance between the rotor of the steam turbine and the inner wall of the shell and the radial clearance of the shaft seal are small, in order to run smoothly, the turbine and the driven machinery should be strictly centered, It is required that the external force acting on the turbine should be less than the allowable value of the steam turbine, therefore, the pipe connected with the turbine, such as the pipe between middle and low cylinder, extraction steam pipe and exhaust pipe should be used the corrugated expansion joint, change the variable rigid connection to flexible connection to reduce the force acting on the turbine. Place the pipe as far as possible with a long rod of the constraint-type expansion joint

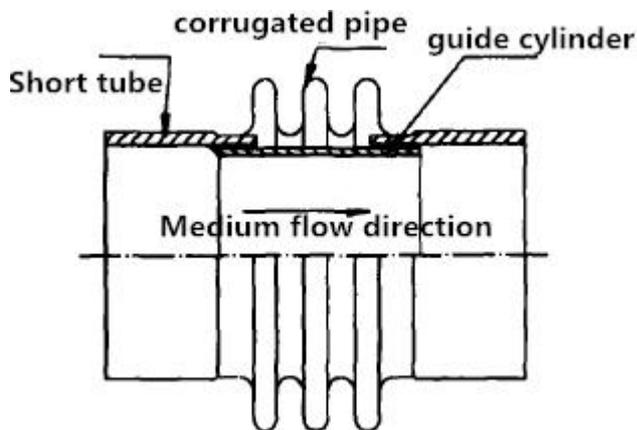




or bend force balance type expansion joint (Pic 4), the force acting on the pull rod, and it will no longer act on the steam turbine to ensure the normal operation of the turbine.

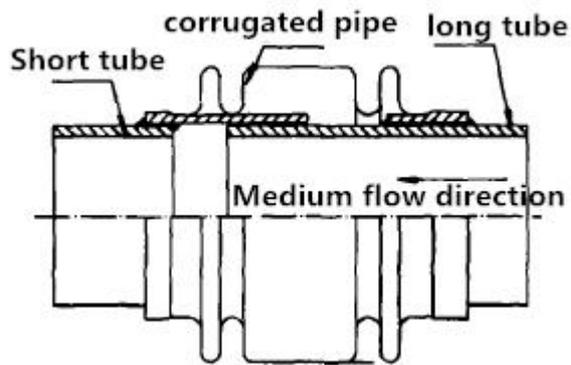
2.3.2 Expansion joint for smoke and wind coal powder pipe and pneumatic ash removal system

The common feature of these two parts is that the medium flow fast ($> 15\text{m/s}$), and it is corrosive. As the high speed of medium resulting in high-speed friction, the erosion of the wall is very serious, which requires expansion joint to have better wear resistance. If the structural design is unreasonable will cause premature damage to the expansion joint. In order to reduce the friction of the media corrode the expansion joint, it's the key to set the guide cylinder reasonably. Ordinary expansion joint is welded in the nozzle on the inner wall of the draft tube (Pic 5-a), so that the diameter of the pipe diameter change raised, exacerbated the friction, even if the selection of thick guide cylinder, will soon eroded, until the destruction. After practice tests, Pic 5-b structure is more reasonable, the connected pipe of this structure expansion joint welded with the pipe, and the connected pipe is guide cylinder, the medium can flow stably and the wear reduced. And the thickness is the same with the pipeline to achieve the same life with the pipe. This type of the corrugated expansion joint has been in use for as long as six years without any problem.



(a) Ordinary structure





(b) Improved structure

3 Conclusion

Expansion joint products are playing a very important role in thermal power plants, with the development of technology, expansion joint will have more economical and practical, reasonable structure of the products in thermal power plant applications.

