PIPING APPLICATIONS: A STUDY OF THERMAL EXPANSION EFFECTS ON SUPPORT SYSTEMS

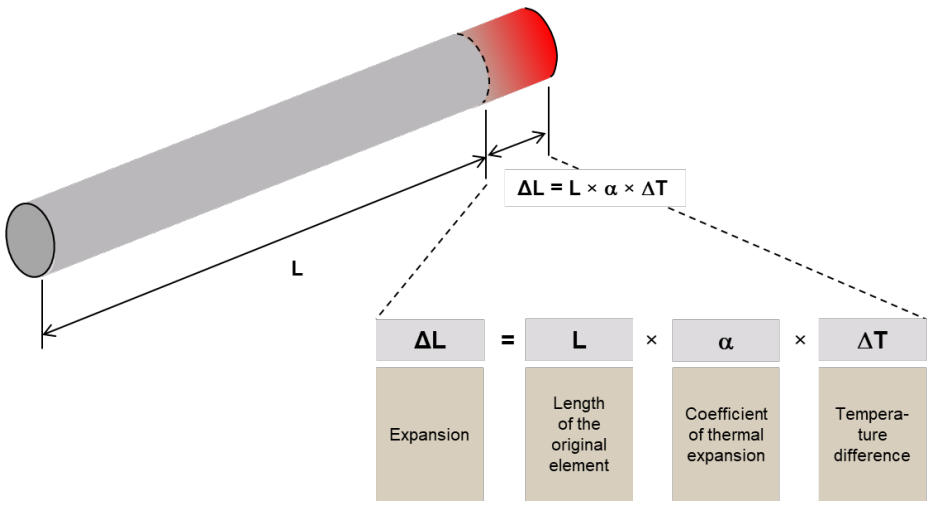
How to control pipe expansions to prevent substructure damages and utility disruptions

In many cases, industrial plants are affected by the transport of fluids or gases at high temperatures that also change in the different operating phases of the plant or production. In other cases, the pipes are exposed to different climatic conditions. In both circumstances, it is possible that a metal pipe undergoes elongation due to temperature variations. It therefore becomes essential to study any expansions of the pipeline, and the consequent forces applied to the supports.

How to define thermal expansions?

Thermal expansion is defined as the variation in length of a pipe that undergoes a certain temperature difference, where this temperature difference is the difference between the operating temperature and the assembly one. The thermal expansion in this case will depend on three factors:

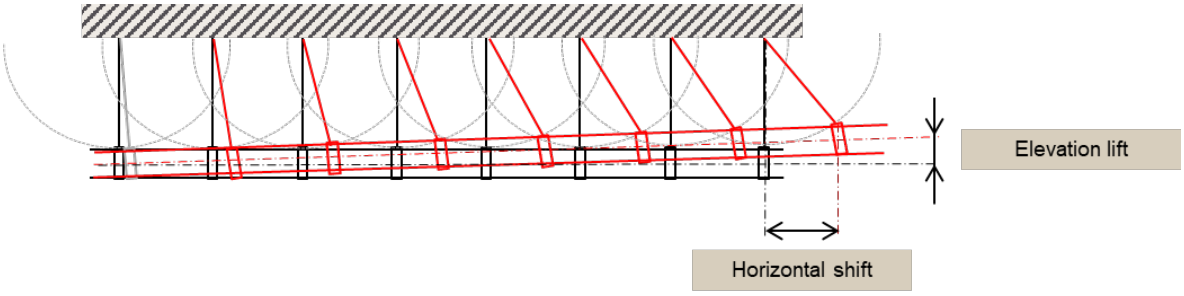
- Length of piping at room temperature
- Coefficient of thermal expansion of the pipe material
- Temperature variation from operating temperature to ambient temperature



What can access in the case of uncontrolled pipe expansions?

The systems interact with the structures and with the support elements, and for this reason it is important to study and control the expansions so as not to damage the system itself, the adjacent systems and the structures to which the system is connected.

Imagine that we have a pipe that is only supported to withstand gravitational vertical loads, and that this pipe is subject to a certain temperature variation ΔT which causes a certain elongation ΔL. If the expansion is not controlled, an effect could be the one shown below, i.e. a horizontal displacement that leads to a rise in the pipe, also deforming the static supports. This can cause breakage of the junction elements of the pipe itself, correspondence of changes in direction, deformation of supports and other damage to the structure.



How to limit the damage and control the deformations of a pipe subject to thermal expansion?

It is possible to avoid damage to pipes or structures as a result of thermal expansion by studying the system in its complexity and evaluating the fixed points (where movement is prevented), the flexible points or the slides (where the movement of the axial direction) and finally the compensation areas.

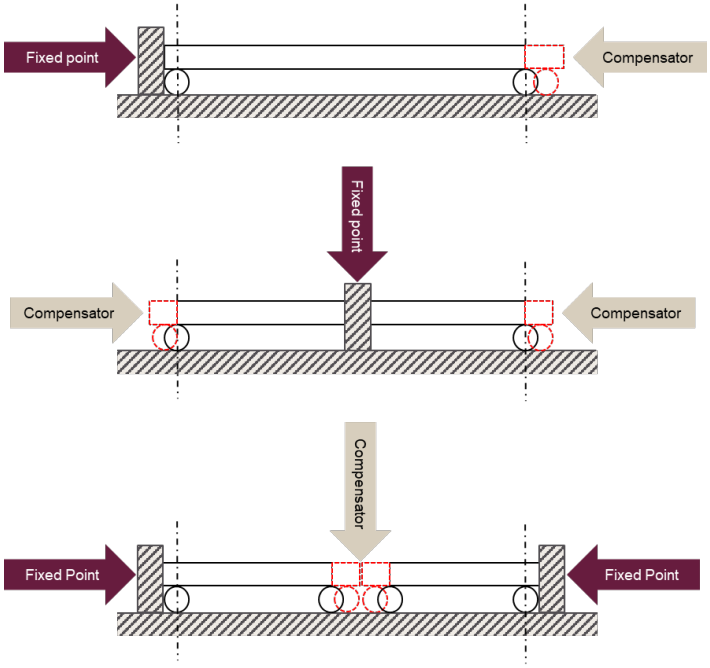
The principle is to reduce or completely eliminate the tensions induced by the thermal effect in the pipeline, thus fixing the piping in one point (through fixed points) and compensating for the expansion through dedicated elements, which can be:

- Natural compensators: made up of pipe bends, an example are the classic lira or omega compensators
- Artificial compensators: made up of pre-industrialized elements such as bellows compensators

This can be done in the following 3 ways:

- Arrange a fixed point on one side of the pipeline, and allow expansion on the other side through a natural or artificial compensator
- Arrange a fixed point in the center of the pipeline and allow expansion on both sides of the pipeline

- Arrange two fixed points at the ends of the pipeline and allow compensation in the center of the pipeline



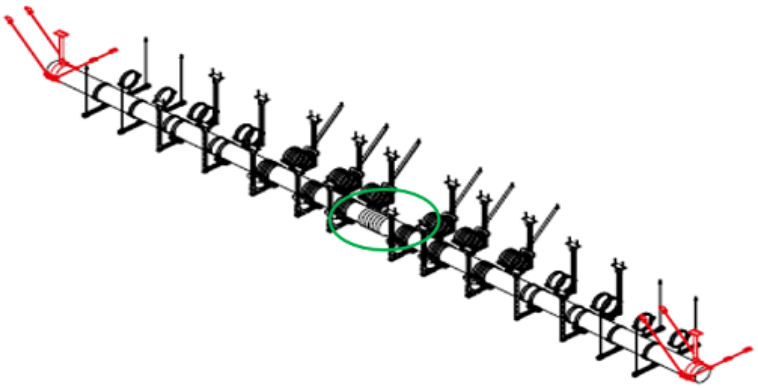
Where to arrange the fixed points?

It is usually a good rule to arrange a fixed point in the center of a straight section of a pipe that has a length greater than 10 m, and consequently define the compensation through natural and artificial compensators.

Precisely for this reason it is important to divide the system into:

- Fixed zone (near fixed points)
- Expansion zone (between the fixed zone and the compensation zone)
- Compensation area (in correspondence with the natural or artificial compensator)

It is important to consider that in the expansion area it is necessary to consider the use of elements that allow the movement of the pipeline in the axial direction in the section between the fixed area and the compensation area. In fact, in the expansion zone it is necessary to statically support the pipe and allow the movement in an axial direction through slides. An example is shown below, where the elements in red represent the fixed points (fixed area), the supports in black are in the expansion area, while the element highlighted in green represents the compensator.



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