walraven
BIS – Better Installation Systems

Data sheet

- Fixing Points and Sliding Devices
- Thermal Expansion per pipe type

Data sheet Fixing Points and Sliding Devices, Thermal Expansion (EN-US) - 03/2011 - PDF - subject to modifications

The expansion and contraction of pipes usually occurs under the influence of temperature changes. Fixing points are applied to pipes with considerable expansion. The fixing point is made to a neutral point so that the pipe can expand in both directions. Slides are applied in between the fixing points, so that the pipe is free to expand and contract.

To select the appropriate fixing point it is necessary to know:

- the pipe material
- the diameter and thickness of the pipe
- the minimum and maximum temperature
- the maximum pressure in the pipe

The expansion and contraction of the pipe can be accommodated:

- in a natural way, in existing bends or expansion loops
- in a designed way, for example by using a compensator

When a compensator is being used, consideration must be given to the pressure in the pipe. Therefore, it is preferable to accommodate the expansion in a natural way. The fixing point is used to ensure that the expansion is directed to the expansion loop or compensator where the force and movement is controlled. The pipe fixings between the fixing point and the expansion loop, only guide the pipe. At these ‘guiding points’ it is important that the friction resistance is by the fixing point.

When an expansion loop is being used, the distance between the first guiding clamp and the loop is important. The smaller this distance, the bigger the force to bend the pipe and the bigger the expansion to loose in the bend. This force is transferred to the fixing point.

The occurring force on a fixing point $\mathbf{F_f}$ when using an expansion loop:

1. The friction force caused by the slides $\mathbf{F_w}$;
2. The force caused by the bending of the expansion loop $\mathbf{F_b}$.

$$F_f = F_w + F_b$$

To determine the bending force $\mathbf{F_b}$, first determine the length of the expansion loop. The length of this loop depends on the change in length of the pipe. The change of length of the pipe **ΔL** depends on the length between the fix point and the expansion bend, the co-efficient of expansion L of the pipe material and the difference in temperature **ΔT**.

$$\Delta L = L \times \alpha \times \Delta T$$

The length of the expansion bend $\mathbf{L_b}$ depends on the expansion ΔL, the outside diameter of the pipe $\mathbf{D_b}$ and the material properties of the pipe **K**.
K depends on the elasticity modulus of the pipe material **E** and the maximum allowable/acceptable tension in the material **σ**.

$$K = \sqrt{(1.5 \times E)/\sigma}$$

$$L_b = K \sqrt{(D_b \times \Delta L)}$$

The bending force **Fb** depends on the moment of inertia **I** of the pipe, the length of the expansion bend $\mathbf{L_b}$ and the wall thickness of the pipe $\mathbf{D_b - D_i}$.

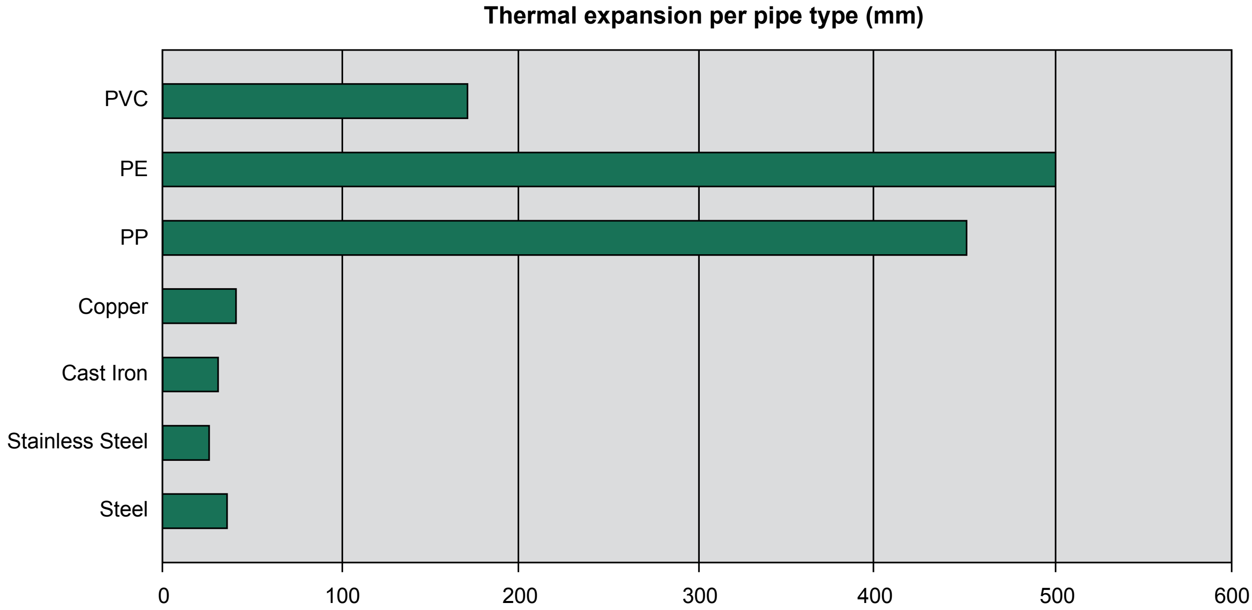
$$F_b = \frac{\sigma \times \pi\ (D_b^4 - D_i^{4)}}{32 \times D_b \times L_b}$$

The friction force $\mathbf{F_w}$ depends on the co-efficient of friction μ of the slides and the loads **F** to the slides. The load consists of the weight of the pipe and the content $\mathbf{F_p}$.

$$F_w = F_p \times \mu$$

Legend:

F_f	force to the fixing point	N	L_b	length of the expansion bend	mm
F_w	friction force	N	ΔL (Delta L)	change of length of the pipe	mm
F_p	weight of the pipe plus content	N	ΔT (Delta T)	change maximum and minimum temperature	°C
F_b	force to bend the expansion bend	N			
D_b	outside diameter of the pipe	mm	α (Alfa)	linear expansion co-efficient of the pipe material	mm/m°C
D_i	inside diameter of the pipe	mm			
I	moment of inertia of the pipe	mm^4	μ (Mu)	friction co-efficient of the slide	
E	elasticity modulus of the pipe material	N/mm^2	σ (Sigma)	maximum acceptable tension in the pipe	N/mm^2
K	material constant		π (Pi)	mathematic number 3.142	



Pipe length: 50 meter,
Temperature difference: +50°C

Calculation method:

ΔL= L x α x ΔT
ΔL= length change in mm
L = pipe length in meters
α = linear expansion coefficient
ΔT= temperature difference T-max. - T-min.

Pipe material	Expansion*
	(mm/m °C)
PVC	0,0700
PE	0,2000
PP	0,1800
Copper	0,0170
Cast iron	0,0115
Stainless Steel	0,0100
Steel	0,0120
* indication	

Example 1:

Pipe material: Steel
Pipe length : 20 meter
T-max. = +60°C
T-min. = +20°C
Installation temperature : +20°C
ΔT = +60°C - +20°C = 40°C (difference minimum/maximum temperature)
ΔL = 20 x 0.012 x 40 = 9,6 mm (expansion in mm = 20 x 40 x α = 9,6 mm)

Please note: if the installation temperature is higher than T-min. (for example coolant pipes) the pipe will contract a certain length.

Example 2:

Pipe material: Stainless Steel
Pipe length: 50 meter
T-min. = -30°C
T-max. = +30°C
Installation temperature: +20°C
ΔT warm = +30°C - +20°C = 10°C
ΔT cold = +20°C - -30°C = 50°C
ΔT total = ΔT warm + ΔT cold = 10°C + 50°C = 60°C
ΔL warm = 50 x 0.01 x 10 = 5 mm expansion
ΔL cold = 50 x 0.01 x 50 = 25 mm contraction