Chapter:	Precautions
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Description:	The temperatures in a solar collector loop are more deviating than in a conventional district heating network and the equipment must therefore be able to withstand the thermal stress.
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Introduction

The difference in temperature of the components can be quite large between night and day – especially in Northern European countries. In some situations the temperature may go from -30 ℃ (ambient temperature) to 95 ℃ (operating temperature) during start up of normal operation, i.e. a difference of 125 K. It might even be higher if a higher operating temperature is used. All components and each connection in the system have to be able to cope with the expansion and contraction associated with the temperature variations. If the pipes are dimensioned for one load cycle* per day during a lifetime of 30 years, they have to be able to withstand a total of (30 years x 365 days) 10950 load cycles.

Due to this increased number of load cycles compared to normal district heating network pipes the type of soil surrounding the pipes can play a role concerning the lifetime of the pipes. Preliminary investigations show that certain soil types may have a potentially destructive effect on the pipes. The pipe manufacturer should be consulted before choosing the filling material for the trenches where the pipes are placed. [1]

Expansion of components

In table 8.1.1 the temperature expansion of different component materials are listed. The “maximum expected expansion at normal operation” is based on variations which may appear on a daily basis in some regions. The “extreme expansion” should preferably be avoided completely, but in case of stagnation of collector fluid, as a result of pump failure, it might be inevitable. The system must be able to comprehend such an extreme expansion to avoid the considerable damage repair costs if the extreme situation should arise.

Table 8.1.1. Temperature expansion of different component materials.

Material	Linear temperature expansion coefficient [2] [10^{-3} mm/(m·K)]	Maximum expected expansion at normal operation (ΔT = 125 K) [mm/m]	Extreme expansion in case of fluid stagnation (ΔT = 185 K) [mm/m]
Aluminium	22.2	2.8	4.1
Brass	18.7	2.3	3.5
Copper	16.6	2.1	3.1
Steel	13.0	1.6	2.4
Iron (forged)	11.3	1.4	2.1

* *One load cycle: Heated up from ambient temperature to operating temperature and cooled down to ambient temperature again.*

For cobber pipes an example of the expansion is seen in figure 8.1.1 below.

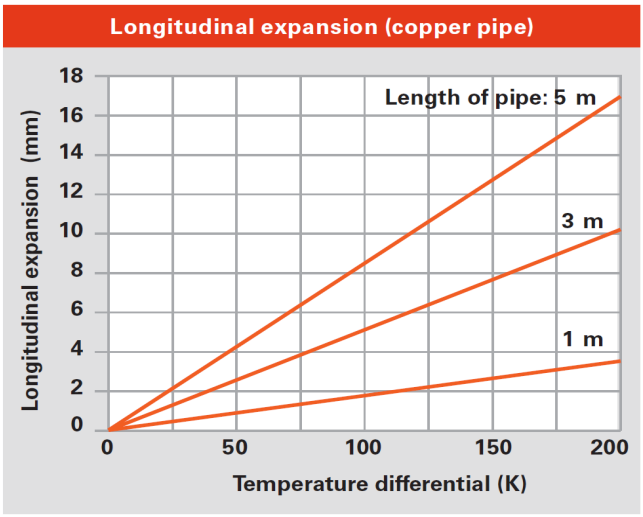

Figure 8.1.1. Longitudinal expansion of cobber pipes [3]. *As seen in table 8.1.1 the expansion is almost 30 % larger than for steel pipes.*

To avoid too large mechanical stresses, several options are possible which will handle the expansion of the pipes. Three examples are shown in figure 8.1.2.

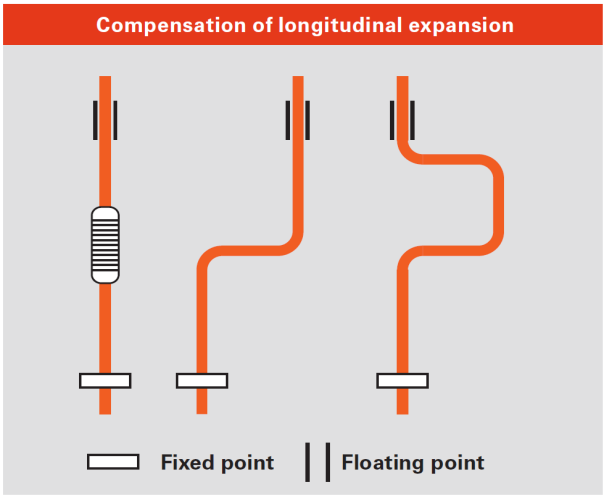

Figure 8.1.2. Pipes including compensation for longitudinal expansion [3].

Solar collector fluid expansion

An expansion device is necessary for all large solar systems. This allows for volume changes of collector

fluid caused by volumetric thermal expansion without unallowable increasing of pressure and unnecessary collector fluid loss that is caused by opening of the safety valve. Several smaller expansion vessels instead of one large vessel minimize the risk of damage if a failure in one of the vessels should occur. The membrane of the expansion vessel(s) must be resistant to collector substance exposure, high temperatures and pressures. Usually a nitrile membrane is used.

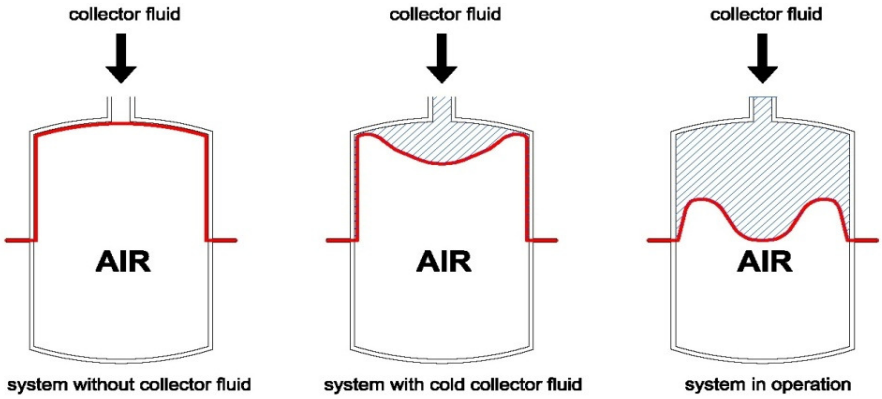

Figure 8.1.3. Cross section of expansion vessel in different situations. (Source: CityPlan – based on [4])

In case of extreme pressure in the solar collector loop due to pump failure, a safety valve should open to let some of the fluid out of the loop and into a container in order to decrease the pressure. The boiling may continue inside the collectors and they should be able to cope with the associated pressure in short periods. Further information on handling stagnation pressure and temperatures are described in fact sheet 8.2 *"Safety equipment"*.

References

[1] Pipe-Soil interaction in large solar thermal heating and cooling plants, I. Weidlich & D. Trier, August 2011.

[2] The Engineering Toolbox www.engineeringtoolbox.com/linear-expansion-coefficients-d_95.html

[3] "Technical guide – Solar thermal systems" p. 82, Viessmann GmbH, 2009.

[4] Solární tepelné soustavy (Solar thermal systems), MATUŠKA T. Společnost pro techniku prostředí – odborná sekce Alternativní zdroje energie, 2009.

The SDH fact sheets addresses both technical and non-technical issues, and provide state-of-the-art industry guidelines to which utilities can refer when considering/realizing SDH plants. For further information on Solar District Heating and the SDHtake-off project please visit www.solar-district-heating.eu.

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