THE RIGHT PRE-INSULATED PIPE SYSTEM FOR LARGE-SCALE SOLAR DISTRICT HEATING NETWORKS

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Abstract – A pre-insulated pipe system for a solar district heating pipe system is more difficult to design than a normal district heating network in a city. The reason is the number of temperature cycles in a solar district heating network. Wrong static design and wrong choice of products are expensive learnings. It is crucial to optimize the static design and choice of products with the right assumptions in order to achieve the expected service life. The operating costs, stemming from the heat loss are a big part of the total cost of ownership of the district heating network. It is therefore essential to choose the right pre-insulated pipe system together with the right static design so that the total cost of ownership will be lowest possible under the given assumptions in a specific project.

1. EXPERIENCE WITH SOLAR NETWORKS

Especially Denmark has many years' of experience with establishing large-scale solar district heating projects, and therefore has a vast experience with the district heating system for solar panel fields, collecting heat from the sun. In many cases a dearly bought experience.

The design of the first district heating systems for solar district heating projects was typically based on the knowhow from traditional district heating in cities both as regards the design of the pipe system as well as the choice of products like casing joints and components.

The knowhow and attention to the conditions, which a solar district heating project is exposed to simply were inadequate. This applies to the temperature, but especially to the number of temperature cycles which district heating pipes are exposed to during the service life of the system. The number of temperature cycles taken into account were far from sufficient.

The number of temperature cycles in a pipe system for a solar district heating field may be 40 times higher than the number in a conventional district heating system, designed in accordance with the European standards. If this is not taken into account in the design of the system and choice of products, there is a risk of the casing joints peeling off and fatigue failure in T-pieces, bends, and other components. See Fig. 1-5.

Fig. 1 - Branch, damaged by large movements.

Fig. 2 - Moisture spread, stemming from a casing joint, damaged by large movements.

Fig. 3 - Released copper ions from brass valve, causing corrosion of the steel pipe. The damage is on the return pipe. No damage on the flow pipe.

Fig. 4 - Shrink wrap peeled off due to the large number of movements.

Fig. 5 - Dislocated casing joint due to the large number of movements

2. DESIGN CRITERIA

2.1 Standard district heating systems

Standard district heating systems are designed in accordance with the specifications in EN 13941.

In relation to the number of load cycles the system is designed for a minimum service life of 30 years with the following number of load cycles:

Transmission pipelines	100
Distribution pipelines	250
House connections	1000

A full temperature load cycle appears from Fig. 6 where 1 is the time and 2 the temperature cycle in relation to the mean temperature.

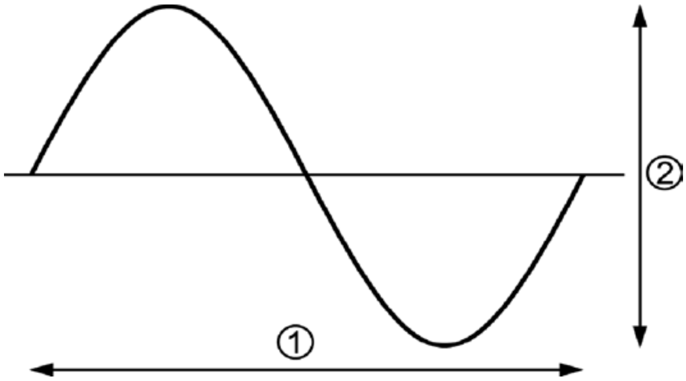

Fig. 6 - Full temperature cycle

2.2. Large-scale solar district heating systems

In solar district heating projects the extent of temperature load cycles is much larger, what is decisive for the system design.

For the hot pipeline it is not unusual to apply the following conditions:

Design temperature: 10–110°C (cyclic load, 1 cycle/day)

Short-term temperature peak: 110-150°C max. 5 hrs twice a year

Full load cycles during 30 years' service life: 10950 cycles.

The cold pipeline will naturally have a considerably lower number of full temperature load cycles, but still more than in a normal district heating system.

The solar district heating pipe system must be designed to cope with the vast number of full load cycles – both as regards handling the movement itself and the fatigue in the steel.

In general directional changes in solar district heating systems should be made as 90° bends.

3. THE RIGHT PRODUCT CHOICE

It is crucial to choose components, which can withstand the large movements in the solar district heating system.

3.1 The system

In the solar panel field single pipes must always be used.

3.2 Pre-insulated components

Fundamentally, branches and bends must be carried out with pre-insulated components. T-joint or bend joint solutions is not applicable.

3.3 Casing joints

Experience has taught that most shrink joint solutions or solutions with shrink wrap/collars cannot withstand the large number of temperature load cycles. They are simply dislocated from the position, where they are installed due to the friction between the casing joint and the surrounding material.

Weld joint solutions should therefore always be used for solar district heating projects, so the PE casing and PE casing joint are welded together.

3.4 Standpipes for solar panel connection

Around the standpipes there must always be room for free movement. This is ensured by inserting the pipe in an empty conductor pipe, which allows full movement in the temperature range, which the system operates in. See Fig. 7 as regards the conductor pipe solution.

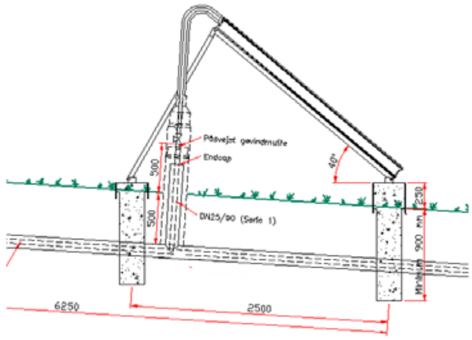

Fig. 7 - Principle for vertical introduction to the solar panel

3.5 Pipes with branches to the standpipes

It is advantageous to make pipes with branches to the standpipes, designed for the specific project. Indoor manufacturing of such pipes ensures the optimum conditions for making special solutions of high quality.

Fig. 8 and 9 - Standpipes made indoor. In the indoor factory straight pipelines are manufactured with standpipes, designed so they match the exact position of the solar panels.

4. CONCLUSION

In the preceding the importance of designing the pipe system according to the actual conditions it is subjected to in the daily operation during its entire service life has been established. Both as regards static design, but also as regards the choice of components. If this is done in circumspection, the conditions for achieving the expected service life of the system without operational disruptions are ensured.

This helps ensuring the lowest possible total costs of a solar district heating system during the service life of the pipes.

Another factor with a heavy impact on the total costs during the service life of the system is the heat loss from the pre-insulated pipe system. To ensure the lowest total costs during the service life of the pipe system it is crucial that the insulation of the pipes is optimized and the pipe with the optimum insulating properties is chosen. The pipe system must be optimized, so the heat loss costs during the service life of the pipe system plus the investment in the pipe system are as low as possible.

With LOGSTOR's calculation tool ”Calculator” the total costs, including the heat loss, can be calculated for various solution scenarios and on this basis the best solution for the specific project can be chosen.

See Fig. 10, which is an example of the difference in heat loss per year for different pipe solutions. The difference may be the insulation series, but also pipes with the property that its low heat loss remains unchanged during the service life of the system. This is the case with LOGSTOR ContiPipes with diffusion barrier between the PE casing and the foam, ensuring that the insulating gases in the foam do not diffuse out over time.

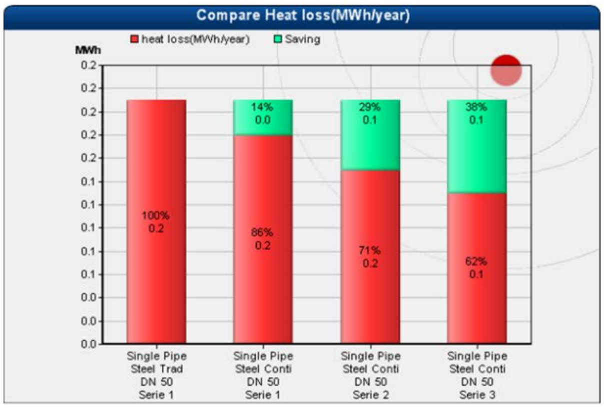

Fig. 10 - Comparison of the heat loss per year for different pipe solutions. Steel trad are traditionally foamed pipes without diffusion barrier. Steel conti are pipes with diffusion barrier.