

Thermal Pre-stressing of Plastic Jacket Pipes, the Managed Safety Concept !

In light of the pressure to reduce costs the concept of cold laying of pipes is momentarily a main point of discussion. Without doubt, this concept is an interesting technology. Primary is the concept of cost reduction during the actual laying of the pipe. Additional costs occurring in the planning phase and speciality components appear to be less considered. The actual performance of this method will only be evident over the thirty years or so of predicted life expectancy of the piping.

The primary factor effecting the integrity and operational availability of the plastic jacket pipe network lies in the controlled and certified achievement of a stress reduction with the aim to minimise elongation and contraction of the system under varying temperatures during use. This is conditional for the durability of the media pipe / foam / jacket compound, integrity of joints, prevention of wire ruptures in leak warning systems, all on using standard tube components available world-wide.

Thermal pre-stressing – a technology based on the elementary laws of physics – unconditionally meets with these demands. The piping will extend through a rise in temperature from about 10°C laying temperature to 130°C during operation. The earth covering of the pipe system considerably limits the extension and the limitation of the stretching capability of the system can be exceeded. However, if the system has been pre-heated to approx. 75°C and then covered by earth and fixated, only half of the potential elongation limits are achieved resulting in a 100% higher integrity margin for the system.

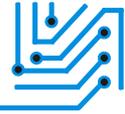
For pre-stressing of the system a variety of known, tested and documented procedures are available. This allows for a cost-effective approach to each situation and system.

By objective analysis of cost benefit ratios, thermal pre-stressing comes into play starting at DN 100. For smaller diameters, use of elbows or cold laying are the methods of choice. In the area up to DN 250, thermal pre-stressing can be the preferred choice vs. conventional compensation elements. To reach the predicted life expectancy of a system => DN 250, thermal pre-stressing has to be used as routine.

However, the technical possibilities, limitations and costs of the various modalities must be observed.

There are three types available:

1. Thermal pre-stressing with hot water
2. Thermal pre-stressing with steam
3. Electro-thermal pre-stressing



Thermal Pre-stressing with Hot Water

Pre-heating with hot water offers cost advantages, when available heated water in the existing network can be conducted in the new one and remain online.

The section to be pre-heated must be sealed and parallel-running pipes might be joined in a closed loop system. In an operational system between the closure elements this exists, however if the pipes after pre-heating need to be emptied, a number of problems occur in evacuating the pipes, as well as additional costs.

The temperature required within the system can be easily calculated and maintained by mixing both forth and back flow within the closed system. During summer periods additional hot water may be required via an independent hot water heating vat if needed.

The pre-calculated elongation of the pipe is verified in the pre-stressing process, and if necessary the filled pipe can be lifted to reducing friction to reach the desired extension. Due to the important weight of the heating medium and the effect of increasing friction reducing the capability of extension, the hot water method is limited to pipes up to DN 250.

Thermal Pre-Stressing with Steam

In particular with pipes of large diameters and single pipe systems, this type of pre-stressing becomes meaningful. The weight of the steam is meaningless compared to the weight of the pipes themselves, and therefore does not influence their extension.

The pipes to be pre-heated must be closed and be able to be aerated in a controlled fashion. In so far as the closures are not valves in nature, they must be removed after pre-stressing. The condensation occurring in the pipe results in affordable elimination and drying effort.

The necessary steam is prepared in mobile steam generators and expanded into the pipe that was previously evacuated by means of a vacuum pump. Alternatively, the pipe can be pre-flooded with steam and then kept closed using valves until the desired extension has been achieved. In this method, residual air and condensation can be pumped out during the inactive periods, in particular in areas of unequal height by section.

The pre-heating with steam allows for a fast and equal temperature spread over a longer section maintaining good temperature and extension controls. However the material and effort required by the operator should not be underestimated, as High- Low- pressure - steam generators may not be operated without continuous supervision.



Electro-Thermal Pre-Stressing

By electro-thermal pre-stressing, the heating of the pipes is achieved through direct resistance heating of the steel pipes using high direct current. This system can be applied to all pipe diameters.

Electro-thermal pre-stressing includes all of the advantages of steam, however does not have the disadvantage of condensation and air residuals. The pipes remain dry and are less likely to corrode.

As opposed to the previous methods, the pipes do not have to be sealed. The length of the pipe sections to be pre-stressed is, depending on their diameters, a choice of from 10 to 1.600 m, determined by the relevant regulations for electrical safety, which must be observed.

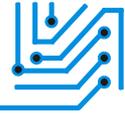
Another possibility is the ‚Pilgrim Step Method‘ whereby the pipes are laid in the open trench and, on reaching their required extension through pre-stressing, sand is filled over the stressed section of pipes. A manhole area is kept free at a distance of 1,5 times the extension value from the end of the pipe section. From that point the next section will be pre-heated. This allows for the extension value of the first section to be taken over in the next section. This method allows for various lengths of choice to be determined by the operator. Also the so-called Pipeline-Method can use this pre-stressing methodology.

In particular in areas of high density traffic within city limits, where time is limited to lay piping, the „manhole“ method is useful. This allows for different pipe sections to be pre-stressed simultaneously, when using electrical shunts. It is also possible using this pre-stressing method to let two pipes ends „grow“ towards each other and then weld them together. The statical construction is the same as for „one-time-compensators“, however, costs for material, longer special joints and additional welding works and proofs do not occur.

The required energy-input in the electrothermal pre-stressing process and the temperature profile at the pipe are technically fully controlled.

Preplanning of the steps and values for control of the extension results are together with the work step protocol joined in the master protocol. Specialists in pre-stressing generally supply such site-specific documentation.

There are a number of systems available like truck based large units with built in energy source - which need specialized personnel and enough scope for action on the site - or compact modular systems.



Compact modules can easily be moved from one site to another, placed directly to the labour-spot with small handling-equipment, and set up with minimum effort. The connection of multiple modules together allows for any kind of pre-stressing capacity.

The length of the pipe sections to be pre-stressed can be between 10 to 4.000 meters, depending on their diameter and also determined by the relevant regulations for electrical safety at the building site. It is also possible to use speciality adapters to pre-stress over different diameters.

Connection and use of the module systems are simple enough for minimum training in use by the site team. The user can supply his own energy source further reducing costs and optimising the system.

Major advantages of thermal pre-stressing:

Thermal pre-stressing offers, independent of method, basic advantages over all other procedures of pipe laying.

- Widely used and safe calculating method for the planning and laying of pipes with pre-determined values.
- Control of the pre-heating results done easily on site.
- Use of standard pipe components without additional reinforcement etc.
- Reduces the risk of arching up due to side excavation
- Minimisation of extension components (welding sites) and extension cushions
- Ability to work sectionally
- Simple repair
- Extension possibility at a later date and also via drilling

Keeping these aspects in mind is mandatory for a modern quality management concept.