FERNWÄRME-TECHNIK GmbH

FW LNG-PIPE

Liquid Natural Gas -162°C
FW STEEL-CASED PIPE-IN-PIPE systems for LNG-Powered Ships

The FW LNG-PIPE-SYSTEM

Liquefied **N**atural **G**as

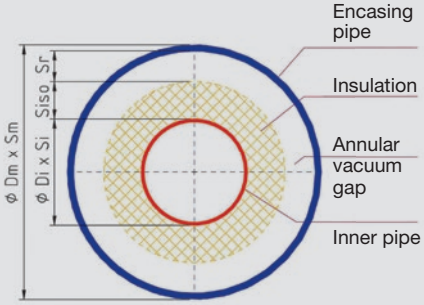
LNG (Liquefied Natural Gas) is liquefied by cooling natural gas to -162°C. Afterwards, its volume is reduced to just around 1/600th of the fuel volume in its gaseous state.
This makes it possible to also transport natural gas safely and inexpensively across long distances or to remote regions without a pipeline. LNG terminals are used for the liquefaction or reconversion to the gaseous state. Once the conveyed liquid gas has been pumped from the terminal to land and reconverted to its gaseous state, it can easily be fed into the pipeline network.

The LNG transport chain

The LNG transport chain can be subdivided into four activities: Exploration and production, liquefaction, transport and storage, and conversion back to gas.
Currently it is only practical to use and trade liquefied natural gas at transport distances > 3000 km. LNG ships are used for transport. The natural gas pipeline Russia-Germany through the Baltic Sea – 1200 km in length – transports the gas in a gaseous state.

Supply options

Changing the aggregate state from gaseous to liquid reduces the volume by 600 times. In the course of the progress in LNG technology made up to now and with a view to future knowledge, a general increase in the significance of the „LNG“ supply option is very likely.



FW LNG-PIPE system for the transport of liquid gas on ships

The FW LNG-PIPE is a double-pipe system designed for the transport of fluids on ships. The ship is also powered by LNG.
It consists of an inner pipe which transports the media, a cold-resistant heat insulation layer, and a encasing pipe. The inner pipeline is guided by bearings within the encasing pipe. End closures for sealing the ring space are installed at the ends of the FW LNG-PIPE. The ring space is evacuated to 1 mbar to reduce the heat transfer to the medium and the cooling of the encasing pipe.

The system is continuously monitored by the pressure in the ring space, which also ensures leakage detection. Wall ducts are used to route the FW LNG-PIPE through the bulkhead partitions.
The FW LNG-PIPE system is designed for the specific usage conditions. The product development included the construction of a 50-m long simulation route on the factory premises. The pipeline was operated with liquid nitrogen at a temperature of -196°C. More than 100 measuring sensors were attached to the test line. It could be proven in the trials that the FW LNG-PIPE meets all the requirements on the piping system for transporting liquefied gas.

Components and materials

FW LNG-PIPE consists of:

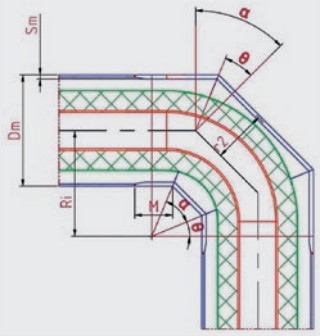
- Inner pipe
- Heat insulation
- Encasing pipe

Pipes produced from the material ASTM A312 TP316/TP316L in accordance with ASME B36.19M/B36.10M with an acceptance test certificate 3.2 as per EN 10204 are used as the material for the inner pipe and encasing pipe.
The pipes are heat-insulated by a flexible silicate aerogel insula-tion for cryogenic applications of the Cryogel type.

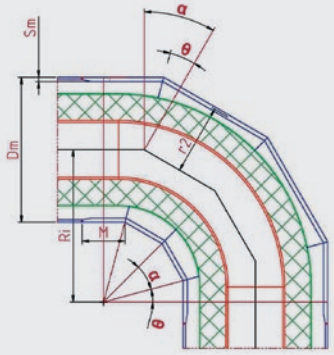
Production

FW LNG-PIPE is manufactured to project requirements. The dimensioning and static pipe calculations of the pipelines are carried out by FW-FERNWÄRME-TECHNIK GmbH on the basis of customer specifications and customer isometry.
The results of the calculations and the customer isometry form the basis for the creation of the production documents and the associated pipe-laying plan for the on-site installation.

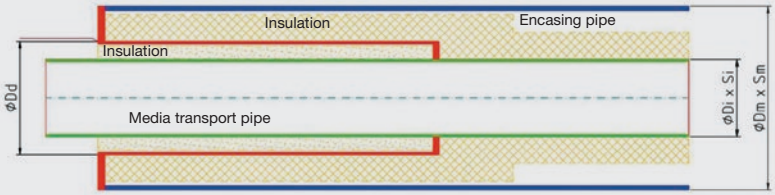
Prefabricated SIS pipe bend



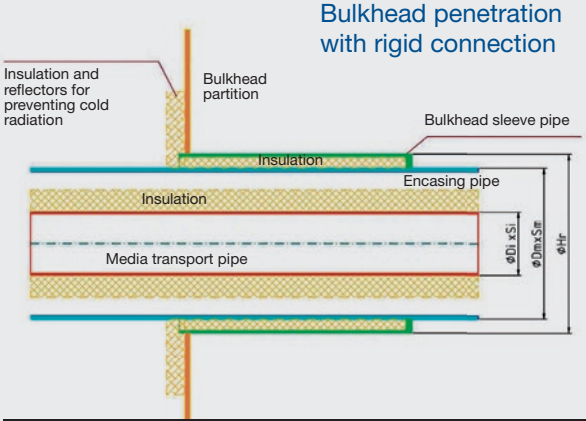
SIS pipe bend with multiple segments for large dimensions



End fixpoint



Bulkhead penetration with rigid connection



Inner pipe		Encasing pipe		Ring space	
Outer diameter Di	Wall-thickness Si	Outer diameter Dm	Wall-thickness Sm	Insulation thickness Siso	Annular gap Sr
inch	Schedule	inch	Schedule	mm	mm
1“	10S	4“	10S	20	17
2“	10S	6“	10S	30	21
3“	10S	8“	10S	40	21
4“	10S	10“	20	40	33
6“	10S	12“	20	50	21

FW STEEL-CASED PIPE-IN-PIPE systems

According to unverified sources, a Frenchman inserted a steel pipe inside another one to convey steam through the inner pipe. The steel casing pipe system was born.

At the end of 1970, FW-FERNWÄRME-TECHNIK GmbH designed and used the first thermally pre-stressed double-pipe systems. The technology has been continuously improved. FW STEEL-CASED PIPE-IN-PIPE systems are currently among the safest district heating pipelines and demonstrate their durable use at operating temperatures of up to 400°C and in remote locations having the highest degrees of difficulty for pipe laying.

In 2010, FW-FERNWÄRME-TECHNIK GmbH started to further develop the double-pipe system for low-temperature applications. Since it is difficult to procure liquefied natural gas as a cylinder rack, the trials were performed with liquid nitrogen at a temperature of -196°C.

The development work focused on

- Materials testing with liquid nitrogen
- Trials for the material selection for inner, casing, and insulation materials

NEWEST TECHNOLOGY

High performance, flexible, industrial insulation for sub-ambient and cryogenic applications

Cryogel® Z flexible aerogel blanket insulation is engineered to deliver maximum thermal protection with minimal weight and thickness. Ideal for use in subambient and cryogenic applications, Cryogel® Z incorporates an integral vapor retarder with zero water vapor permeability to ensure maximum protection of your assets.
Cryogel® Z insulation features unique silica aerogel within a flexible fiber blanket to deliver industry-leading thermal performance in an easy-to-handle and environmentally safe product.
Cryogel® Z's extremely low thermal conductivity reduces heat gain and liquid boil-off. The inherent flexibility of Cryogel® Z's blanket form minimizes installation labor, eliminates the need for contraction joints, and makes the product durable and resistant to mechanical abuse.

FW STEEL-CASED PIPE-IN-PIPE systems for shipbuilding

In the period from 15 May 2013 to 30 June 2015, the state of Lower Saxony assisted in completing the „development to product maturity of a triple pipeline system for the underground transport of LNG and crude oil“ on the premises of FW-FERNWÄRME-TECHNIK GmbH in Celle.
It provided information which could be successfully used for the prefabrication of FW-LNG pipelines for shipbuilding.

FW STEEL-CASED PIPE-IN-PIPE systems with their vacuum-tight casing pipe ring space provide an improvement in the insulation effectiveness of around 40 %.

- They protect the insulation installed here
- They prevent oxygen penetration

Properties which cannot be achieved by a single-wall pipe.
The LNG connection lines between the tank and machine rooms and the bunker station were prefabricated as FW LNG-PIPE for two ships in China and two additional ships in the USA.

FW LNG-PIPE is currently being used by order of TGE Marine Gas Engineering for an LNG-powered crane ship.
The ship is being built in Asia; the LNG connection lines, which require monitoring, are also designed here as FW LNG-PIPE.
The planning and production is in turn being carried out at FW-FERNWÄRME-TECHNIK GmbH.

Specifications

Calculation data:
Medium: LNG
Temperature: -196°C
Pressure: 19 bar

Delivery of FW LNG-PIPE
FW LNG-PIPE in prefabricated construction units in lengths of 6 -12 m, consisting of:

Inner pipe of seamless or welded steel pipe
ASTM A 312 material TP316/ TP316L, dimensions according to ASME B 36.19M/B 36.10M or EN 10216-5/ EN10217-7, 1.4401/1.4404, dimensions according to EN ISO 1127 with acceptance test certificate in accordance with DIN EN 10204/3.1

Signal and monitoring system Remote vacuum monitoring

Cryogel heat insulation, flexible insulating aerogel mat 160 kg/m³, temperature resistant -270°C to +90 °C or equivalent, insulated in many layers, also thoroughly insulated at the pipe bearings and fastened with stainless steel bands.

Encasing pipe made from welded steel pipe
ASTM A 312 material TP316/ TP316L, dimensions according to ASME B 36.19M/B 36.10M or EN 10217-7, 1.4401/1.4404, dimensions according to EN ISO 1127 with acceptance test certificate in accordance with DIN EN 10204/3.1

Construction project: _____ **Project No.:** _____

Item	Quantity	Unit	Description		
1		lin. m	**FW-LNG-PIPE**		
			Inner pipe	Inch 1“	(33,7 x 2,77 mm)
			Encasing pipe	Inch 4“	(114,3 x 3,05 mm)
			Insulation thickness of encasing pipe material	mm 20	
			Assembly	On site	
2		lin. m	**FW-LNG-PIPE**		
			Inner pipe	Inch 2“	(60,3 x 2,77 mm)
			Encasing pipe	Inch 6“	(168,3 x 3,4 mm)
			Insulation thickness of encasing pipe material	mm 30	
			Assembly	On site	
3		lin. m	**FW-LNG-PIPE**		
			Inner pipe	Inch 4“	(114,3 x 3,05 mm)
			Encasing pipe	Inch 10“	(273,0 x 6,35 mm)
			Insulation thickness of encasing pipe material	mm 40	
			Assembly	On site	
4		lin. m	**FW-LNG-PIPE**		
			Inner pipe	Inch 6“	(168,3 x 3,4 mm)
			Encasing pipe	Inch 12“	(323,8 x 6,35 mm)
			Insulation thickness of encasing pipe material	mm 50	
			Assembly	On site	

Item	Quantity	Unit	Description
5		Pcs	**46-90° bends, suitable for the pipe in Pos. 1** consisting of a encasing pipe bend, mitred, and an inner pipe bend according to ASME B 16.9 with the same wall thickness as the inner pipe. Prefabricated and attached to a construction unit. Surcharge
6		Pcs	as before but suitable for the pipe shown in Pos. 2 Surcharge
7		Pcs	**End fixpoint suitable for the pipe in Pos. 1** consisting of end fixpoint plates and a spacer pipe for heat separation, welded vacuum-tight between the inner pipe and the encasing pipe. Prefabricated and attached to a construction unit. Surcharge
8		Pcs	as before but suitable for the pipe shown in Pos. 2 Surcharge
9		Pcs	**Flexible bulkhead connection, suitable for the pipe in Pos. 1** consisting of protective pipe with welded encasing pipe ring, with axial/lateral compensator, inner insulation 20 mm. Prefabricated and attached to a construction unit. Surcharge
10		Pcs	as before but suitable for the pipe shown in Pos. 2 Surcharge
11		Pcs	**On-site connection materials suitable for the pipe in Pos. 1** consisting of the aforementioned encasing pipe for the production and adaptation of half shells at the construction site. Glass tape to protect the heat insulation during the welding operations. Heat insulation with stainless-steel tape and clasps. Welding additives provided by the customer. Surcharge

The FW-CHAMBER-PIPE and the history of its development

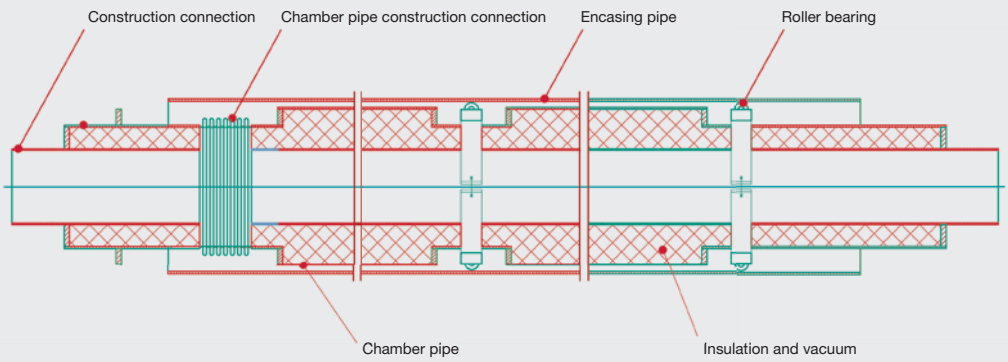
FW-FERNWÄRME-TECHNIK GmbH designed FW STEEL-CASED PIPE-IN-PIPES for a country in Asia. It was produced and installed locally; the 16 m long construction units were installed in the trenches and largely the inner pipes were welded.
The open encasing-pipe on-site connections should be closed with rubber mats specially developed for this purpose in a way that no water can penetrate the encasing pipes.

The encasing pipes were carelessly left unsealed. A typhoon touched down on the construction site in the two days afterwards and forced large volumes of water into the encasing pipes. With reference made to a set commissioning deadline, the installation company insisted on starting operation with the four steel casing pipelines lying in a trench in parallel – all of which were flooded – one week later.

We tried to prevent this because temperatures of up to 285°C destroy the mineral fibre insulation.
And this is precisely what occurred.

In order to rule out the chance of recurrence, we considered protecting the heat insulation by a third pipe fitted over the entire construction unit length and developed the FW CHAMBER-PIPE.

FW CHAMBER-PIPE



Qualität
made by FW since 1980

FW-FERNWÄRME-TECHNIK GmbH

FW STEEL-CASED PIPE-IN-PIPE
FW SAFETY PIPING
FW CHAMBER-PIPE LNG
FW CHAMBER-PIPE OIL

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