

for low-temperature pipelines

Product description

Mannesmann Line Pipe has developed an advanced bainitic steel for the transportation of gaseous or liquid media at ultra-low temperatures.

Starting material production at Salzgitter Flachstahl GmbH is based on the ASTM A553 Standard Specification for Alloy Steel, Quenched and Tempered, 8 and 9 % Nickel. This material, known from its use in heavy plate for LNG tanks, has been adapted to the requirements of strip rolling for the production of LNG line pipe at the HFI pipe mills in Hamm and Siegen.

This was accomplished by a quench-and-temper treatment in which the pipe body is heated to austenitizing temperature, followed by hardening and tempering. As hardening leads to a dramatic increase in brittleness, subsequent tempering at approximately 620 °C is essential to ensure transformation of the martensitic to a tempered martensitic/bainitic microstructure with the required mechanical properties.

The material used is a so-called air-hardening material which requires no accelerated water quenching. Cooling in air is beneficial because it helps to avoid the generation of internal stresses or negative geometrical effects. Pipes heat treated in this way possess high toughness in the weld and base material as shown in Figure 1.

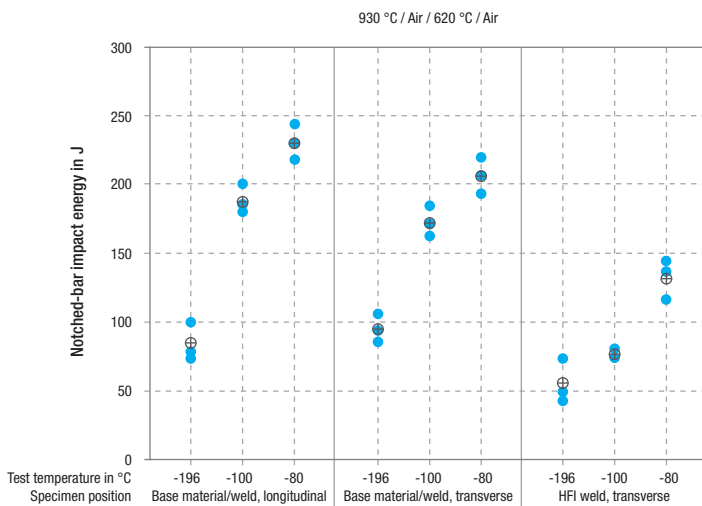


Figure 1: Charpy-V test results (full-size specimen after Q & T) as a function of test temperature and specimen position

Application

FW Fernwärme-Technik in Celle, Germany, developed a special multi-pipe system in MLP Type 1 steel for the transportation of liquefied natural gas (LNG) at a temperature of M 162 °C (Figures 2 and 3). In a 3-year test period with liquid nitrogen it was proved that the pipe system fulfills all requirements of LNG transportation. Moreover it offers potential to replace expensive and less available austenitic steels for applications at temperatures down to M 196 °C.

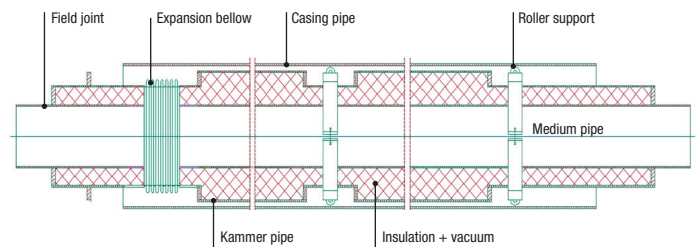


Figure 2: Schematic illustration of FW-Kammer-Pipe

The system concerned is a triple pipe system with a chamber for the transportation of fluids at cryogenic temperatures and meets the following requirements:

- avoidance of thermal bridges and very low heat transfer to the fluid
- possible natural compensation of cold induced contraction
- passive protection of the outer pipe against corrosion in soil
- in the event of an inner or outer pipe leak, pipeline operation will continue until repair
- permanent vacuum (over 30 years) in the chamber
- cost savings through the use of fine-grain steel for the outer pipe



Figure 3: FW-Kammer-Pipe during assembly

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Material Datasheet 202 | Mill Standard: SMLP Type 1

Scope

This Material Specification applies to welded nickel-alloyed low-temperature steels, whose properties in the delivery condition are specified below. Pipes in these steels are produced to the technical delivery standard ASTM A 553.

The HFI welding technology used is essential for the reliability of the products. The manufacturers ensure that their calculation, design and processing methods are appropriate for the material, correspond to state of the art technology, and are suitable for the intended use.

Chemical composition

C %	Si %	Mn %	P %	S %	Al %	Cu %	Cr %	Ni %	Mo %	N %
max. 0.08	max. 0.32	0.40–0.70	max. 0.015	max. 0.005	0.015–0.060	max. 0.40	max. 0.30	8.5–9.5	max. 0.10	max. 0.012

Other elements: Nb max. 0,02 %; V max. 0,02 %; Ti max. 0,02 %

Mechanical properties at room temperature

Mill standard	Yield strength $R_{10.5}$ min. in N/mm ² for wall thicknesses < 16 mm	Tensile strength R_m in N/mm ² for wall thicknesses < 16 mm	Elongation A2 ¹¹ min. in %
SMLP Type 1	585	690–825	22

The test is carried out on longitudinal specimens

Charpy V-notch testing

Mill standard	Charpy test results in [J] Average ¹⁾ of 3 Charpy-V specimens at test temperature in °C	
	-196 transverse	-196 longitudinal
SMLP Type 1	40	70

The lateral expansion results of the impact test specimens are available on request.

¹⁾ Minimum average values, only one individual value may be 30 % below the average value.

Expansion coefficient	T - Temperature in °C	
	a ₂₀ , τ in 10 ⁶ /K	
Average value, for information only.	-195	8.6
	-100	10.0
	0	10.6
	100	11.4
	200	11.8
	300	12.3
	400	12.4
	480	12.6

Delivery condition

- Quenched & Tempered (Q&T)
- Pipe heating is performed by electromagnetic induction.

Technical delivery condition

- Pipe testing according to ASTM A 553. Test results are according to this MDS, tolerances to ASTM A 553.

Certification

Pipes made from this material are supplied with 3.1 inspection certificates (confirmed by the manufacturer's independent inspector) or 3.2 (confirmed by an inspector authorized by the customer and the manufacturer's independent inspector) according to EN 10204. In the certificates it will be stated that the pipes supplied meet the purchase order requirements, including specific test requirements.

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