Sandvik® HT5/Sanicro™ 30

Composite tubes for syngas coolers

SANDVIK

High-performance tube materials for syngas coolers

For convection syngas coolers, CSC, where the corrosive syngas is inside the tube and the water/steam is on the outside, Sandvik has developed a a composite tube consisting of Sandvik HT5/Sanicro 30 (ASTM/ASME T12/UNS N08800).

In the case of a radiant syngas cooler design, with syngas on the outside of the tube and water/steam on the inside, Sandvik supplies single-component austenitic stainless steel tubes in grades Sanicro 30 (UNS N08800, EN 1.4558) and Sanicro 28 (UNS N08028, EN 1.4563).

Gasification

Gasification is a method of producing synthesis gas, syngas, from different types of organic material, e.g. coal, petroleum products, biomass or waste. Syngas can be further processed into various chemicals and/ or used for the production of electricity. Energy conversion of syngas into electricity as well as carbon capture are potentially more efficient and easier to achieve than through direct combustion.

After gasification, gas is cooled and heat is recovered in syngas coolers. Syngas can be corrosive which means higher alloyed materials and special products have to be used.

Excellent corrosion resistance

The high-alloy stainless component (Sanicro 30) provides excellent protection against corrosive syngas. The gas is a mixture of CO, H_2, H_2O, CO_2, N_2, HCl and H_2S, which result in a reducing atmosphere. The low-alloy ferritic steel (Sandvik HT5), carrying the steam side pressure, reduces the risk of steam side induced stress corrosion cracking (SCC).

Attractive design properties

The metallurgical bond between the inner and outer tube components ensures mechanical integrity of the tube even after bending.

The bond also guarantees the effectiveness of the respective properties of the two materials. Since the corrosion resistant alloy is normally thinner than the load carrier, the values of thermal expansion and thermal conductivity of a composite tube are closer to the values of the low-alloy component. Compared with a single-component stainless tube, this means lower stresses, due to lower thermal elongation and lower tube metal temperature.

Practical experience

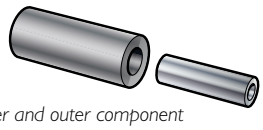
About 10,000 meters (32808.4 ft) of Sandvik HT5/Sanicro 30 composite tubes was manufactured and supplied for two US coal gasification projects in 1994/95. The two IGCC projects started up in 1995 and 1996.

In 2009 additional 2,000 meters (6600 ft) were produced for a replacement syngas cooler tube for one of these projects. The new vessel was installed in 2010. The tubes used in the old cooler were investigated and showed only limited material degeneration. The thickness of the stainless steel component was still within the tolerances of the as-delivered tubes after 15 years operation.

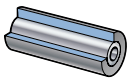
Another 5000 meters (16400 ft) were produced in 2010 and 18,000 meters (59100 ft) in 2011/2012 for gasification projects in North America and Asia.

Figure 1. Hot extrusion.

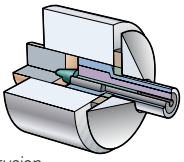
Production route of composite tubes



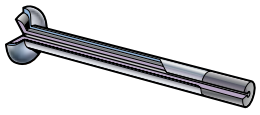
Inner and outer component



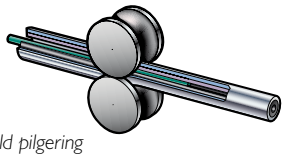
Extrusion billet



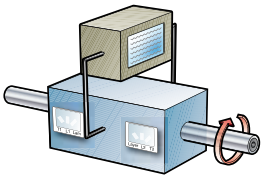
Hot extrusion



Extruded composite tube or composite hollow



Cold pilgering



Non destructive testing

Figure 2. Sandvik composite tubes consist of two different materials metallurgically bonded together through hot extrusion. By selecting the correct alloy for the outside and inside component, the corrosion resistance and the mechanical properties are optimized and a tube that meets conflicting material requirements inside and outside is obtained.

Grades

Outer component
Sandvik® HT5 (ASTM/ASME SA-213/T12, EN 1.7335).

C	Si	Mn	P max.	S max.	Cr	Mo
0.10	0.25	0.5	0.025	0.025	1.0	0.5

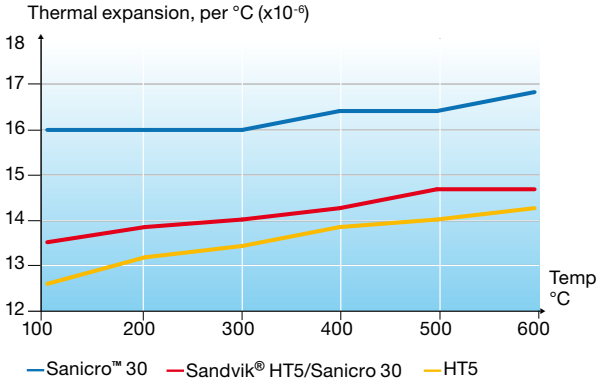
Density: Sandvik HT5 = 7.9 g/cm³

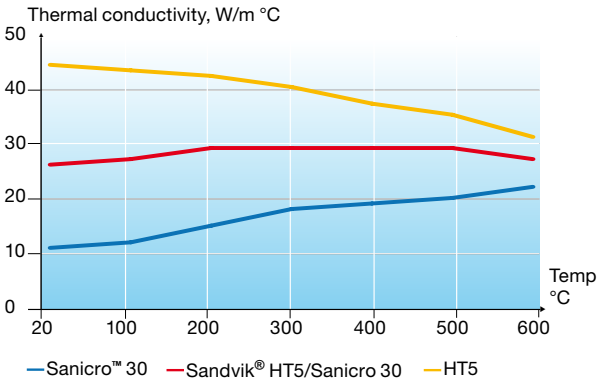
Inner component
Sanicro 30™ (ASME SB407, UNS N08800, EN 1.4558).

C max.	Si	Mn	P max.	S max.	Cr	Ni	Ti	Al
0.030	0.5	0.6	0.020	0.015	20	32	0.5	0.3

Density: Sanicro 30 = 8.0 g/cm³

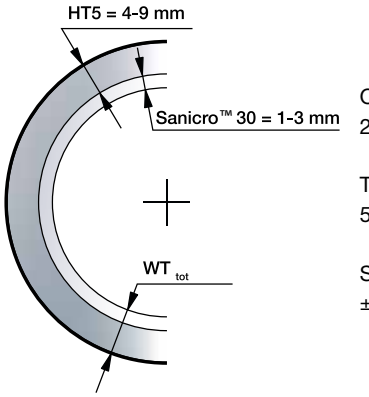
Physical properties
Typically, the thickness of the component made of Sanicro™ 30 is between 25 and 30% of the total wall thickness of the composite tube. The calculations of the physical properties of the composite tube are based on a ratio of 25% Sanicro™ 30 and 75% Sandvik® HT5. The data for the outer and inner components are based on real measurements.





Specifications
Sandvik tube specification 7-1-1253 ASME SA-213, ASME SA-450, EN 10216-2:2002 + AZ:2007, EN 10216-5.

Sizes and typical tolerances
Wall thickness and wall thickness tolerances. Total minimum wall = Sandvik HT5 + Sanicro 30 (pressure bearing component required in min wall according to ASME Code Sec I and II.).



Outside diameter
25–80 mm ±0.40 mm

Total wall thickness
5–10 mm ±15%

Sanicro 30 thickness
±0.40 mm

By courtesy of BORSIG Process Heat Exchanger GmbH

Welding

Butt welding

Butt welding of composite tubes must be carried out so that dilution is kept under control.

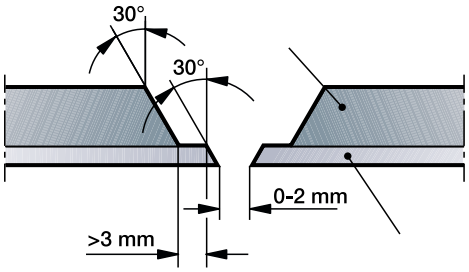


Figure 3. Edge preparation.

To obtain the optimum corrosion resistance and mechanical properties of the welded joints, the following edge preparation (fig. 3) and welding procedures (fig. 4) are recommended, see table 1.

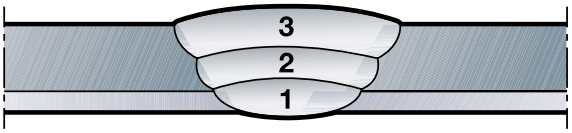


Figure 4. Welding sequence.

Table 1. Recommended filler metals and welding methods

Option	Inner component (1)		Transition (2)		Outer component (3)	
	Method	**Filler**	**Method**	**Filler**	**Method**	**Filler**
A	MMA	Sanicro™ 71*	MMA	Sanicro 71	MMA	Sanicro 71
	TIG	Sanicro 72**	TIG	Sanicro 72	TIG	Sanicro 72
B	TIG	Sanicro 72	MMA	Fe with low C e.g. OK 53.18	MMA	OK 76.18*** or similar
			TIG	Fe with low C	TIG	OK 13.12**** or similar

*AWS A5.11 (ENiCrFe-3) **AWS A5.14 ERNiCr-3 ***AWS A5.5 E8018-B2L ****AWS A5.28 ER80S-G

Sandvik Group
The Sandvik Group is a global high technology enterprise with 50,000 employees in 130 countries. Sandvik's operations are concentrated on five business areas in which the group holds leading global positions in selected niches: Sandvik Mining, Sandvik Machining Solutions, Sandvik Materials Technology, Sandvik Construction and Sandvik Venture.

Sandvik Materials Technology
Sandvik Materials Technology is a world-leading developer and manufacturer of products in advanced stainless steels and special alloys for the most demanding environments, as well as products and systems for industrial heating.

Quality management
Sandvik Materials Technology has quality management systems approved by internationally recognized organizations. We hold, for example, the ASME Quality Systems Certificate as a materials organization, approval to ISO 9001, ISO/TS 16949, ISO 17025 and PED 97/23/EC. We also have product and/or shop approvals from bodies such as TÜV, JIS, DNV and Lloyd's Register.

Environment, health and safety
Environmental awareness, health and safety are integral parts of our business and are at the forefront of all activities within our operation. We hold ISO 14001 and OHSAS 18001 approvals.

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