

Sandvik Sanicro 28

Composite tubes for steam boiler applications

High temperature corrosion resistance

Sandvik Sanicro 28 has excellent high temperature corrosion properties and its high chromium content makes it resistant to gas corrosion. It is, therefore, a good material for reducing atmospheres and low NO_x firing, e.g. for use in water walls, evaporators and superheaters in various steam boiler applications such as black liquor recovery, municipal refuse, waste heat and biomass boilers.

Sandvik composite tubes offer the following advantages:

- Lower thermal expansion
 - reduces system stresses
- Higher thermal conductivity
 - lowers operating metal temperature, i.e. reduces corrosion
- Elimination of the risk of SCC, pitting and crevice corrosion at the water/steam side
 - provides safer systems
- Joint welding of composite tubes with carbon-to-carbon or low alloy-to-low alloy welds means:
 - proven reliability for long-term service
 - good structural stability
 - wider tolerances for achieving precise welds
 - elimination of high-alloyed joints
- Easier bending – the inner carbon steel or low alloy layer supports the outer stainless layer during bending.



Developed to meet more severe conditions

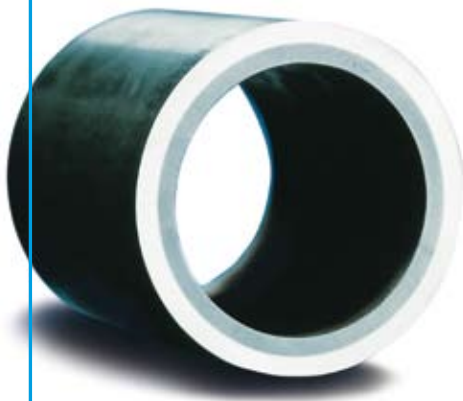
Composite tubes with steel grade Sandvik Sanicro 28 as the outer component have been developed to meet more severe conditions in different types of boiler. Sandvik Sanicro 28 is an austenitic stainless alloy, initially designed for use in highly corrosive phosphoric acid applications. It has good corrosion resistance in strong acids and good resistance to stress corrosion cracking, intergranular corrosion, pitting and crevice corrosion.

Composite tubes consist of an external layer of highly alloyed stainless steel or nickel based material, metallurgically bonded to an internal load carrier of normal carbon or low-alloyed boiler tube material. All tubes are subjected to a 100% non-destructive (ultrasonic and eddy current) examination to check for inner and outer defects, to verify the metallurgical bond and to ensure that the thickness of the layers is within stipulated tolerances.



More than 2 million meters of composite tubes have been supplied for more than 300 boilers worldwide, confirming composite tubes as an established industry product.

Sandvik Materials Technology has produced composite tubes since the early 1970s and supplies its largest volumes for furnace walls in recovery boilers in the pulp and paper industry.



Grades

Outer component

Sandvik Sanicro 28, UNS N08028, W.-Nr. 1.4563, EN 1.0216-5, EN 1.4563, SS 2584. Sandvik Sanicro 28 is used as composite tube cladding. The pressure vessel design calculation is based on the load-carrying component, which is a normal boiler tube material (see below).

The cladding is often considered as only corrosion protection, whereas, in fact, it will add significant strength to the tube.

Typical inner components

Normal boiler tube materials such as: Sandvik 4L7 (ASME SA210 A1, EN 1.0425, P265GH, W.-Nr. 1.0405, ST 45.8.III, SS 1435).

Sandvik HT8 (ASME SA213 T22, EN 1.7380, W.-Nr. 1.7380, 10CrMo910, SS 2218).

Sandvik HT7 (ASME SA213 T91, EN 1.4903, W.-Nr. 1.4903, X10CrMoVNb 9-1).

Chemical composition, Sandvik Sanicro 28 (nominal), %

C max	Si max	Mn max	P max	S max	Cr	Ni	Mo	Cu
0.020	0.6	2.0	0.025	0.015	27	31	3.5	1.0

Chemical composition, load carrying (normally inner) components (nominal), %

Sandvik	C	Si	Mn	P max	S max	Cr	Ni max	Mo	Other
4L7	0.21	0.3	0.7	0.030	0.015	–	–	–	–
HT8	0.10	0.3	0.5	0.020	0.020	2.3	–	1.0	–
HT7	0.10	0.4	0.5	0.020	0.010	8.5	0.40	1.0	V, Nb, N

Specifications

Sandvik specifications 7-1-0009, 7-1-1169, 7-1-1288 PED 97/23/EC.
EN 10216-2, EN 10216-5, EN 12952-2 Annex C.
ASME Section I and Section II, VD-TÜV Werkstoffblatt 541 03.2001.

Mechanical properties at 20°C, Sandvik Sanicro 28

Proof strength $R_{p0.2}$ MPa, min.	Tensile strength R_m MPa	Elongation A, % min.	Hardness HRB max.
220	550-750	40	90

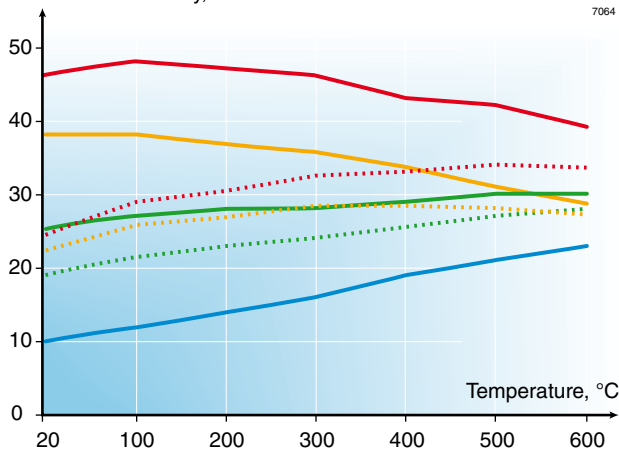
Physical properties, Sandvik Sanicro 28

Density	g/cm ³	lb/in ³
	8.0	0.29

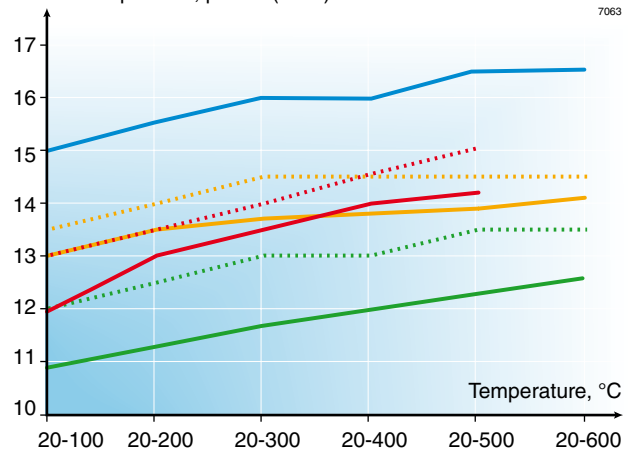
Thermal expansion/conductivity

The composite tube values below have been calculated for a 63.5mm x 6.33mm minimum wall overall dimension, with a Sandvik Sanicro 28 outer component = 1.65mm average wall and a carbon steel inner component = 4.88mm minimum wall.

Thermal conductivity, W/m °C



Thermal expansion, per °C (x10⁻⁶)



— Sandvik Sanicro 28 — 4L7 ··· Sandvik Sanicro 28/4L7 — HT8 ··· Sandvik Sanicro 28/HT8 — HT7 ··· Sandvik Sanicro 28/HT7

Welding

Butt welding

Butt welding of composite tubes should be carried out in such a way that dilution is kept under control.

The melting point of the bonding zone is lower than the melting point of the stainless steel. If the bonding zone is exposed to heat input, local melting may occur.

In order to obtain the optimum corrosion resistance and mechanical properties of the welded joints, the following edge preparation, figure 1, and welding sequence, figure 2, are recommended. Recommendations of welding methods, filler metal and welding parameters are listed in table 1.

Panel welding

Shop welding of panels should be carried out with a machine specially designed for the purpose. The weld should not penetrate the stainless steel layer of the composite tube, as this may result in hot cracking or formation of brittle weld structures. Furthermore, excessive dilution of the fully austenitic stainless steel filler metal during fin welding (carbon steel fin) may also lead to hot cracking or a brittle weld structure.

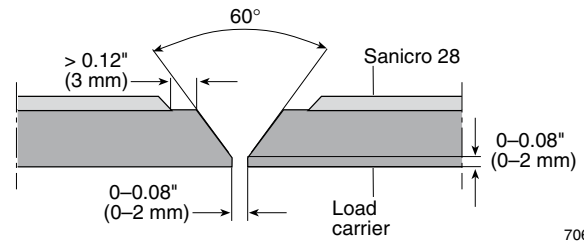


Figure 1. Edge preparation.

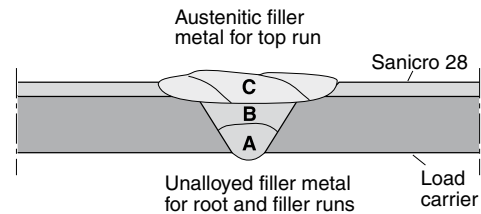


Figure 2. Welding sequence.

Table 1. Welding methods, filler metal and welding parameters

Pass (Ref. to figure 2)	Welding method	Filler metal	Correspond to	Max. heat input kJ/mm (kJ/in)	Max. interpass °C (°F)
Root run (A)	TIG/MIG (GTAW/GMAW)/(141/132) MMA (SMAW/111)	Depending on load carrier used	Depending on load carrier used	Depending on load carrier used ¹⁾²⁾	
Filler run (B)	TIG/MIG (GTAW/GMAW)/(141/132) MMA (SMAW/111)	Depending on load carrier used	Depending on load carrier used	Depending on load carrier used ¹⁾²⁾	
Top run (C) ³⁾	TIG/MIG (GTAW/GMAW)/(141/132) TIG/MIG (GTAW/GMAW)/(141/132) MMA (SMAW/111) MMA (SMAW/111)	Sandvik 27.31.4.LCu Sandvik Sanicro 60 ⁴⁾ Sandvik 27.31.4.LCuR Sandvik Sanicro 60 ⁴⁾	AWS A5.9 ER 383 AWS A5.14 ER NiCrMo-3 AWS A5.9 E 383-16 AWS SFA5.11 E NiCrMo-3	1,0 (25,0) 1,0 (25,0) 1,0 (25,0) 1,0 (25,0)	150 (300) 100 (212) 150 (300) 100 (212)

¹⁾ Higher heat input may be applied for the root and filler runs if the stainless peel off is increased. ²⁾ Contact Sandvik for advice.

³⁾ MMA is recommended for manual welding to ensure low penetration and to maintain mechanical strength.

⁴⁾ For more corrosive conditions use Sandvik Sanicro 60.

Tangential panels

GMAW (I35/MIG) welding with Sandvik 27.31.4.LCu or Sandvik Sanicro 60 welding wire is recommended for this kind of construction. Welding is performed in a single pass, from the inside of the panel, in the natural joint formed between the tubes, see figure 3.

Finned panels

GMAW (I35/MIG) or SAW (I2) welding are suitable methods for fabricating finned panels. The choice of filler metals depends on the fin material to be used.

A basic flux should be used in SAW welding. In

general, dilution should be minimized in order to avoid hot cracking or brittle weld metal structures. The impurity level in carbon steel fin materials should be considered in order to minimize the susceptibility for hot cracking.

Thick fins should be bevelled in order to minimize the amount of fin material in the weld, see figure 5.

Bending

In principle, composite tubes can be bent by the same methods as those used for single component tubes.

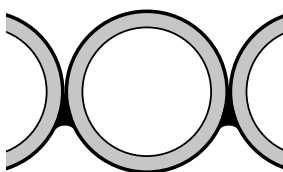


Figure 3. Welded tangential panel.



Figure 4. Welded finned panel.

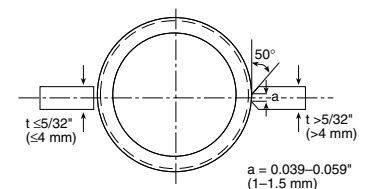


Figure 5. Edge preparation of fins.

Deliveries

Load carrying component Sandvik	Application	Delivery year	Quantity, m
4L7	Copper, nickel and lead smelting Waste heat boiler/evaporator; Brazil, Finland, Japan, Korea, Sweden.	1993-2005	> 20 000
4L7	Municipal waste incineration Superheater; Sweden, Norway, UK	1992-2005	> 10 000
4L7	Waterwall; Sweden, UK, Denmark, France.	1995-2005	> 10 000
HT8, HT7	Biomass firing Superheater; Sweden.	1998/2005	> 3 000
HT8, HT7	Black liquor recovery Superheater; worldwide.	1994-2005	> 30 000
4L7	Pulverized coal firing Waterwall; USA.	1995-1996	> 1 000
HT8, HT5	Coal gasification Test in syngas cooler; The Netherlands, USA.	1995-1990	300
	Total meters supplied		> 74 000



Figure 6, left. Bonding zone in a composite tube Sandvik Sanicro 28/HT7 (Sandvik Sanicro 28 on ASTM A213/T91). The Sanicro 28 component is shown at the top of the figure.

Quality Assurance

Sandvik Materials Technology has a quality management system approved by internationally recognised organisations. We hold for example: an ASME Quality System Certificate as a Materials Organisation, approval to ISO 9001 and QS 9000, as well as approvals from LRQA, JIS and other organisations as a materials manufacturer.

Environment

Environmental awareness is an integral part of our business and is at the forefront of all activities within our operation. We hold approval to ISO 14001.

Further information

www.smt.sandvik.com/composite

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Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice.



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