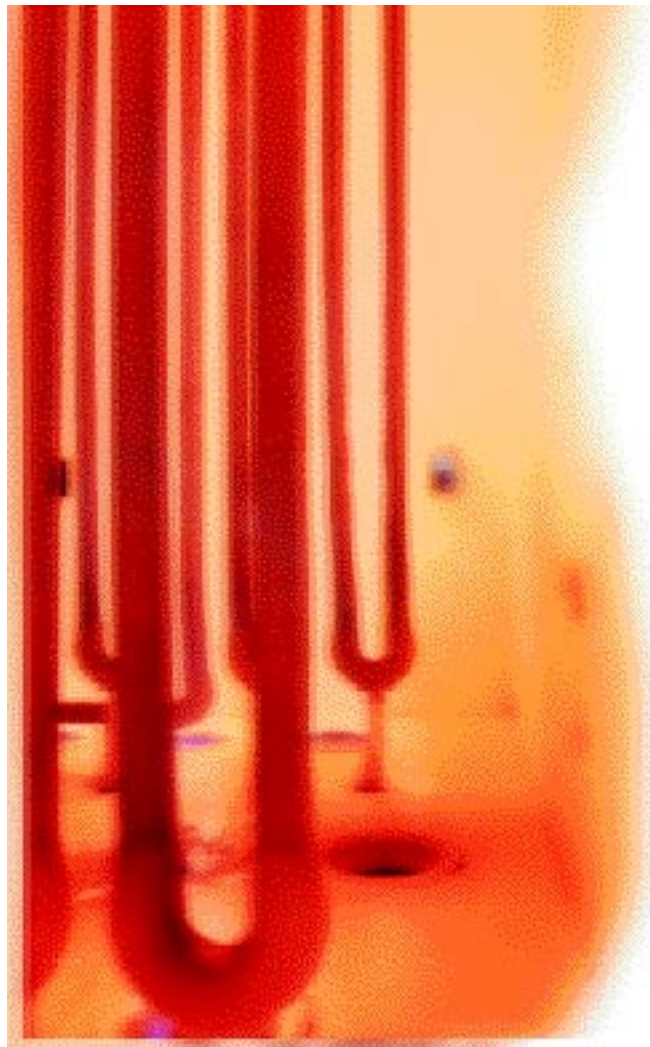


Sandvik Stainless ***High Temperature Grades***

A TUBE MATERIALS SELECTION GUIDE



Sandvik's High Temperature Grades improve your production

[Test tube]

The close co-operation with our customers has provided us with solid know-how about high temperature applications. Test installations [picture] at production facilities make us confident that we improve our customers' production.

Supportive stock

On the following page you will find the standard stock programme for high temperature materials. We have built up our stock to safeguard and simplify our customers' maintenance routines. Therefore we can deliver fast when something unexpected occurs.

The Sandvik QA system

Sandvik has a comprehensive quality assurance system, which is implemented throughout the entire organisation and monitored by a function which is independent from the operating departments. Together with our modern testing methods and advanced equipment this is our guarantee of a high quality and reliable product.

Approvals

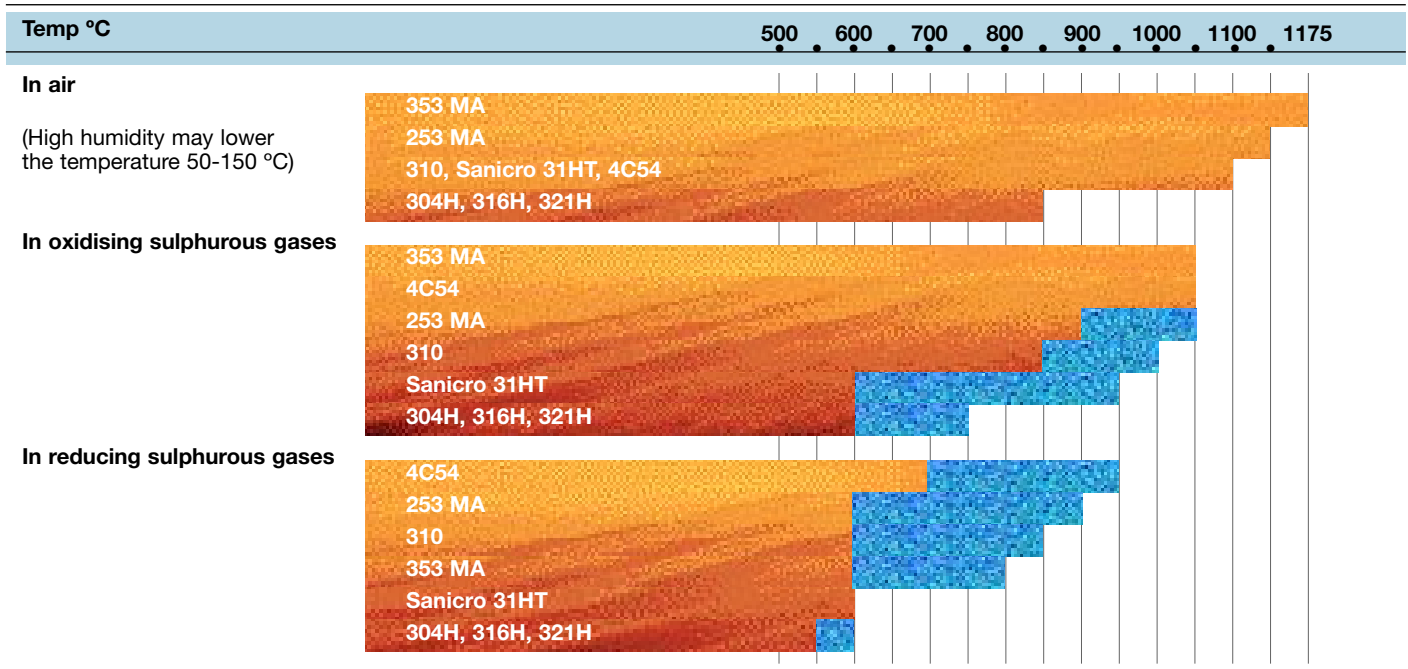
The Sandvik mills have quality assurance systems approved by internationally recognised organisations and hold the following approvals

- Approval by accredited third party to ISO 9001 or ISO 9002
- ASME Quality System Certificate as Material Organization
- TÜV approval to AD-W0/TRD 100

Many Sandvik HT benefits for you

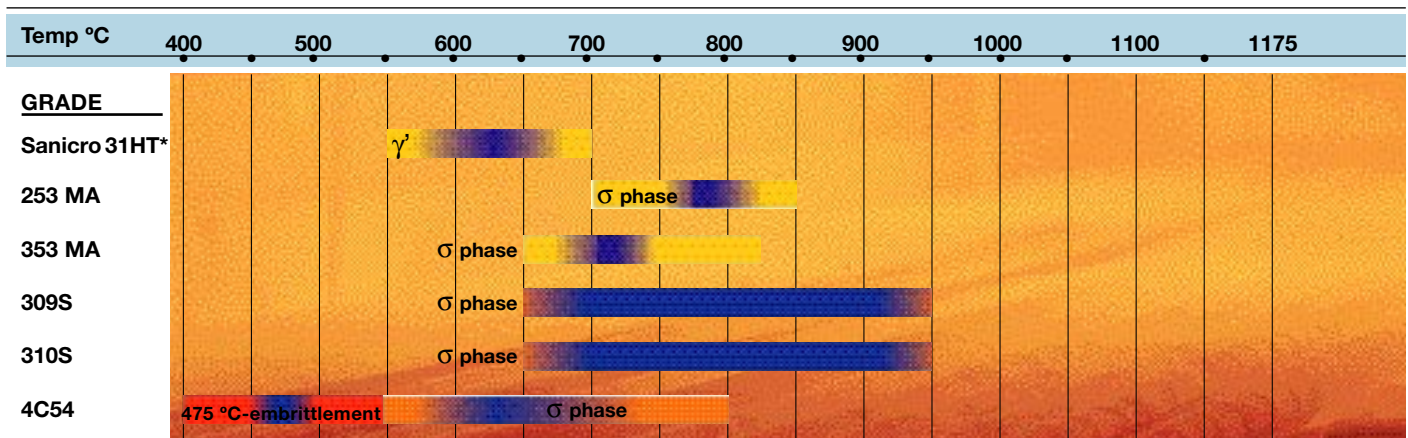
- Technical knowledge about the applications and the materials
- Long service life
- Good fabrication properties
- Stocked tube and pipe for critical applications

Maximum working temperature in different gases



The maximum temperature is depending on the level of flue gas impurities (S, Na, V).

Structural stability



Within the precipitation ranges for the different phases the dark blue colour indicates the highest degree of precipitation.

1% σ phase is precipitated at 800°C for 353 MA after 7000 h, for 253 MA after 2000 h, and for 310 and 309 after <200 h.

4C54 precipitates 1% σ phase at 650°C after <200h.

* A modified Sanicro 31HT is used at 550-700°C to eliminate the risk of precipitating γ' .

All HT grades are subjected to various degrees of embrittlement. However, due to the lower chromium content the lower alloyed grades (304H, 316H and 321H) have good structural stability.

High temperature corrosion properties

A comparison between Sandvik High Temperature Steels and TP 310.

	Oxidation	Carburisation	Nitriding*
TP 310	0	0	0
353 MA	+++	+++	++
253 MA	+	+	0
Sanicro 31HT	0	++	++
4C54	0	-**	-

* in cracked ammonia atmosphere. ** 4C54 has very good resistance to metal dusting corrosion.

0 = reference value + = superior to - = inferior to.

Chemical compositions and standards

Sandvik grade	Chemical composition (nominal), %						Standards EN ¹⁾	AISI	UNS	SS	AFNOR
	C	Si	Cr	Ni	Mo	Other					
4C54	0.20	0.5	26.5	–	–	N=0.2	1.4749	446-1	S44600	2322	–
Esshete 1250	0.1	0.5	15	10	1.0	Mn=6, Nb,V, B	1.4982	–	S21500	–	–
5R10	0.05	0.6	18.5	9	–	–	1.4301	304/304H	S30400/S30409	2333	Z6CN18.09
5R60	0.05	0.4	17	12	2.6	–	1.4436	316/316H	S31600/S31609	2343	Z6CND17.12
6R35(8R30)	0.06	0.5	17.5	10	–	Ti 5xC	1.4541	321/321H	S32100/S32109	2337	–
8R40	0.06	0.4	17.5	11	–	Nb 10xC	1.4550	347/347H	S34700/S34709	2338	Z6CNNb18.10
7RE10	0.06	0.75	24.5	21	–	–	1.4845	310S/310H	S31008/S31009	2361	Z12CN25.20
8RE18	0.07	0.5	22.5	14	–	–	1.4833	309S/309H	S30908/S30909	–	–
253 MA	0.08	1.7	21	11	–	N=0.17, REM ²⁾	1.4835	–	S30815	2368	–
353 MA	0.05	1.6	25	35	–	N=0.16, REM ²⁾	–	–	S35315	–	–
Sanicro 31HT	0.07	0.6	21	31	–	Ti, Al, Fe	1.4876/ 1.4959	Alloy 800HT	N08810/N08811	–	–
Sanicro 70	0.05	0.4	16.5	72.5	–	Fe 10	2.4816	Alloy 600	N06600	–	–

1) Product standards for tubes are under development.

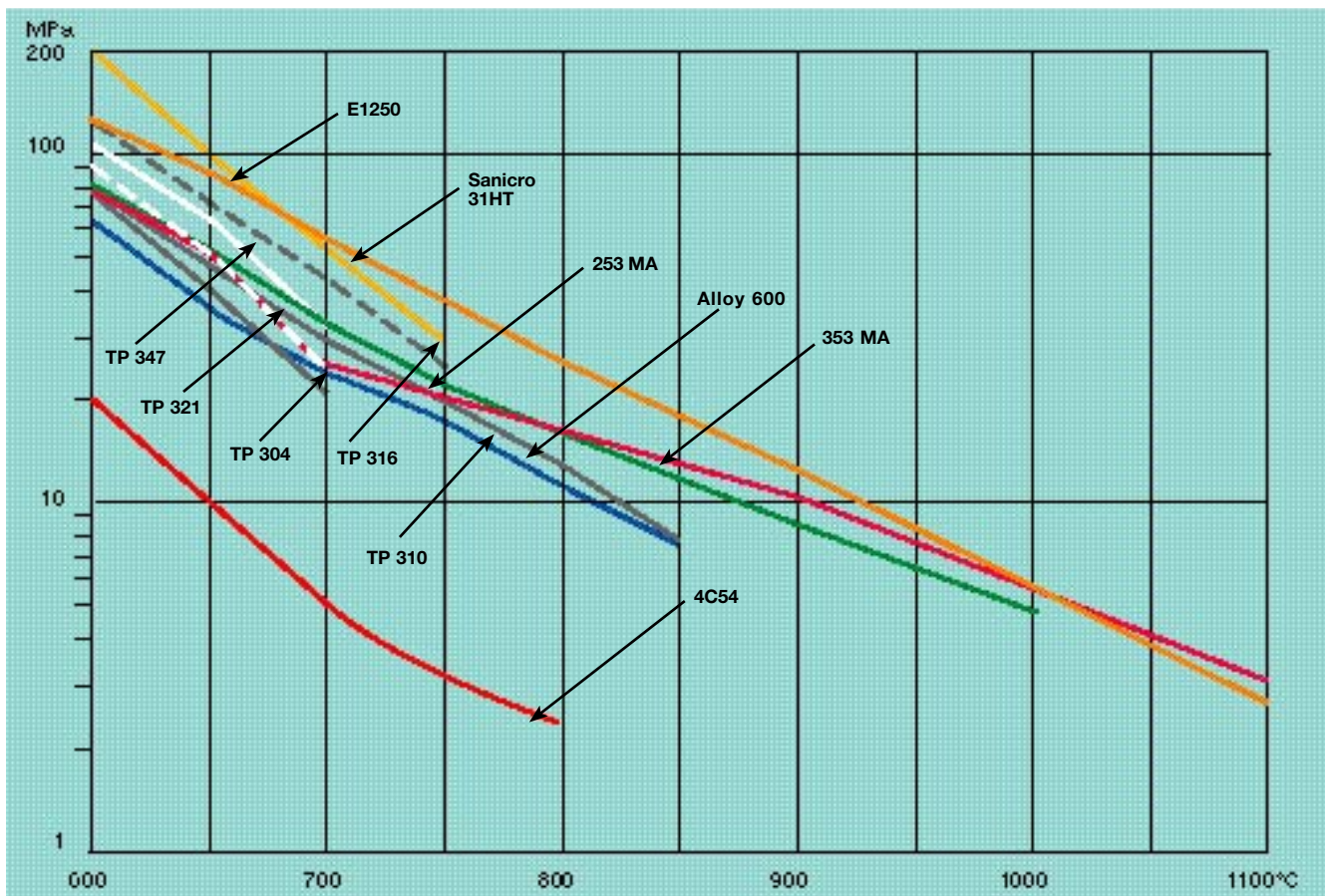
Werkstoff-Nr. corresponds to EN with the exception of 253 MA – W.-Nr. 1.4893.

2) REM = Rare Earth Metals

Sandvik and Sanicro are trademarks registered by Sandvik AB. 253 MA and 353 MA are trademarks registered by Avesta Sheffield AB. Esshete is a trademark registered by British Steel.

Creep rupture strength

$R_{m}/100\ 000\ h$, for some Sandvik stainless steels and high nickel alloys



High Temperature Applications as you know them

The steel grades described in this brochure are the basis of Sandvik special stainless steel for high temperature service. In this programme you will find your optimum grade of steel for a wide range of applications. The total Sandvik steel programme for tube, pipe and hollow bar is presented in the brochure S-110.

Sandvik high temperature grades are used in all type of industries, such as the steel and metallurgical industry, the petrochemical industry ethylene furnaces, ammonia industry pigtails and in power industry boiler tubes.

Further information on boiler tubes is available in the brochure Sandvik Boiler Tubes, S-1302 and in the Composite Tube brochure, S-121.



RECUPERATORS

Sandvik tubes are used in recuperators and air heaters serving the glass industry, carbon black industry, steel industry, direct reduction of iron ore (Midrex process), chemical waste incineration and sewage sludge waste incineration.



PYROMETER TUBES

Depending on the service conditions specific grades are offered ex-stock for the best service.

MUFFLE TUBES

Muffle tubes are used in wire drawing mills and Bundy tube production. Because of the various service conditions different steel grades are offered to optimize the service life and reduce the maintenance cost. For further information see Sandvik Muffle Tube brochure S-1301.

Quick materials selection chart

STEEL GRADE	MAIN APPLICATION	MAIN TEMPERATURE °C	MAIN SERVICE CONDITIONS
4C54	Recuperator, Pyrometer	600-1000	Reducing sulphurous
253MA	Recuperator, Pyrometer	600-1000	Oxidizing
353MA	Recuperator, Ethylene	900-1150	Oxidizing, Carburizing
Sanicro 31HT	Muffle tubes	800-1100	Cracked ammonia
	Petrochemical industry Pigtails		Carburizing

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.

From stock – Tube and Pipe for High Temperatures

Outside diameter mm	Wall thickness mm	Nominal size	Weight kg/m	4C54 SS 2322 AISI 446-1	253 MA SS 2368 UNS S30815	353 MA – UNS S35315	Sanicro 31HT – UNS N8810/8811
17.15	2.31 3.20	3/8" Sch 40S Sch 80S	0.858 1.12	●	● ●		●
21.3	2.65		1.24	●			
21.34	2.77	1/2" Sch 40S	1.29		●		●
26.0	4.0		2.20	●			
26.67	2.11 2.87	3/4" Sch 10S Sch 40S	1.30 1.71		● ●	●	●
26.9	2.65		1.61	●			
33.4	3.38	1" Sch 40S	2.54		●	●	●
	4.55	Sch 80S	3.29		●		
33.7	3.25		2.48	●			
42.16	3.56	1 1/4" Sch 40S	3.44		●	●	●
42.4	3.25		3.19	●			
44.5	3.0		3.12	●			
48.26	2.77 3.68 5.08	1 1/2" Sch 10S Sch 40S Sch 80S	3.15 4.11 5.49		● ● ●	●	●
48.3	3.25		3.67	●			
60.3	3.65		5.18	●			
60.33	2.77 3.91 5.54	2" Sch 10S Sch 40S Sch 80S	3.99 5.52 7.60		● ● ●	●	●
73.03	5.16	2 1/2" Sch 40S	8.77		●		
76.1	3.65		6.62	●			
88.9	4.05 5.49	3" Sch 40S	8.60 11.5	●	●	●	
114.3	6.02	4" Sch 40S	16.3		●		

Sandvik	Specifications	Tolerances
4C54	ASTM A268	ISO 1127
253 MA	ASTM A312	ASTM A312
353 MA	ASTM A312	ASTM A312
Sanicro 31HT	ASTM B407	Cold finished to ASTM B407 Hot finished to ASTM A312

