



Advanced (700 °C) PF Power Plant: A Clean Coal European Technology

CESI Auditorium, Milano, Italy

Thursday, 27th of October 2005

Advanced Materials for AD700 Boilers

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Membrane Wall Materials

Header and Piping Materials

Superheater and Reheater Materials



700 °C- Plant – Future Potential

400 MW

High pressure part

Steam rating 275 kg/s
990 t/h

Allowable working pressure (gauge) 393 bar

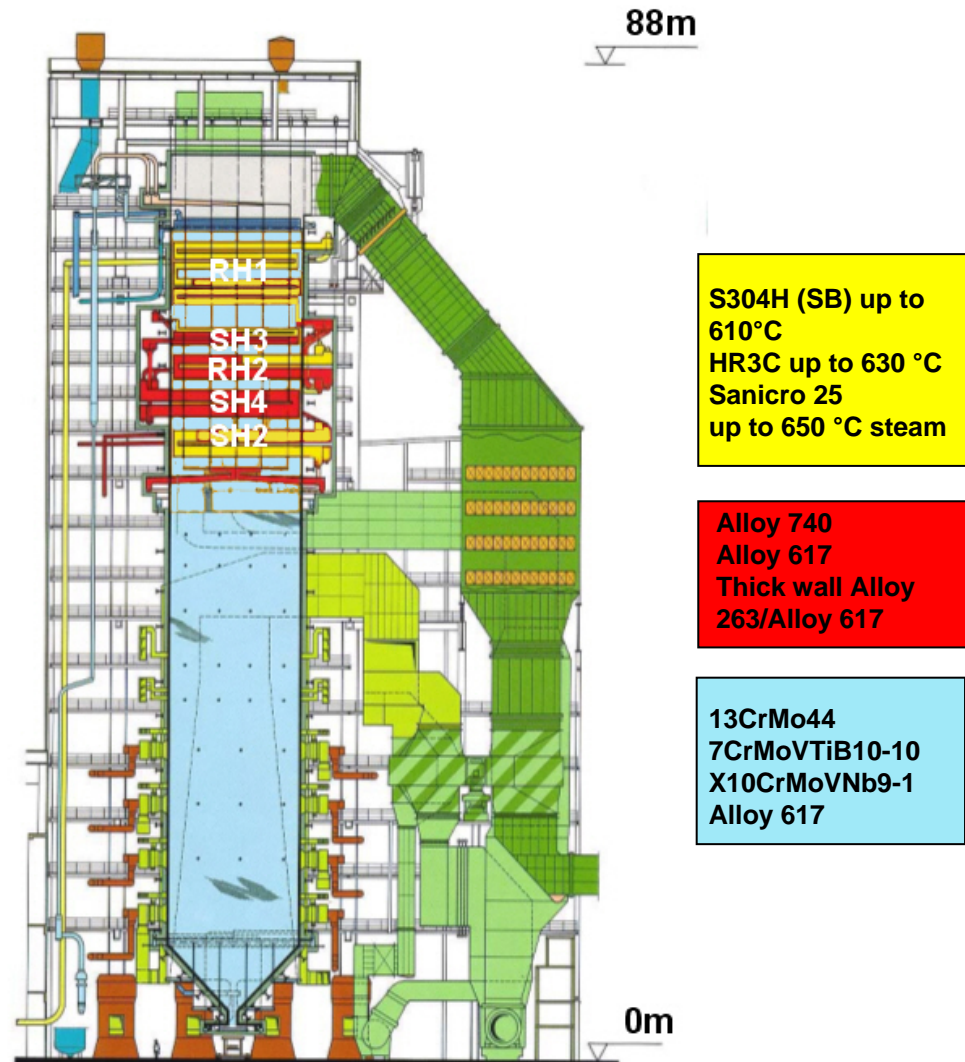
SH-Outlet temperature 700 °C

Reheater

Steam rating 215 kg/s
774 t/h

Allowable working pressure (gauge) 83 bar

RH-Outlet temperature 720 °C



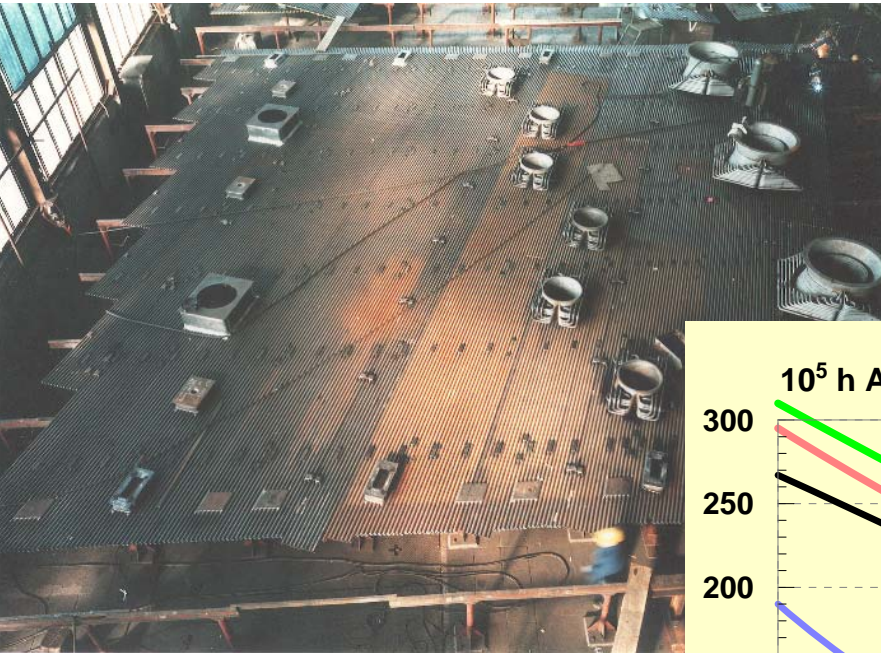


Materials for Membrane Walls

	C	Si	Mn	P	S	Al	Cr	Ni	Mo	V	Nb	Ti	W	N	B	Co
13CrMo4-5	0,19- 0,17	max. 0,35	0,40- 0,70	max. 0,025	max. 0,020	max. 0,040	0,70- 1,15	max. 0,30	0,40- 0,60	----- -----	----- -----	----- -----	----- -----	----- -----	----- -----	----- -----
7CrMoVTiB 10 -10 T 24	0,050- 0,095	0,15- 0,45	0,30- 0,70	max. 0,020	max. 0,010	max. 0,020	2,20- 2,60	----- -----	0,90- 1,10	0,20- 0,30	----- -----	0,05- 0,10	----- -----	max. 0,010	0,0015- 0,0070	----- -----
VM12	0,08 0,18	0,20 0,60	0,10 0,80	max. 0,020	max. 0,010	max. 0,040	10,0 13,0	max. 0,60	max. 0,80	0,18 0,30	0,030 0,060	----- -----	1,00 1,80	0,030 0,090	0,001 0,010	0,50 2,00
X10CrMoV Nb9-1 T 91	0,08- 0,12	0,20- 0,50	0,30- 0,60	max. 0,020	max. 0,010	max. 0,040	8,00- 9,50	max. 0,40	0,85- 1,05	0,18- 0,25	0,06- 0,10	----- -----	----- -----	0,030- 0,070	----- -----	----- -----
Alloy 617	0,05- 0,10	max. 0,70	max. 0,70	max. 0,012	max. 0,008	0,60 1,50	20,0- 23,0	Rest	8,0- 10,0	Fe m. 2,0	-----	0,20- 0,50	-----	As m. 0,010	Pb m. 0,007	10-13

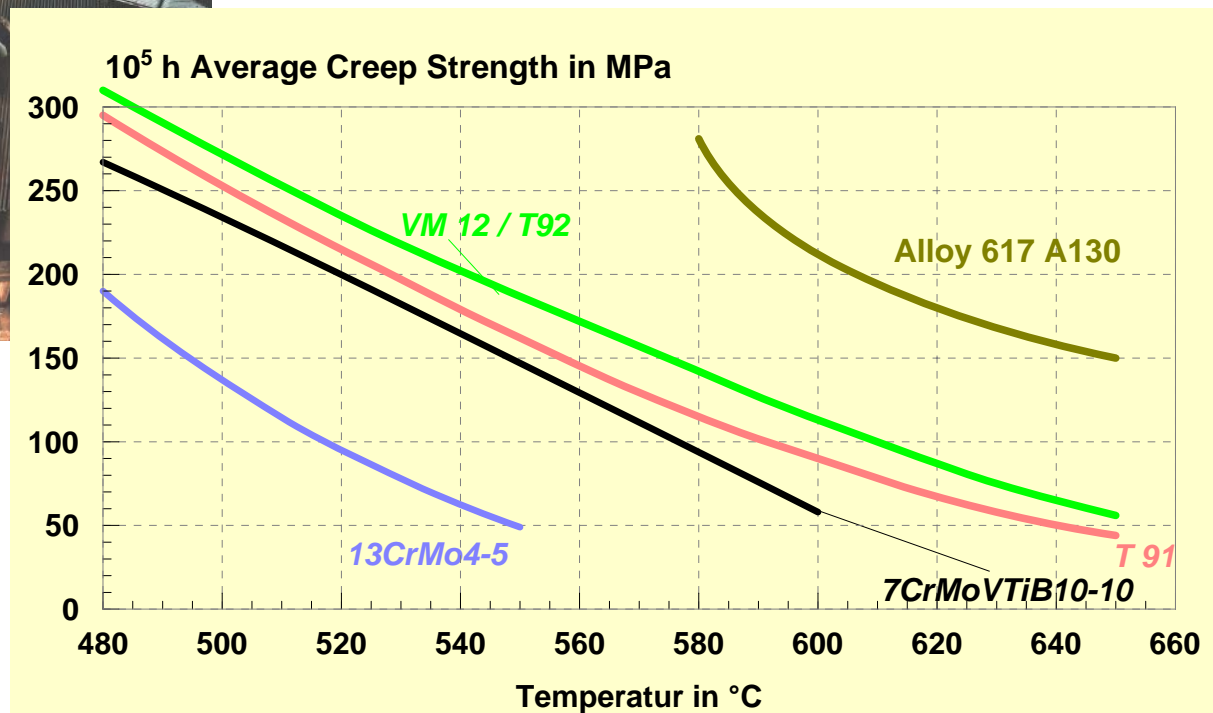


Materials for Membrane Walls



Materials:

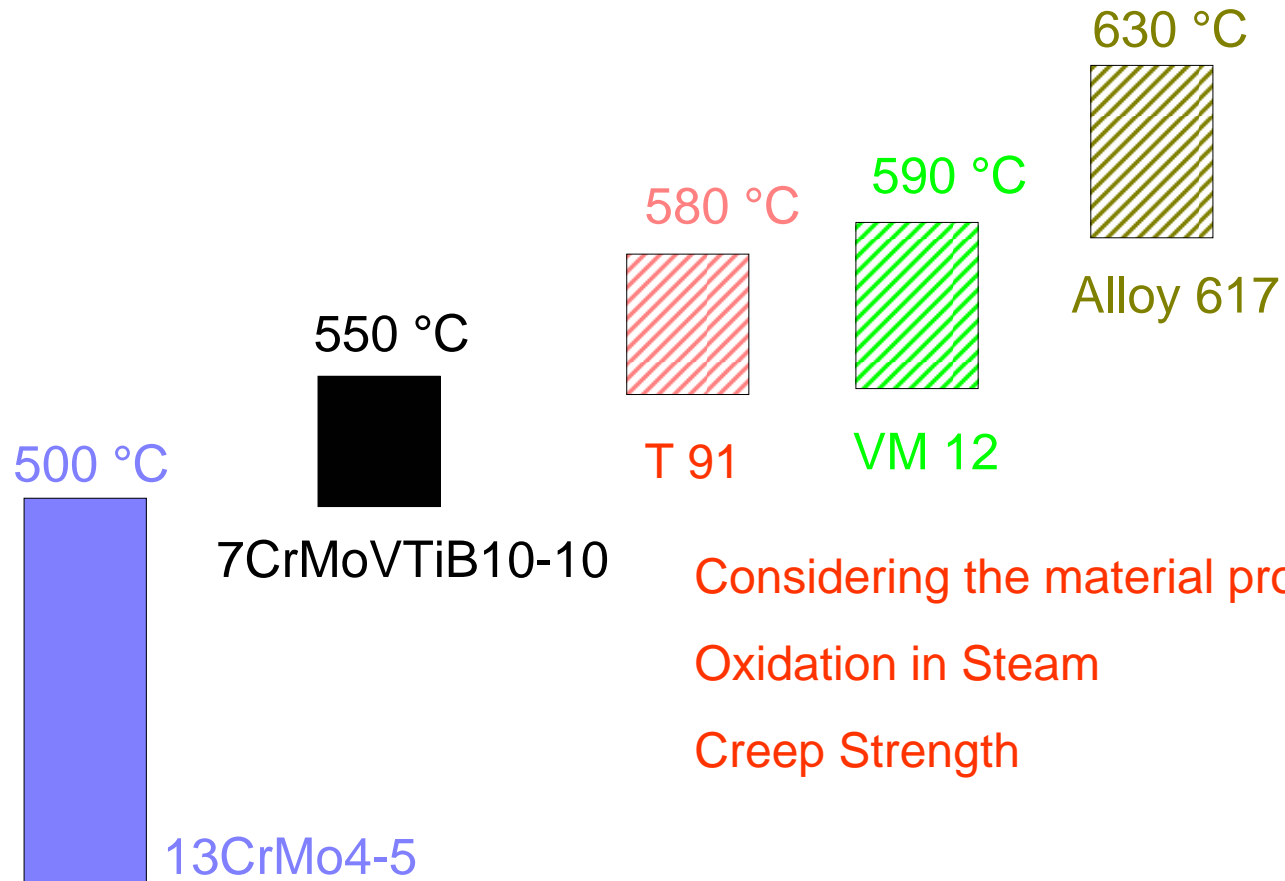
- 13CrMo4-5
- 7CrMoVTiB10-10
- X10CrMoVNb9-1





Materials for Membrane Walls

Design temperatures according EN 12952



Considering the material properties :
Oxidation in Steam
Creep Strength



Codes for Membrane Walls Materials

13CrMo4-5 **DIN EN 10216-2 07.2004**

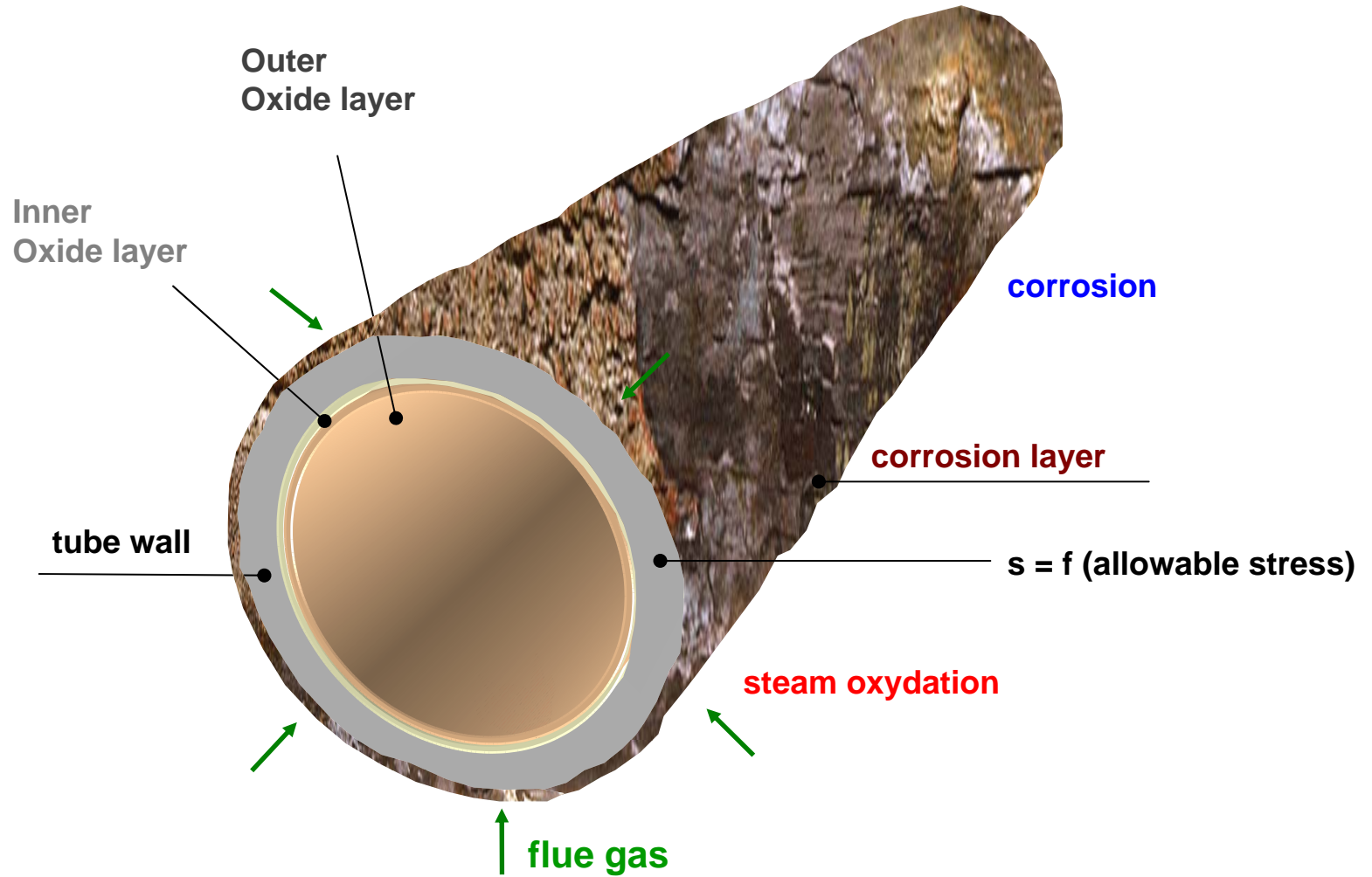
T91 **DIN EN 10216-2 07.2004**

7CrMoVTiB10-10 **VdTÜV 533 12.2003,**
prEN10216-2 3.2004,

T24 **ASTM A213**



Superheater/ Reheater Tubes



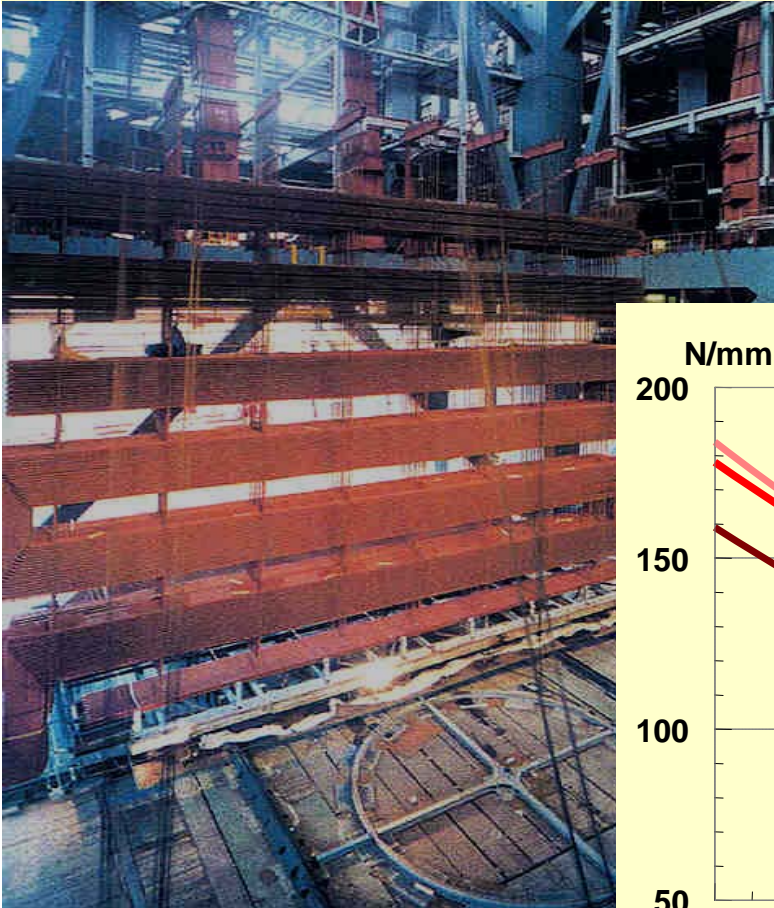


Austenitic and Nickel Base Alloys

	C	Si	Mn	P	S	Fe	Cr	Ni	Mo	Cu	Nb	Ti	Others	used as
TP 347H FG	0,04-0,10	max. 0,75	max. 2,00	max. 0,040	max. 0,030	res.	17,0-20,0	9,0-13,0	-----	-----	8 x C	-----		Tube
Super 304H	0,07-0,13	max. 0,30	max. 1,00	max. 0,040	max. 0,010	res.	17,0-19,0	7,5-10,5	-----	2,50-3,50	0,30-0,60	-----	N 0,05 - 0,12	Tube
HR3C	0,04-0,10	max. 0,75	max. 2,00	max. 0,030	max. 0,030	res.	24,0-26,0	17,0-23,0	-----	-----	0,20-0,60	-----	N 0,15 - 0,35	Tube
DMV310N	0,05-0,07	0,30-0,50	1,00-1,40	max. 0,030	max. 0,010	res.	24,4-25,0	20,8-21,5	-----	-----	0,40-0,50	-----	N 0,18 - 0,24	Tube
Sanicro 25	max. 0,08	yes	yes	max. 0,030	max. 0,010	res.	22,0-24,0	23,0-25,0	-----	yes	yes	-----	N yes	Tube
Alloy617 NiCr23Co12 Mo 2.4663	0,05-0,10	max. 0,70	max. 0,70	max. 0,012	max. 0,008	max. 2,00	20,0-23,0	res.	8,0-10,0	As m 0,010	Bi m 0,010	0,20-0,60	Co 10,00 - 13,00 Al 0,60 -1,50 Pb max. 0,007	Pipe/Tube
Alloy 263	0,04-0,08	max. 0,40	max. 0,60	max. 0,007	max. 0,007	max. 0,7	19,0-21,0	res.	5,6-6,1	max. 0,70	-----	1,9-2,4	Co 19,00 - 21,00 Al max.0,60 B max. 0,005	Pipe/Tube
Alloy 740	0,03	max. 0,50	0,30	max. 0,007	max. 0,007	max. 0,7	22,0-25,0	res.	0,50	max. 0,70	2,0	1,8	Co 20,0 Al 0,90	Tube

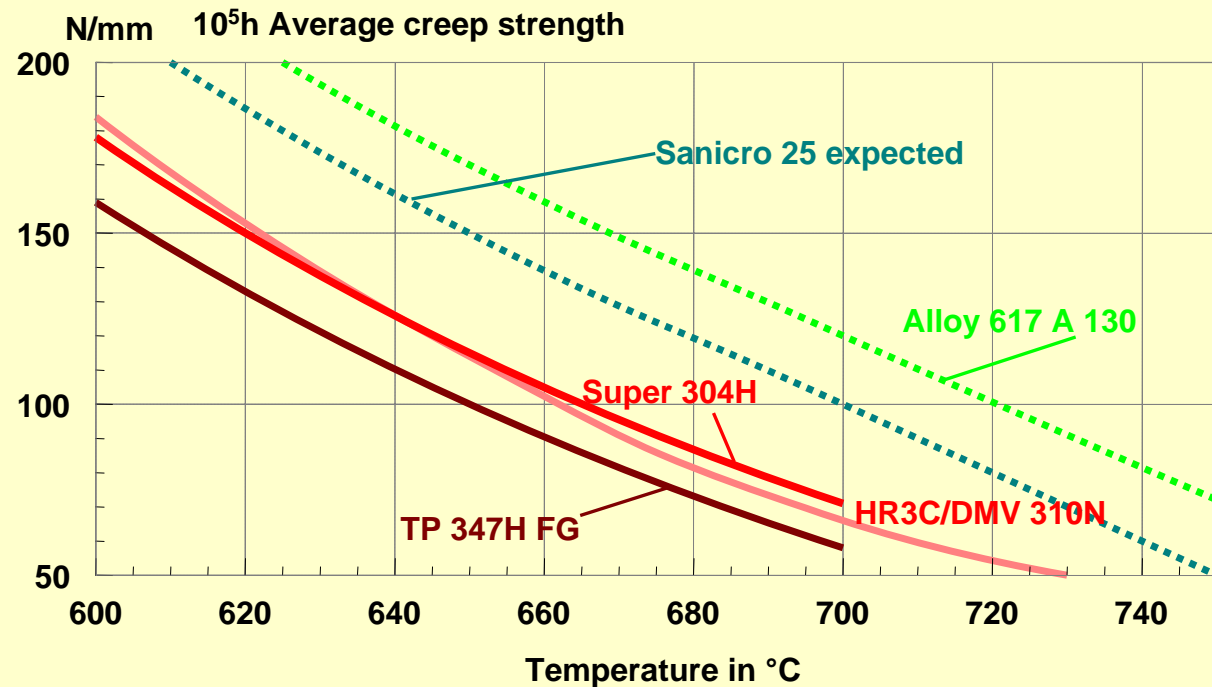


Materials for Reheater and Superheater



Materials:

- TP 347H FG
- HR3C/DMV 310N
- Super304H/DMV 304H Cu

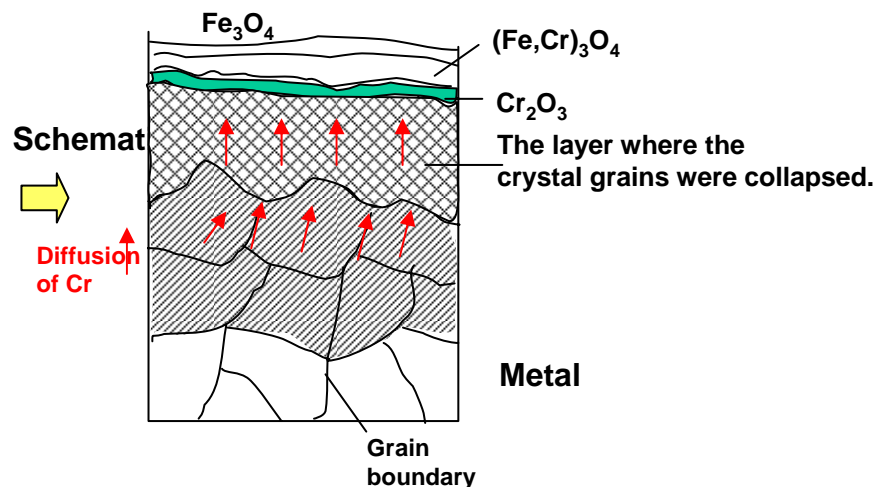
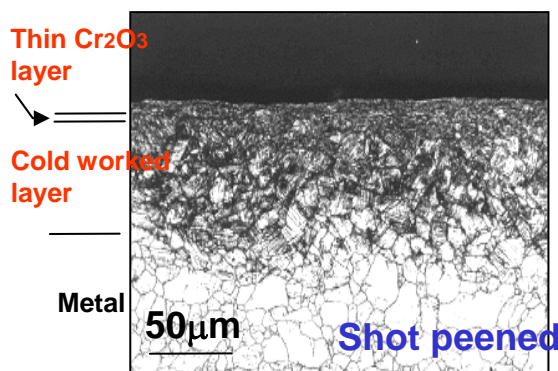




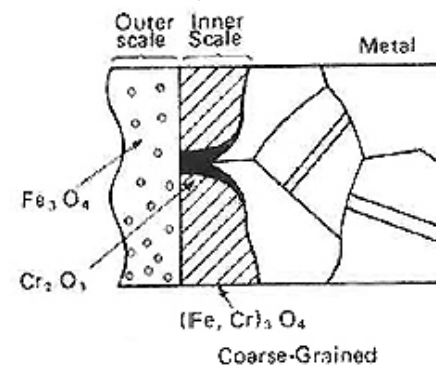
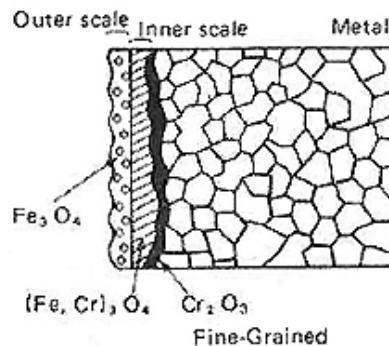
Measures Improving Oxidation Behaviour in Steam

1. High Cr – Content > 24% e.g. HR3C, DMV 310N, Sanicro 25

2. Shot Peening e.g. Super 304H

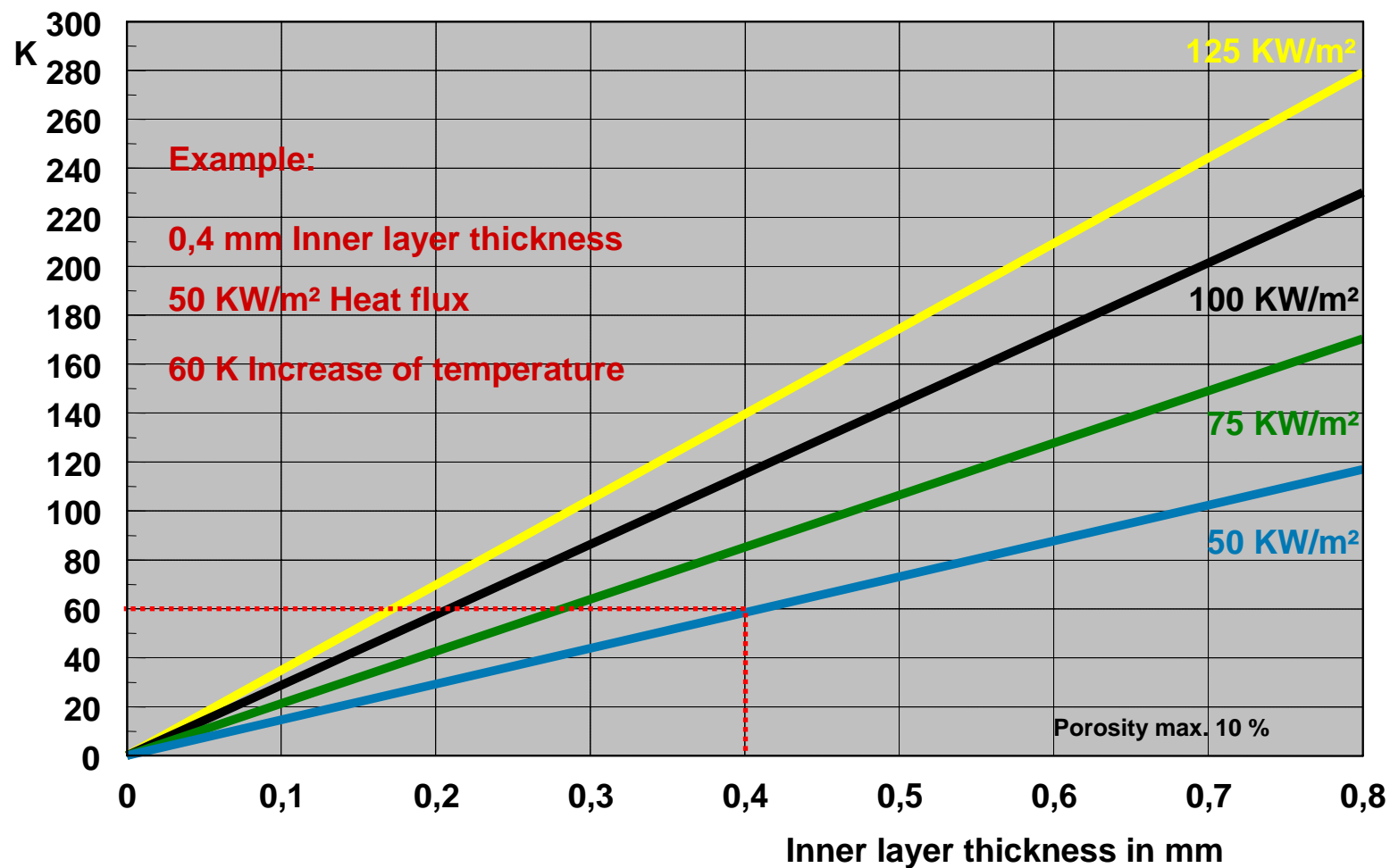


3. Fine Grain e.g. TP347H FG



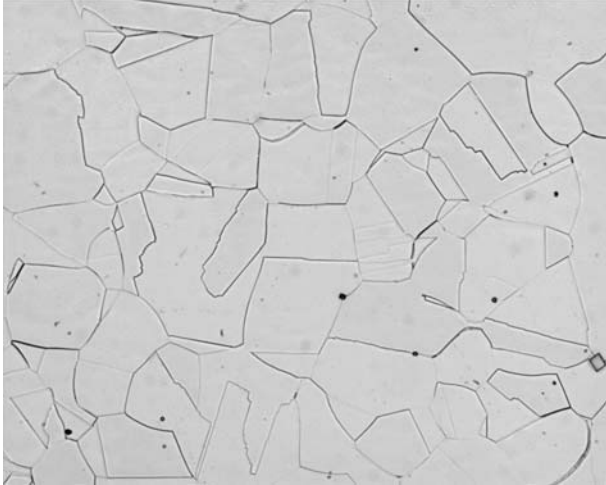


Increase of Temperature on Superheater Tubes Caused by Inner Layer



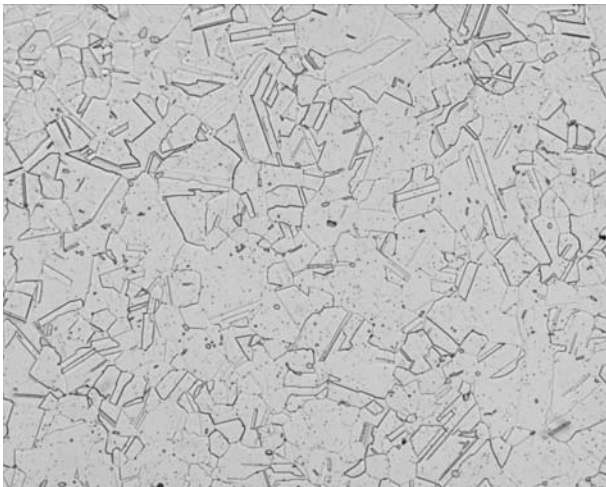
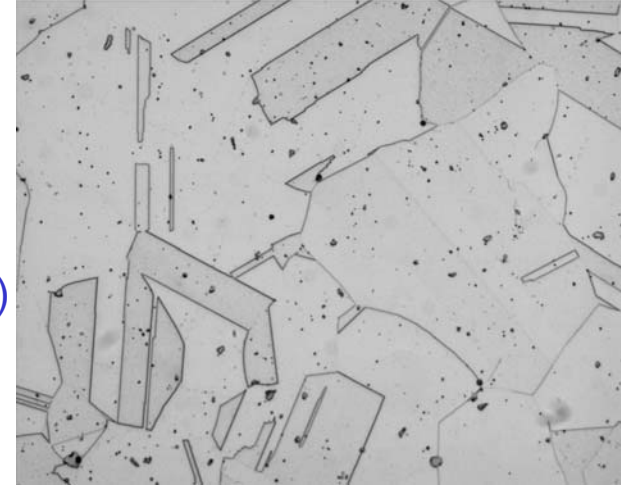


Materials for Reheater and Superheater Tubes



X3CrNiMoN17-13

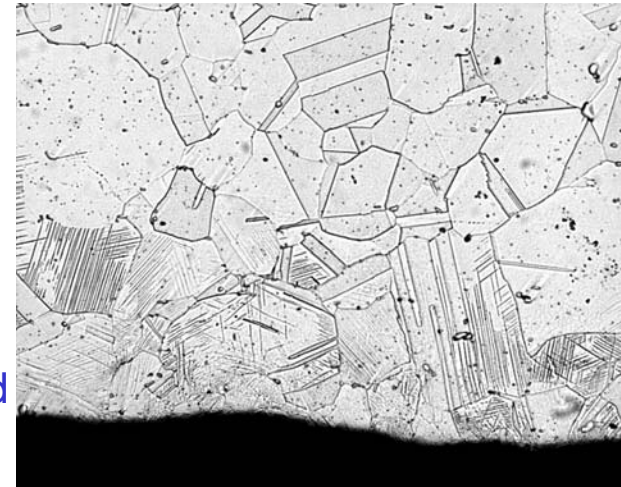
HR3C (24% – 26% Cr)



TP 347H Fine Grain

TP 347H Shot Peened

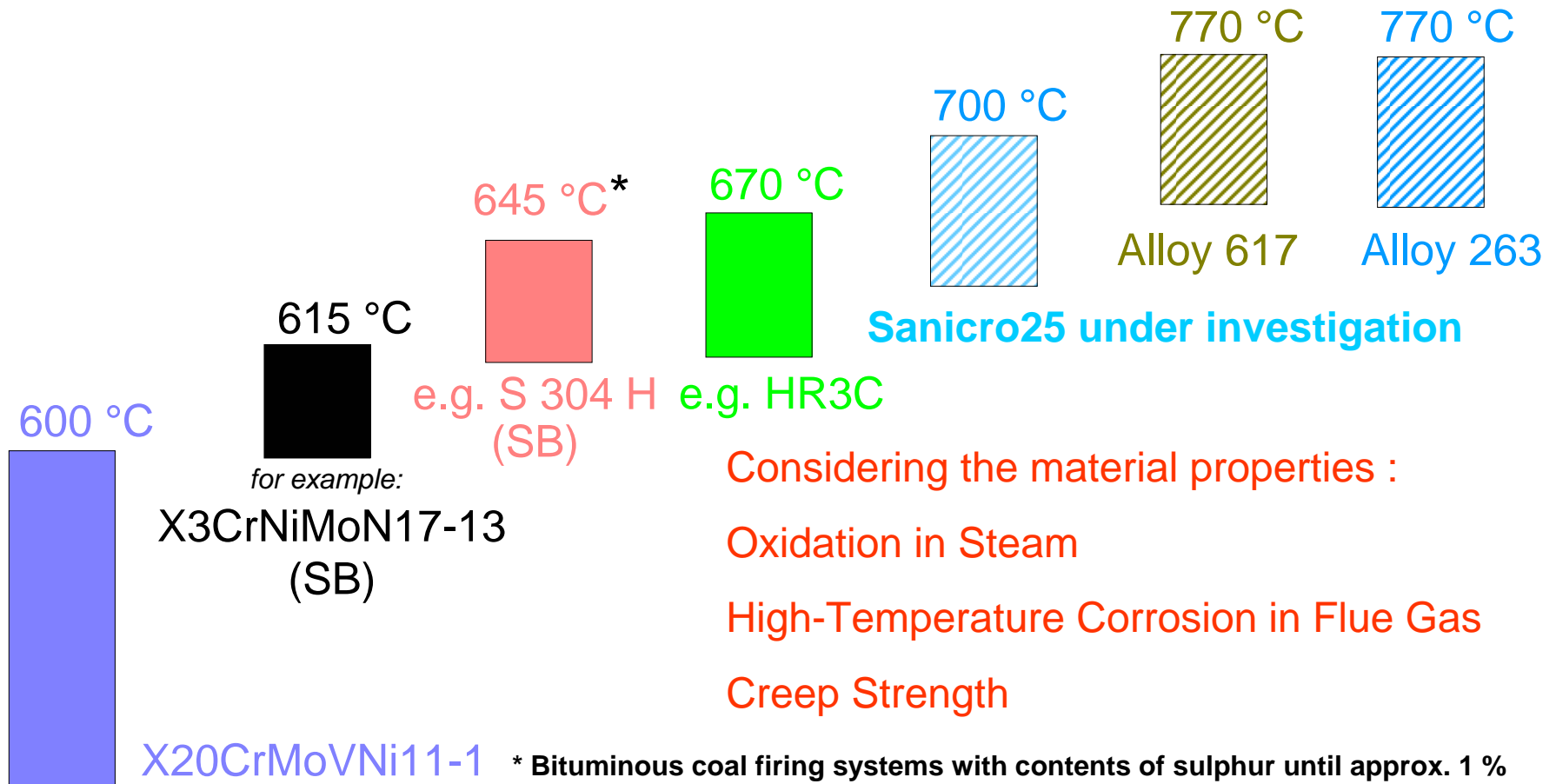
Originally 500 : 1





Materials for Reheater and Superheater Tubes

Design temperatures according EN 12952





Codes for Superheater Materials

Materials	DIN EN	VdTÜV	ASME	Others
X20CrMoV11-1	10216-2			DIN17175
X3CrNiMoN17-13	pr10216-5			DIN17459
TP347H FG (SB)		547 6.2003	Code2159	SA213
Super 304H (SB)		550 9.2003	Code2328	SA213
DMV310N			Code2113	SA213
				Single appraisal
				TÜV Köln
HR3C		546 9.2003	Code2125	SA213
NiCr23Co12Mo		485 9.2001	Code1982	Single appraisal
			Code1956	TÜV Köln

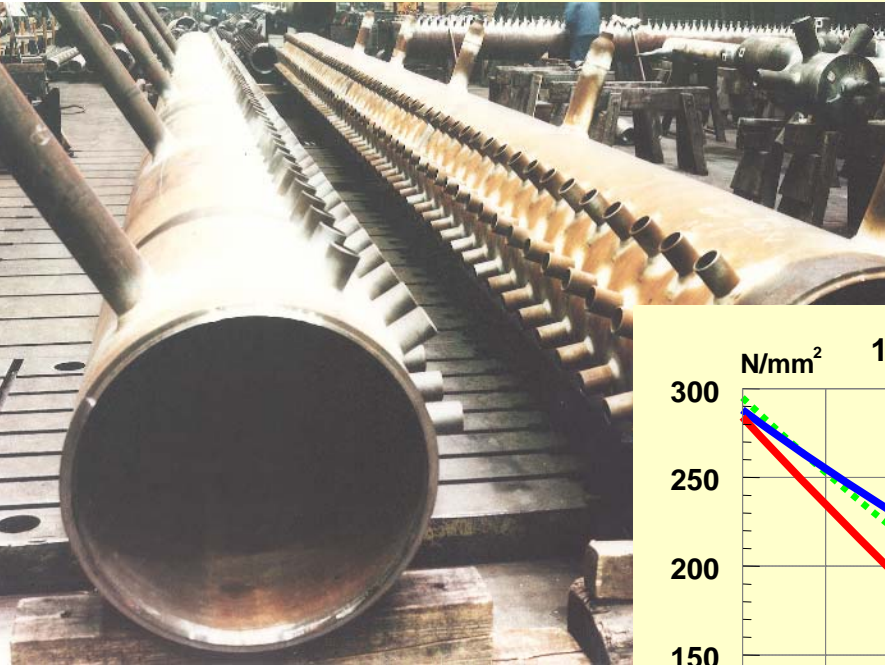


Martensitic Cr – Steels for Headers and Piping

	C	Si	Mn	P	S	Al	Cr	Ni	Mo	V	Nb	Ti	W	N	B	Co
X20CrMo V12-1	0,17- 0,23	max. 0,50	max. 1,00	max. 0,030	max. 0,030	max. 0,040	10,00- 12,50	0,30- 0,80	0,80- 1,20	0,25- 0,35	----- -----	----- -----	----- -----	----- -----	----- -----	----- -----
X10CrMoV Nb9-1 P 91	0,08- 0,12	0,20- 0,50	0,30- 0,60	max. 0,020	max. 0,010	max. 0,040	8,00- 9,50	max. 0,40	0,85- 1,05	0,18- 0,25	0,06- 0,10	----- -----	----- -----	0,030- 0,070	----- -----	----- -----
X11CrMoW VNb9-1-1 E 911	0,09- 0,13	0,10- 0,50	0,30- 0,60	max. 0,020	max. 0,010	max. 0,040	8,50- 9,50	0,10- 0,40	0,90- 1,10	0,18- 0,25	0,06- 0,10	----- -----	0,90- 1,10	0,050- 0,090	0,001- 0,006	----- -----
X10CrWMo Nb9-2 P 92	0,07- 0,13	max. 0,50	0,30- 0,60	max. 0,020	max. 0,010	max. 0,040	8,50- 9,50	max. 0,40	0,30- 0,60	0,15- 0,25	0,04- 0,09	----- -----	1,50- 2,00	0,030- 0,070	0,001 0,006	----- -----
VM12	0,08 0,18	0,20 0,60	0,10 0,80	max. 0,020	max. 0,010	max. 0,040	10,0 13,0	max. 0,60	max. 0,80	0,18 0,30	0,030 0,060	----- -----	1,00 1,80	0,030 0,090	0,001 0,010	0,50 2,00

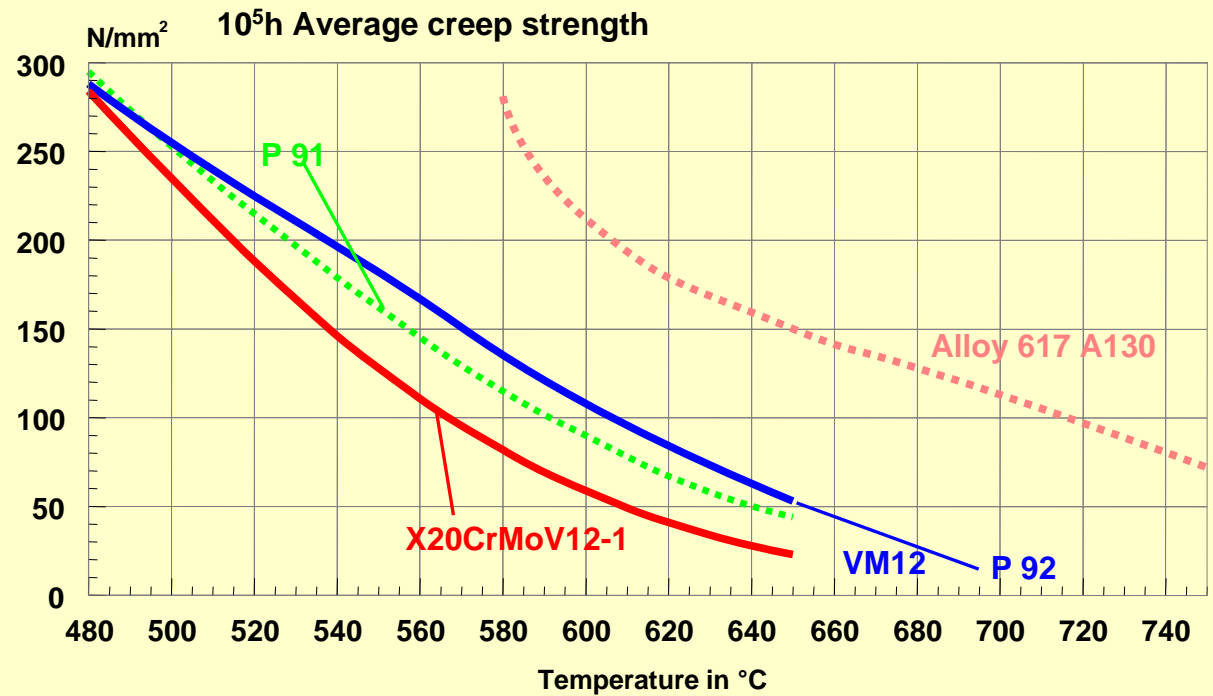


Materials for Headers and Piping



Materials:

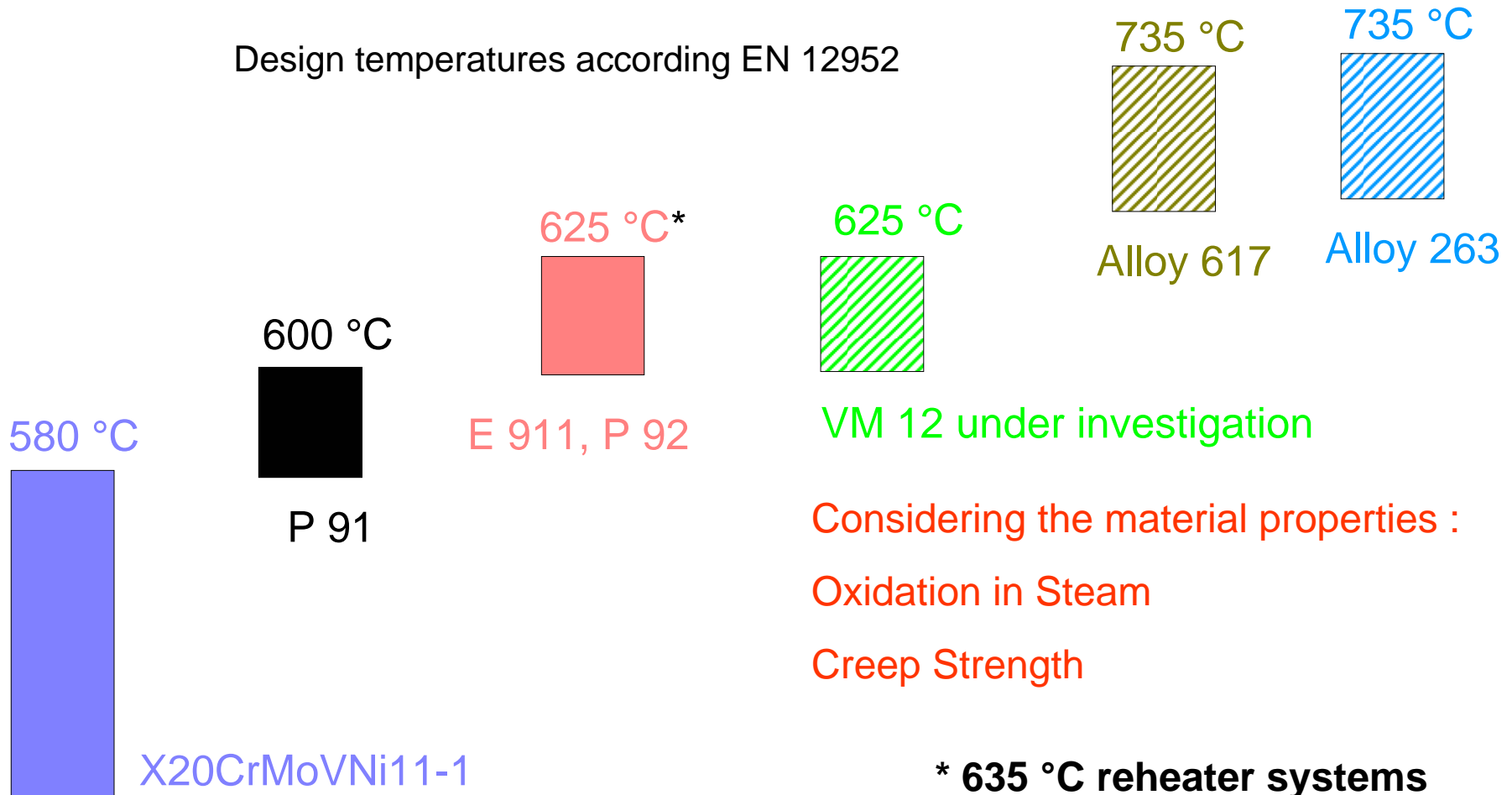
- X20CrMoV12-1
- P91
- E911, P92





Materials for Headers and Piping

Design temperatures according EN 12952





Codes for Headers and Piping Materials

	Others	VdTÜV	DIN EN	ASME / ASTM
X20CrMoV12-1	17175 5.79	110 12.95	10 216 - 2 07.04	-----
P 91	-----	511/2 06.01 511/3 09.01	10 216 - 2 07.04	ASME SA 335 ASTM A 335
E 911	ECCC Evaluation Sept.2005	522/2 09.01 522/3 12.99	prEN10216-2 März 2004	ASME Code Case 2327 May 2000
P 92	ECCC Evaluation Sept.2005	-----	prEN10216-2 März 2004	ASME Code Case 2179 ASTM A 335
VM 12	-----	-----	-----	-----
Alloy 617	Single appraisal 1.2004 TÜV Rheinland	485 9.01	-----	ASME B 167 ASME Code Case 1982 ASME Code Case 1956
Alloy 263	-----	-----	-----	-----

(ECCC) European Creep Collaborative Committee



Status of Investigations

Requirements	7Cr Tub	7Cr For	617 Pipe	617 Forg	VM12 Pipe	VM 12 For	San25 Tub	DMV 310,304, 347 Tub	Sum S304, HR3C, 347	T/P 92	DMV66 mod A263	F92
Chemical Composition	Green	Green	available	Green	Green	Green	Green	Green	Green	Green	Red	Green
Physical / Chemical Properties	Green	Green	Green	Green	Green	Red	Yellow	Red	Green	Green	Red	Green
Mechanical-Technological Properties, incl. Aging	Green	Green	Green	Green	Green	Red	planned	Red	Red	Green	Red	Red
Creep Properties at least 10.000 h for rupture	Green	Red	Green	Yellow	Green	Red	Red	Red	Green	Green	Red	Yellow
Creep Properties at least 30.000 h for rupture	Green	Red	Red	Red	Yellow	Red	Red	Red	Green	Green	Red	Red
Properties of Welding Joints and Heat Affected Zones	Yellow	Yellow	running	Yellow	Yellow	Red	Red	Red	Red	Yellow	Red	Yellow
Manufacturing Concept	Green	Yellow	Yellow	Yellow	Yellow	Red	Red	Red	Red	Yellow	Red	Yellow



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**Thank you
for your attention**

**Grazie per la
vostra attenzione**

