NIPPON STEEL

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Seamless Steel Tubes and Pipes for Boilers
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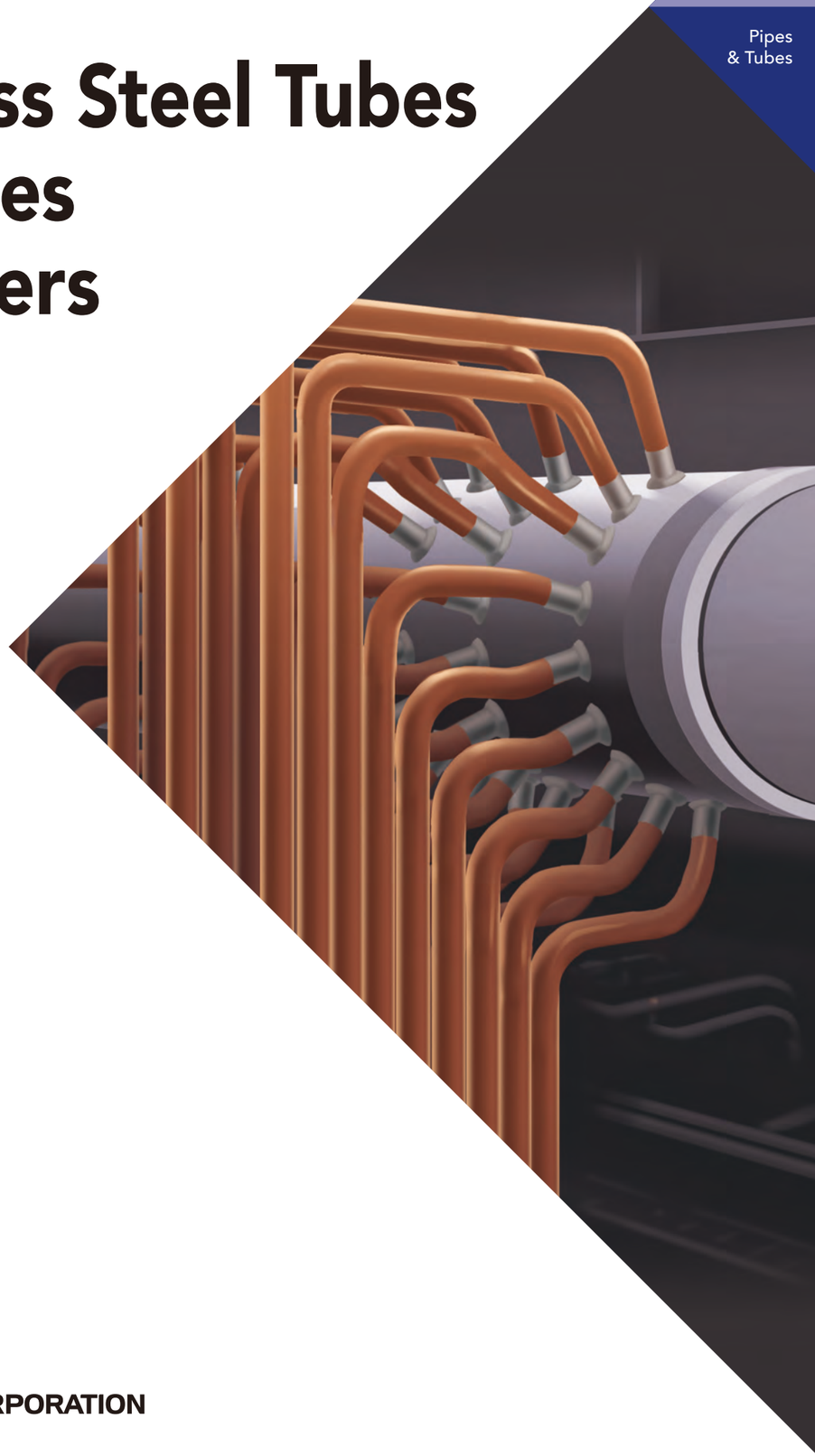
NIPPON STEEL

Pipes
& Tubes

Seamless Steel Tubes and Pipes for Boilers



NIPPON STEEL CORPORATION

Contents

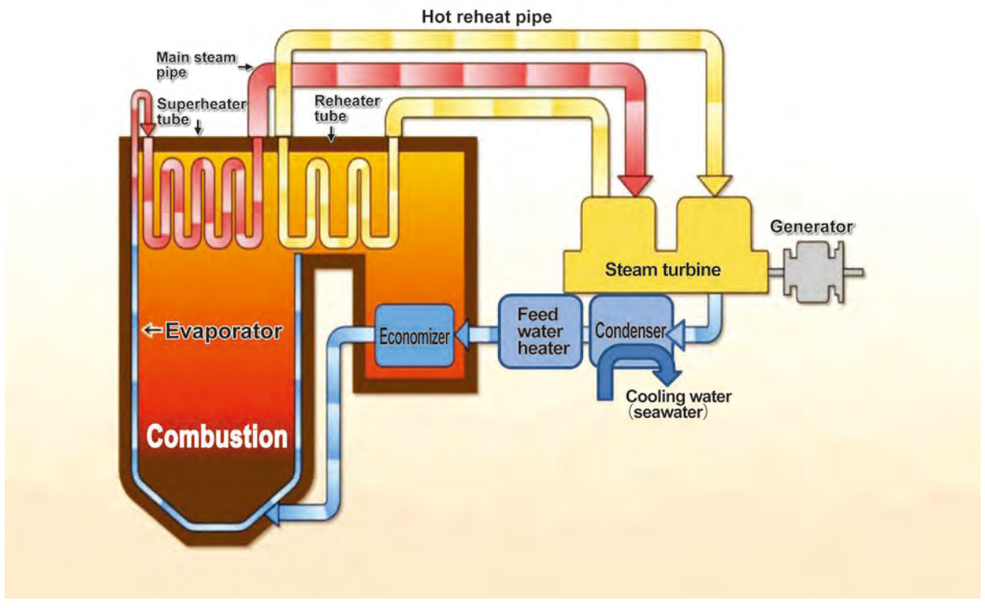
Introduction

We have been manufacturing boiler steel tubes and pipes used in all fields, mainly power generation boilers, up to the present day, ever since we first started manufacturing seamless steel tubes for boilers for the first time in Japan in 1912.
During this time, higher temperatures and pressures and larger-capacity boilers have been developed and have undergone rapid technological innovations, together with changes in fuel conditions. Recently in particular, high-efficiency generation has been demanded in order to control total carbon dioxide emissions, from the viewpoint of the worldwide conservation of the global environment, and ultra-supercritical pressure boilers, pressurized fluidized bed boilers, gas turbine-combined power generation boilers, and high-efficiency industrial waste incineration boilers have been constructed one after another, as new thermal power generation boilers. Steel tubes and pipes, to be used to respond to these situations, have been demand to maintain both high quality and high performance. There has also emerged a need for various steel tubes and pipes such as economic steel tubes and specially-shaped steel tubes.
In rapid response to these requests, as an advanced manufacturer of boiler steel tubes and pipes, we have aggressively proceeded with the development of new materials, improvement of production technology, installation of new facilities, and improvement of inspection and quality control technologies.
We are confident that our boiler steel tubes and pipes will fulfill your expectations in every aspect, such as quality, performance, and access to service networks across various countries.

Every type of steel tube and pipe can be manufactured.

A power generation boiler consists of an economizer, a furnace (evaporator), a superheater tube, a reheater tube, a main steam pipe, a reheat pipe, a water feed pipe, and a feed water heater tube.
We manufacture various carbon steel, alloy steel, and stainless steel tubes and pipes to suit the usage conditions of these pieces of equipment. In addition to JIS standard products, we also manufacture foreign standard products such as ASME (ASTM), EN, and DIN, along with our own proprietary special products.

Power plant system diagram

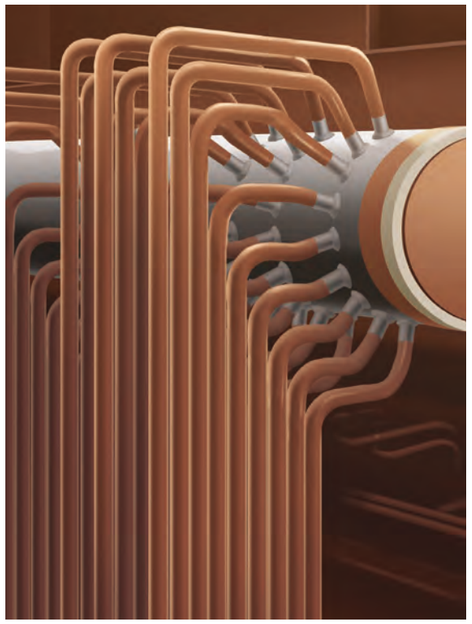


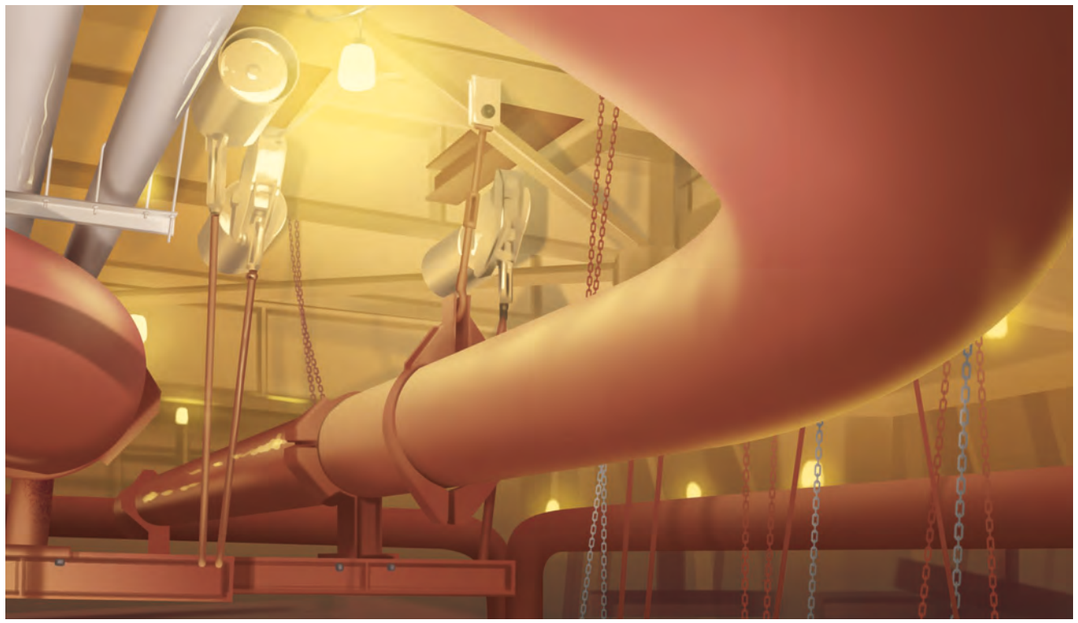
Typical steel grades and main application examples

Steel grade	Compositions	Our own developed steel	Applicable Standards (abbreviation)				Application							
			ASTM (U.S.)	EN (U.K.)	DIN (DE)	JIS (JP) Thermal power standard (T)	(1)Economizer tube	(2)Evaporator	(3)Superheater tube	(4)Reheater tube	(5)Main steam tube	(6)Reheat pipe	(7,8)Feed water heater tube	(9)Water feed pipe
Sulfuric acid corrosion-resistant steel	S-TEN™1 (0.3Cu-0.1Sb)	○	A423、Gr.3 (ASME CC2494)			KA-STB380J2	○ (Economizer and air preheater)							
	CR1A (1.25Cr-0.3Cu)	○				KA-STBA10	○ (Economizer and air preheater)							
Carbon steel	0.15-0.25C		A53-Gr.A、B A106-Gr.A、B A178-Gr.A、C A192 A210-Gr.A-1		St45 St45.4 St45.8 C22	STB340(STB35) STB410(STB42) STB510(STB52) STPT370(STPT38) STPT410(STPT42)	○	○					○	
	0.25-0.35C		A106-Gr.C A210-Gr.C		St55 St55.4	STPT480(STPT49)	○	○					○	○
Low-alloy steel	0.3-0.5Mo		T1、T1a P1		15Mo3 16Mo5	STBA12、13 STPA12		○	○	○			○	
	0.5Cr-0.5Mo-V				14MoV63				○	○		○		
	0.5Cr-0.5Mo		T2 P2			STBA20 STPA20		○	○	○		○		
	1Cr-0.5Mo		T12 P12		13CrMo44	STBA22 STPA22		○	○	○		○		
	2.25Cr-1Mo		T22 P22		10CrMo910	STBA24 STPA24			○	○	○	○		
	HCM2S™* (2.25Cr-1.6W-V-Nb)	○	T23 P23 (ASME CC2199)	—	—	KA-STBA24J1 KA-STPA24J1			○	○	○	○		
High chrome ferritic steel	9Cr-1Mo		T9 P9		X12CrMo91	STBA26 STPA26			○	○	○	○		
	9Cr-1Mo-V-Nb		T91 P91	—	X10CrMoV Nb9-1	KA-STBA28 KA-STPA28			○	○	○			
	NF616 (9Cr-1.8W-V-Nb)	○	T92 P92 (ASME CC2179)	VdTÜV 552/2	X10CrWMoV Nb9-2	KA-STBA29 KA-STPA29			○	○	○			
	12Cr-1Mo-0.3V			—	X20CrMoV121				○	○	○			
Austenitic stainless steel	18Cr-8Ni		TP304 TP304H		X5CrNi89 X6CrNi1810	SUS304 SUS304H			○	○			○	
	18Cr-8Ni-Ti		TP321 TP321H		X6CrNiTi189 X8CrNiTi1810	SUS321 SUS321H			○	○				
	18Cr-8Ni-Nb		TP347、TP347H TP348、TP348H		X6CrNiNb189	SUS347 SUS347H			○	○				
	TP347HFG (18Cr-11Ni-0.6Nb)	○	TP347HFG	VdTÜV 547/2	X8CrNiNb1811				○	○				
	SUPER304H™ (18Cr-9Ni-3Cu-V-Nb)	○	UNS S30432 (ASME CC2328)	VdTÜV 550/2	X10CrNiCuNb 189	KA-SUS304J1HTB			○	○				
	XA704 (18Cr-9Ni-2W-V-Nb-N)	○	UNS S34705 (ASME CC2475)	VdTÜV 554/2		KA-SUS347J1TB			○	○				
	16Cr-14Ni-2.5Mo		TP316 TP316H		X5CrNiMo 17132	SUS316 SUS316H			○	○				
	NF709 (22Cr-25Ni-1.5Mo-Nb-N)	○	TP310MoCbN (ASME CC2581)	VdTÜV 563/2	X6CrNiMo 17132	KA-SUS310J2TB			○	○				
	HR3C (25Cr-20Ni-Nb-N)	○	TP310HCbN (ASME TP310HCbN)	VdTÜV 546/2	X6CrNiNbN 2520	KA-SUS310J1TB			○	○				
	YUS™170	○				KA-SUS309J1TB			○	○				
	MN25R*	○	TP309LMoN (ASME CC2639)			KA-SUS309J3LTB			○	○				

* HCM2S and MN25R were developed jointly with Mitsubishi Heavy Industries, Ltd.

NIPPON STEEL Boiler Steel Tubes and pipes Activity





Three Mainstays of Reliability

1 Integrated production system

2 Quality assurance system

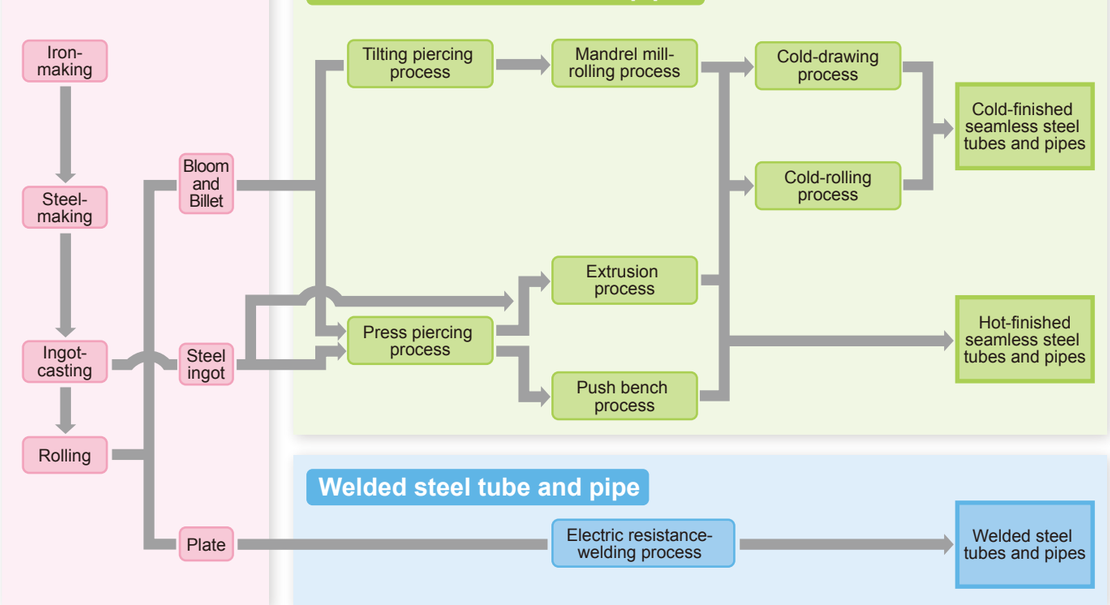
3 Research and development system

Boiler tubes and pipes require extremely superior quality and a variety of steel grades and dimensions suited to usage situations.
To fully meet these requirements, our boiler tubes and pipes have emerged from a secure system through years of experience and foremost engineering prowess, as a backdrop.
They are manufactured based on an integrated production system and on strict quality design and quality control, ranging from raw materials to final products.
In line with diversifying needs, we are developing new materials and products, and are conducting a wide variety of research and development, including manufacturing process research.
Thus, our boiler tubes and pipes that have a superior track record and receive a high level of trust, all based on three mainstays : Integrated production, quality assurance, and research and development.

1 Integrated production system

Our boiler tubes and pipes are consistently controlled, from steel-making to tube and pipe-making, in order to ensure the manufacturing of all steel grades, as well as to assure uniform and stable quality, through strict quality control during each process.
Particularly, steel-making processes, from component mixture to final heat treatment, undergo optimum quality design regarding boiler steel tubes and pipes, by putting years of experience and high engineering prowess to full use so that products can endure long usage periods of one or two decades. In order to bring the quality design into shape, a new refining method in steel-making is introduced and various manufacturing processes are selected according to dimensions, material properties, and internal and external surface accuracy.
Seamless steel tubes and pipes are hot manufactured using mandrel mill-rolling process, extrusion process, and push bench process.
The mandrel mill-rolling process is used to manufacture small-diameter carbon steel tubes and low-alloy steel tubes. The extrusion process is used to manufacture high-alloy steel tubes, such as stainless steel, and special tubes, such as finned tubes. The push bench process is suited for manufacturing large-diameter, thick-wall tubes, and enables the manufacturing of carbon steel, alloy steel, and stainless steel tubes and pipes.
These hot manufactured tubes are cold finished using cold-drawing and cold-rolling processes that fit the applications and thermal treatments.

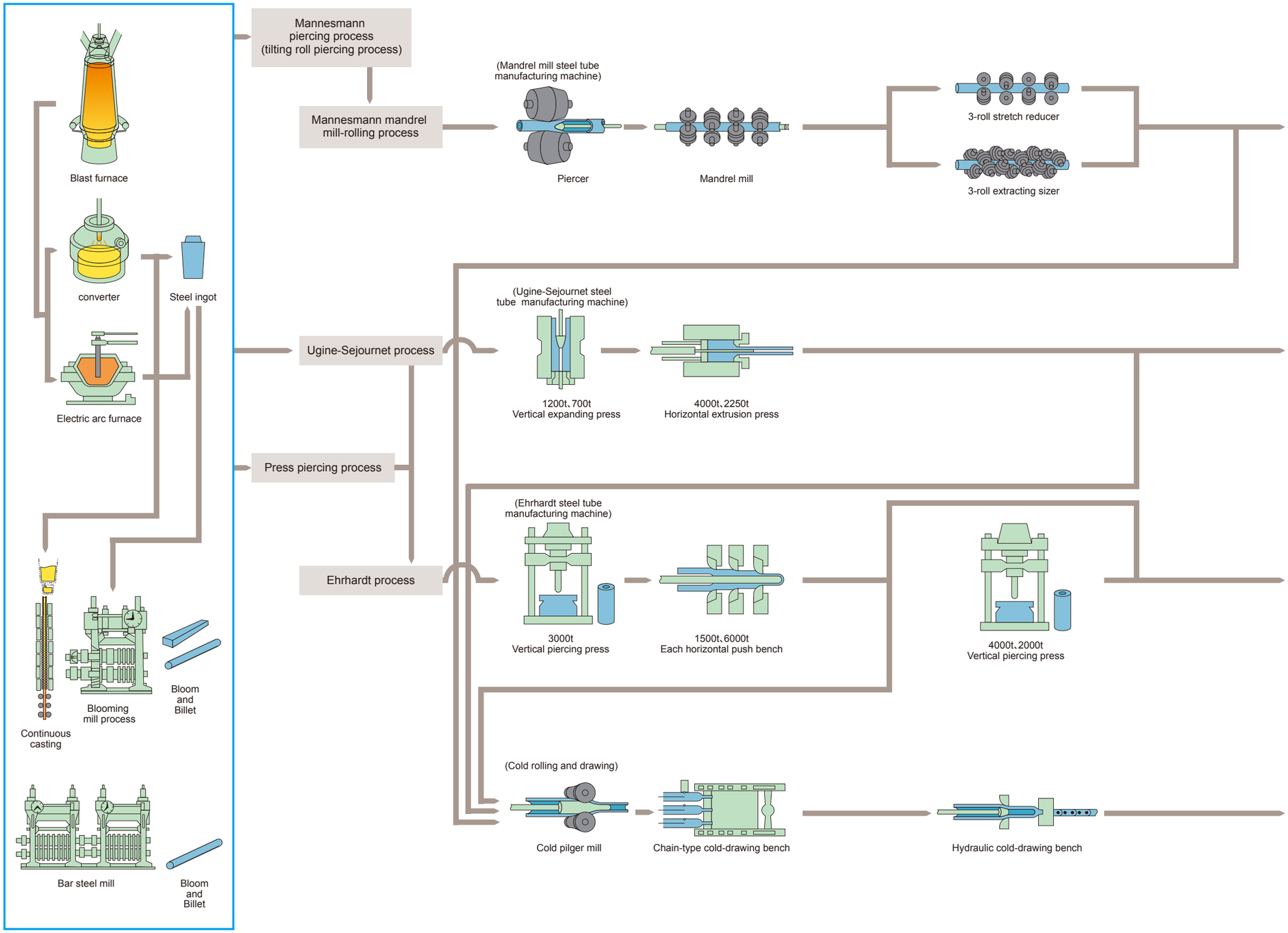
Manufacturing process of boiler steel tubes and pipes



1 Integrated production system

Manufacturing process of seamless steel tubes and pipes

(Some steel grades are not applicable in the following flow.)

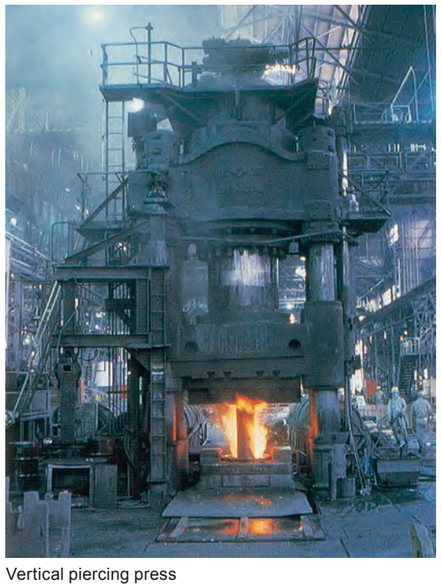


Product	Works	Manufacturable range (outside diameter)	Feature
Hot-finished seamless steel tubes and pipes	Kansai Works Wakayama area	31.8 ～426.0mm	1. The tube manufacturing efficiency is high. 2. The surface is smooth, and thickness deviation is small.
Hot-finished seamless steel tubes and pipes Special steel shapes tubes and pipes	Kansai Works Amagasaki area Kyushu Works Oita area(Hikari Pipe & Tube Div.)	33.4 ～275.0mm 33.4 ～175.0mm Outside diameter 275 mm or less Minimum cross-section area 100 mm^2	1. High alloy, stainless steel, and special metal tubes and pipes can be manufactured. 2. Various special steel shapes tubes and pipes can be manufactured by changing die and mandrel shapes. 3. An order for small-lot and multiple-product types can be filled.
Hot-finished seamless steel pipes Large welded joint	Kansai Works Amagasaki area BENKAN KIKOH Corporation	165.2 ～1270.0mm 21.7 ～914.4mm	1. This product is suited for manufacturing large-diameter, thick-wall steel pipes. 2. The external and internal surfaces can be machined.
Cold-finished seamless steel tubes and pipes	Kansai Works Amagasaki area Kansai Works Wakayama area(Kainan) Kyushu Works Oita area(Hikari Pipe & Tube Div.)	6.0 ～508.0mm 15.9 ～127.0mm 6.0 ～168.3mm	1. The dimensions are accurate, and their dispersion is small. 2. The external and internal surfaces are finely finished.

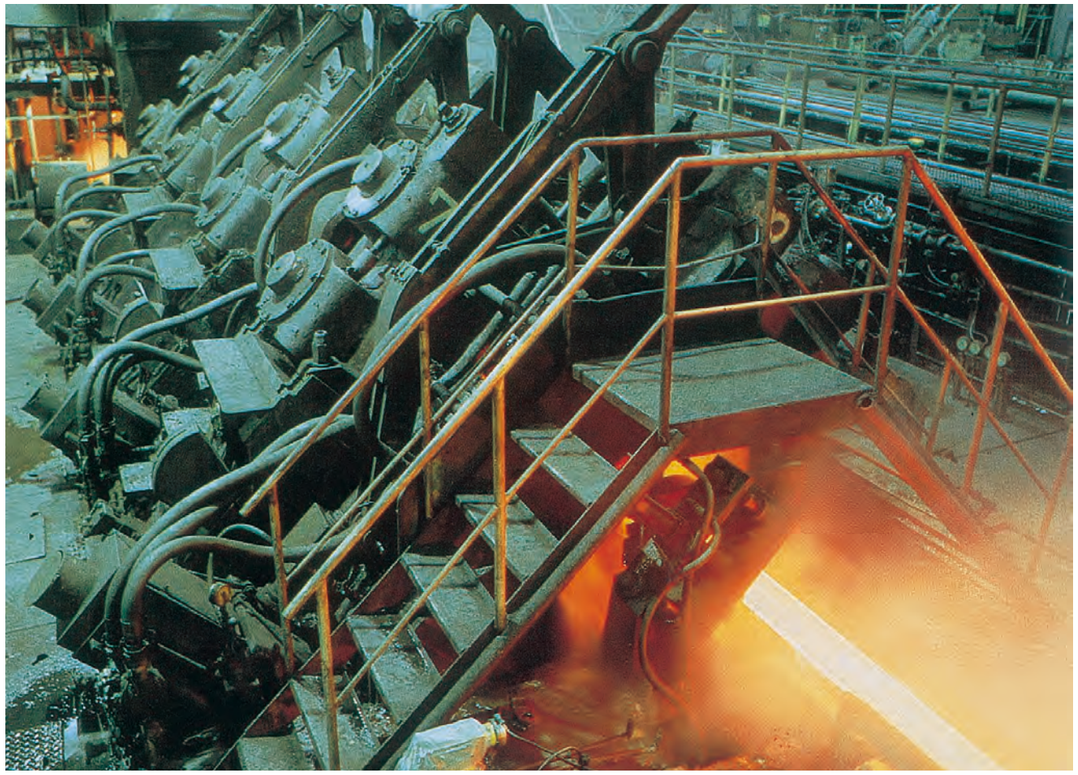
1 Integrated production system

Vacuum-oxygen decarburization process (VOD)

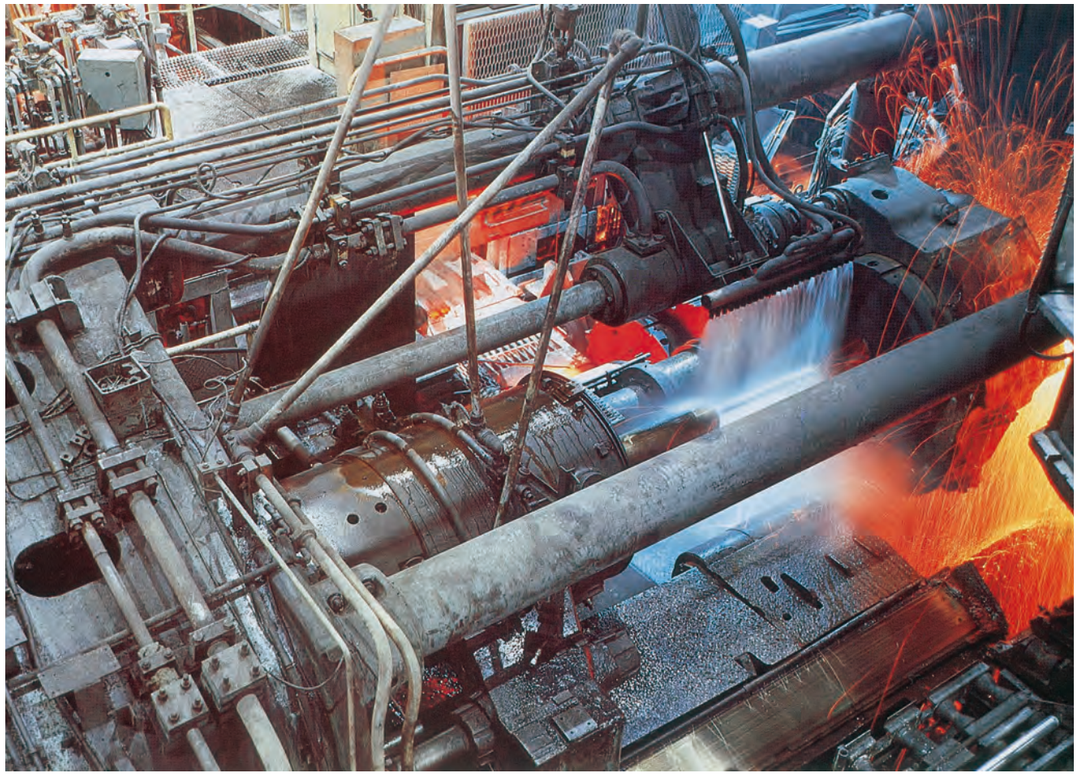
Vacuum degassing process (RH)



Vertical piercing press



Mandrel mill



Horizontal extrusion press

2 Quality assurance system

Boiler tubes and pipes are strongly demanded in order to satisfy especially strict usage conditions, along with operational reliability. We conduct strict quality control in all processes, from steelmaking to tube and pipe-making, and we have established the following quality assurance system.

1. Independence of the quality assurance department

The quality assurance department is independent from the manufacturing department and has primary authority and responsibility concerning quality in order, to take charge of ensuring such quality.

2. Standardization of tasks

Various tasks related to manufacturing and quality are standardized and documented for unification.

3. Adoption of a inspector qualification system

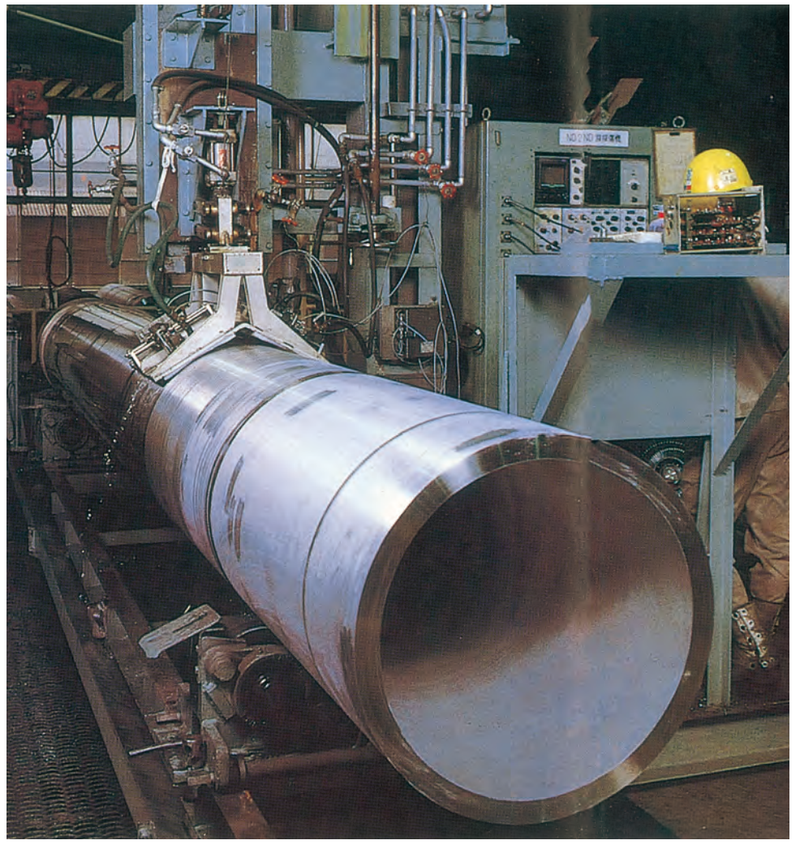
All inspections engaged in work affecting quality have received strict training and have passed a qualification test.

4. Full adoption of nondestructive tests

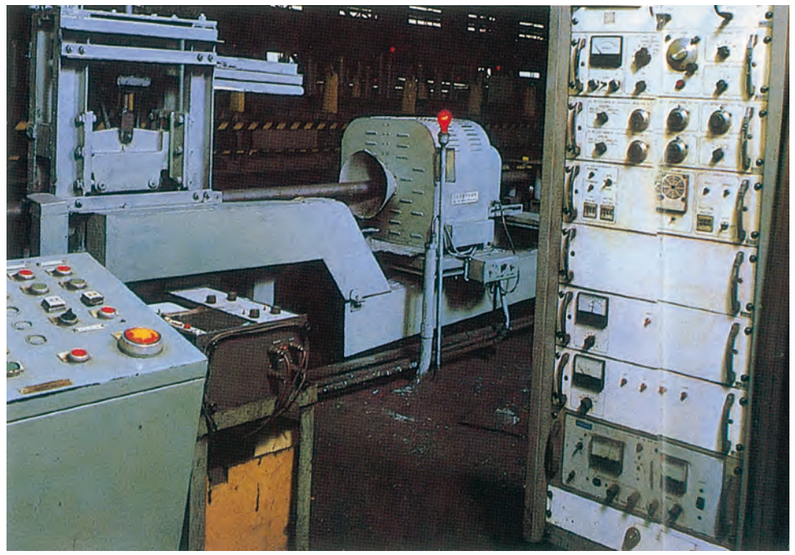
Various required tests and inspections are conducted according to applications, and nondestructive tests are applied to all products in the final inspection.

5. Establishment of periodic gauges and tester calibration systems

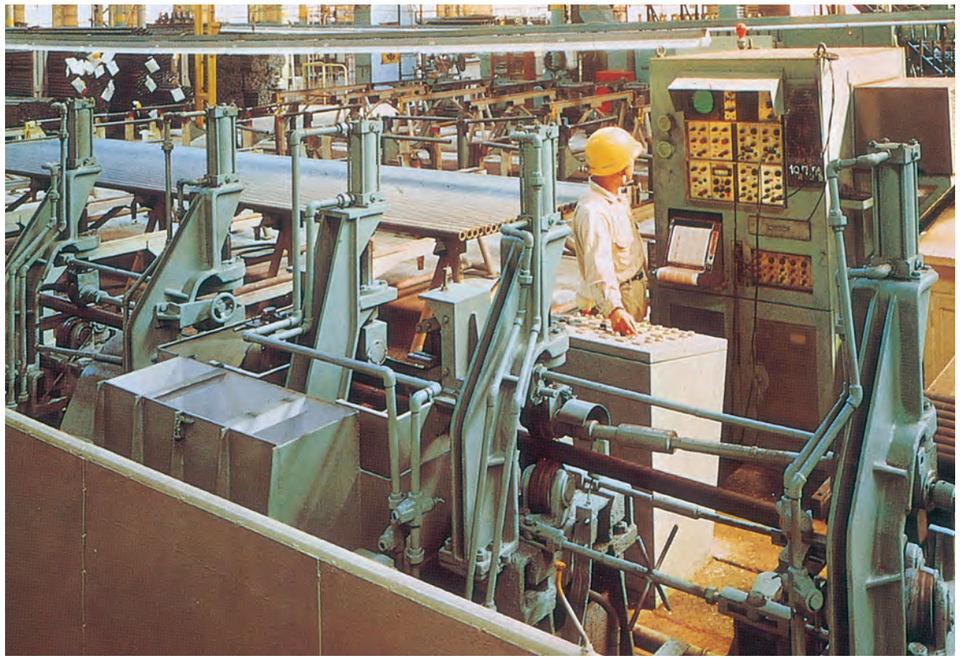
Various gauges and testers are periodically calibrated to ensure quality inspection.



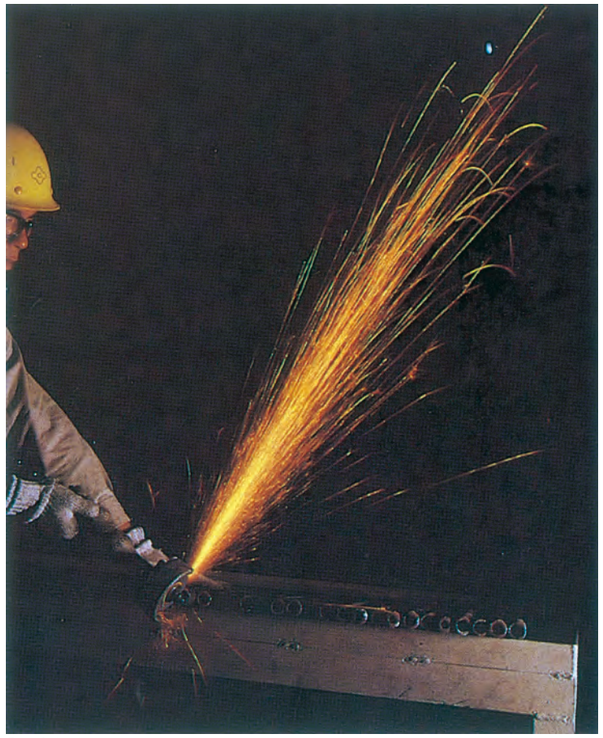
Entrained flow ultrasonic test



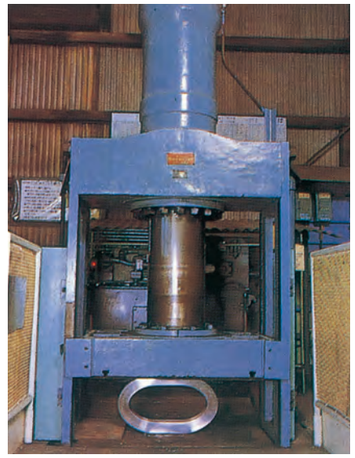
Eddy current test



Water-immersion ultrasonic test



Spark test



Flattening test

3 Research and development system

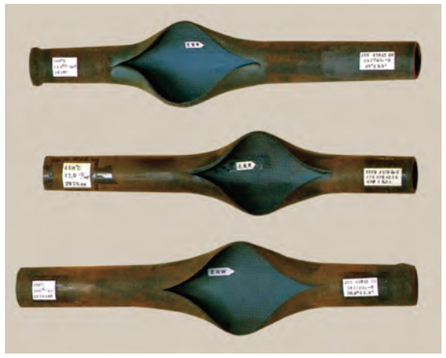
Our boiler tubes and pipes have been used the world over, embodying various characteristic products through distinguished engineering prowess and abundant experience, and they have earned high reputation and trust not only in Japan but also overseas.
It is no exaggeration to say that this is also a good result of systematic research and development systems, ranging from raw materials to products.
At present, with the aim of a further leap forward, we are proceeding with research from the following broad angles.

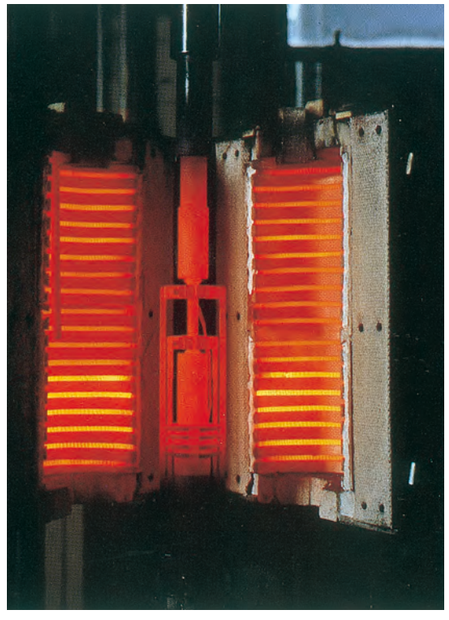
- **Research on high-temperature creep strength properties**
- **Research on high-temperature corrosion protection materials**
- **Research on coal-fired steel tube materials**
- **Research on weldability and workability**
- **Research on manufacturing processes for quality stability**
- **Research on nondestructive inspection and measurement technologies**

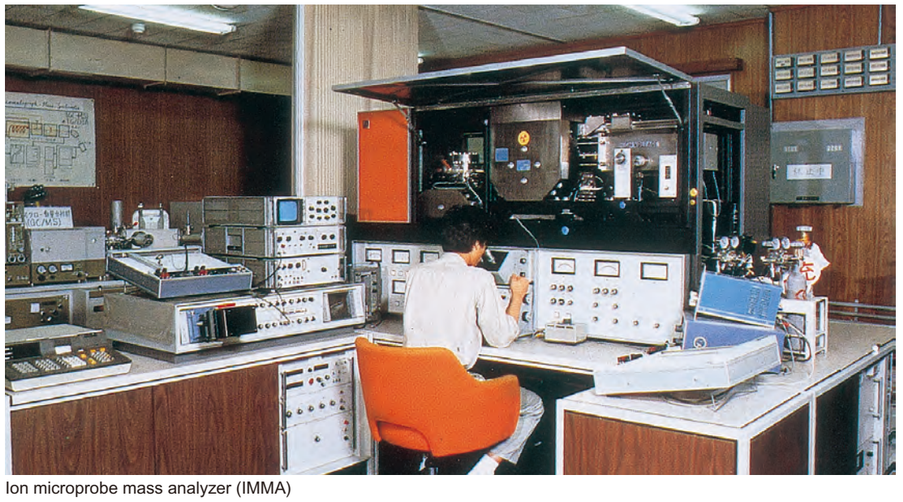
We will also further improve the research department and enhance its functions, and will strive to help promote global iron-making in future.

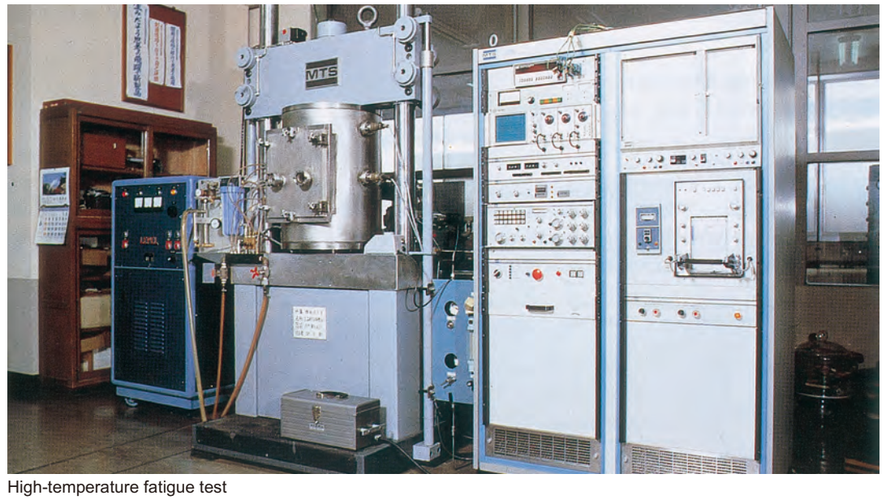

Creep and rupture test


Internal pressure creep tester


Internal pressure creep test specimen and rupture position




Ion microprobe mass analyzer (IMMA)



High-temperature fatigue test

Developed Seamless Tubes and Pipes Products for Boilers

Main proprietary steel grades

Classification	Brand name	Compositions	Applicable standard (abbreviation)			Characteristics ●Example of application	compositions(mass%)										Normal-temperature tensile property		
			ASTM／ASME	EN, etc.	JIS/METI standard		C	Si	Mn	P	S	Ni	Cr	Mo	N	Others	TS, min. MPa	YS, min. MPa	EL, min. %
Ferritic steel tubes and pipes Carbon steel tubes Low-alloy steel tubes High chrome steel tubes and pipes	S-TEN™1	0.3Cu-0.1Sb	ASTM A423 Gr.3 ASME CC 2494		KA-STB380J2 KA-STPT380J2	Sulfuric and hydrochloric acid dew-point corrosion-resistance steel ●ERW tubes, seamless tubes, and heat exchanger tubes	0.14max.	0.55max.	1.60max.	0.025max.	0.025max.	0.50max.		0.20max.		Cu : 0.25-0.50 Sb : 0.15max.	380	230	35/30
	CR1A	1.25Cr-0.3Cu			KA-STBA10	Sulfuric acid dew-point corrosion-resistance steel ●ERW tubes, seamless tubes, and heat exchanger tubes	0.10max.	0.20-0.80	0.80max.	0.025max.	0.015-0.030		1.00-1.50			Cu : 0.25-0.35	410	255	25
	HCM2S™	2.25Cr-1.6W-V-Nb	ASTM A213 T23/A335 P23 ASME CC 2199		KA-STBA24J1 KA-STPA24J1	High-strength 2.25Cr ferritic steel tubes ●Heat exchanger tubes and header pipes for heat recovery steam generator ●Thermal power generation boiler pipes, superheater tubes, and reheater tubes	0.04-0.10	0.50max.	0.10-0.60	0.030max.	0.010max.		1.90-2.60	0.05-0.30	0.030max.	W : 1.45-1.75 V : 0.20-0.30 Nb : 0.02-0.08 sol.Al : 0.030max. B : 0.0005-0.0060	510	400	20
	[Gr.91] Developed by U.S. Oak Ridge National Laboratory	9Cr-1Mo-V-Nb	ASTM A213 T91/A335 P91 ASME SA-213 T91/ SA-335 P91		KA-STBA28 KA-STPA28	High-strength, high-Cr steel tubes (This product was commercialized as a world-first.) ●Main steam pipes, headers, reheat pipes, superheater tubes, and reheater tubes of thermal power generation boilers ●Heat exchanger steel tubes for the chemical industry	0.08-0.12	0.20-0.50	0.30-0.60	0.020max.	0.010max.	0.40max.	8.00-9.50	0.85-1.05	0.030-0.070	V : 0.18-0.25 Nb : 0.06-0.10 sol.Al : 0.04max.	590	410	20 hardness HRC ≤ 25
	Gr.92(NF616)	9Cr-1.8W-V-Nb	ASTM A213 T92/A335 P92 ASME SA-213/SA-335 CC2179	VdTÜV 552/2	KA-STBA29 KA-STPA29	World's highest-strength, high-Cr steel tubes ●Main steam pipes, headers, reheat pipes, superheater tubes, and reheater tubes of ultra-supercritical pressure boilers	0.07-0.13	0.50max.	0.30-0.60	0.020max.	0.010max.	0.40max.	8.50-9.50	0.30-0.60	0.030-0.070	W : 1.50-2.00 V : 0.15-0.25 Nb : 0.04-0.09 sol.Al : 0.04max. B : 0.001-0.006	620	440	20 hardness HRC ≤ 25
Austenitic stainless steel tubes and pipes	TP347HFG	18Cr-12Ni-0.6Nb	ASTM A213TP347HFG (S34710) ASME SA-213 TP347HFG	VdTÜV 547/2		Superior steam oxidation resistance 18Cr austenitic stainless steel tubes with fine-grained microstructuer using an original process ●Superheater tubes and reheater tubes of ultra-supercritical pressure boilers ●Heat exchanger tubes of biomass boilers	0.06-0.10	0.75max.	2.00max.	0.045max.	0.030max.	9.0-13.0	17.0-19.0			8×C-1.10	550	205	35
	SUPER304H™	18Cr-9Ni-3Cu-Nb-N	ASTM A213 (S30432) ASME SA-213 CC2328	VdTÜV 550/2	KA-SUS304J1HTB	Superior steam oxidation-resistance and high-strength 18Cr austenitic stainless steel tubes ●Superheater tubes and reheater tubes of ultra-supercritical pressure boilers	0.07-0.13	0.30max.	1.00max.	0.040max.	0.010max.	7.50-10.50	17.00-19.00		0.05-0.12	Cu : 2.50-3.50 Nb : 0.30-0.60	590	235	35
	XA704	18Cr-9Ni-2W-Nb-V-N	ASTM A213 TP347W (S34705) ASME CC 2475	VdTÜV 554/2	KA-SUS347J1TB	Excellent intergranular corrosion resistance, high-strength 18Cr austenitic stainless steel tubes ●Superheater tubes and reheater tubes	0.05max.	1.00max.	2.00max.	0.040max.	0.030max.	8.0-11.0	17.0-20.0	–	0.10-0.25	Nb : 0.25-0.50 V : 0.20-0.50 W : 1.50-2.60	620	260	30
	NF709	22.5Cr-25Ni-1.5Mo-Nb-N	ASTM A213 TP310MoCbN(S31025) ASME CC 2581	VdTÜV 563/2	KA-SUS310J2TB	High-strength 20 to 25Cr austenitic stainless steel tubes ●Superheater tubes and reheater tubes ●Heat exchanger tubes of refuse incineration and biomass boilers	0.10max.	1.00max.	1.50max.	0.030max.	0.030max.	23.0-26.0	19.5-23.0	1.0-2.0	0.10-0.25	Nb : 0.10-0.40 Ti : 0.20max. B : 0.002-0.010	640	270	30
	HR3C	25Cr-20Ni-Nb-N	ASTM A213 TP310HCbN(S31042) ASME SA-213 TP310HCbN	VdTÜV 546/2	KA-SUS310J1TB	High-strength 25Cr austenitic stainless steel tubes ●Superheater tubes and reheater tubes ●Heat exchanger tubes of black liquor recovery, refuse incineration, and biomass boilers	0.10max.	1.50max.	2.00max.	0.030max.	0.030max.	17.00-23.00	23.00-27.00		0.15-0.35	Nb : 0.20-0.60	660	295	30
	YUS™170	25Cr-13Ni-0.8Mo-0.3N			KA-SUS309J1TB	High-corrosion-resistance 25Cr austenitic stainless steel tube ●Heat exchanger tubes of black liquor recovery and refuse incineration boilers ●Heat exchanger tubes and pipes for the chemical industry	0.06max.	1.50max.	2.00max.	0.040max.	0.030max.	12.00-16.00	23.00-26.00	0.50-1.20	0.25-0.40		690	345	40
	HR2M(HR2EL)	22Cr-14Ni-1.5Mo-N			KA-SUS309J2TB	High-corrosion-resistance 22Cr austenitic stainless steel tubes ●Heat exchanger tubes of black liquor recovery and refuse incineration boilers	0.04max.	1.00max.	2.50-3.50	0.030max.	0.030max.	12.50-15.50	21.00-23.00	1.00-2.00	0.10-0.25		590	245	35
	MN25R	25Cr-14Ni-0.8Mo-0.3N-LC-Low Si	ASTM A213 TP309LMoN (S30925) ASME CC 2639		KA-SUS309J3LTB	High-corrosion-resistance 25Cr austenitic stainless steel tubes ●Heat exchanger tubes of black liquor recovery boilers	0.025max.	0.70max.	2.00max.	0.040max.	0.030max.	13.0-16.0	23.0-26.0	0.5-1.2	0.25-0.40		640	260	30
	HR11N	29Cr-42Ni-1Mo-N	ASTM B407 (N06811) ASME SB-407 CC2518			High-corrosion-resistance, Ni-based alloy tubes ●Heat exchanger tubes of waste to energy plant and black liquor recovery boilers	0.03max.	0.60max.	2.00max.	0.030max.	0.010max.	38.0～46.0	27.0～31.0	0.50-1.50	0.10-0.20		585	240	30
Ni-based alloy tubes and pipes	SUPER625	22Cr-50Ni-9Mo-Nb	ASTM B444 (N06852) ASME SB-407 CC2520			High-corrosion-resistance, Ni-based alloy tubes ●Heat exchanger tubes of waste to energy plant black liquor recovery boilers	0.05max.	0.50max.	0.50max.	0.015max.	0.015max.	Bal.	20.0～23.0	8.0-10.0		Fe : 15.0-20.0 Ti : 0.40max. Al : 0.40max.	585	240	30
	HR6W	23Cr-45Ni-7W-Ti-Nb	ASTM B167 (N06674) ASME SB-167 CC2684	VdTÜV 559/2		High-strength, high-corrosion–resistance, Ni-based alloy tubes for next-generation A-USC boilers ●Main steam pipes, reheat pipes, superheater tubes, and reheater tubes.	0.10max.	1.0max.	1.50max.	0.030max.	0.015max.	Bal.	21.5～24.5		0.02max.	Fe : 20.0-27.0 W : 6.0-8.0 Ti : 0.05-0.20 Nb : 0.10-0.35 B : 0.0005-0.006	590	235	30

＊HCM2S, and MN25R were developed jointly with Mitsubishi Heavy Industries, Ltd.

CC : Code Case () is the UNS number code.

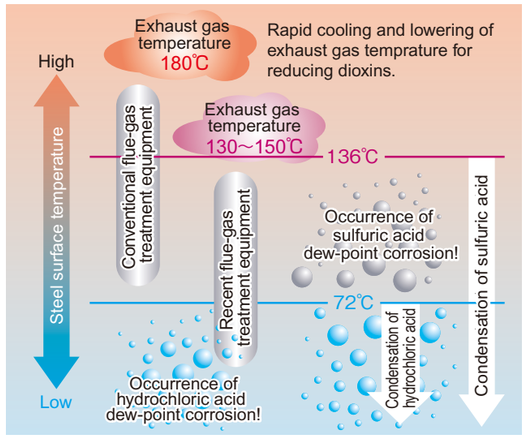
MITI means Ministry of Economy, Trade and Industry

S-TEN™1

Sulfuric and hydrochloric acid dew-point corrosion-resistant steel tubes

There are cases where the exhaust gas treatment equipment of waste combustion facilities or boiler air preheaters using fuel containing sulfur and chlorine is subjected to sulfuric and hydrochloric acid dew-point corrosion. In such an acid dew-point corrosion environment, not only common steel but also stainless steel cannot be used.
We have thus developed S-TEN™ as a material that can be used in such an environment, and we manufacture and sell S-TEN™1 steel tubes.

S-TEN™1 steel tubes can be used as METI "KA-STB380J2," "KA-STPT380J2," "ASME Code Case 2494" and "ASTM A423 Gr.3." They are also certified by classification societies such as NK(Japan), LR(United Kingdom), and TÜV(Germany).



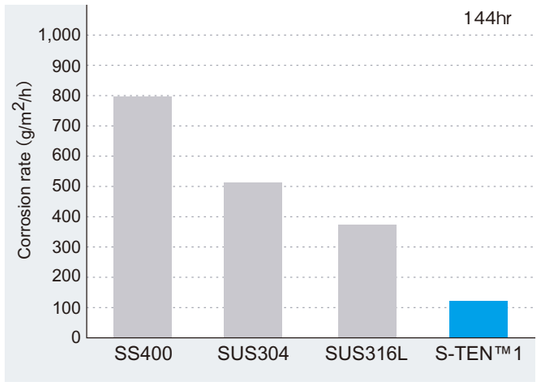
Chemical composition（mass%）

	C	Si	Mn	P	S	Cu	Sb	Ni
S-TEN1	≦0.14	≦0.55	≦1.60	≦0.025	≦0.025	0.25～0.50	≦0.15	≦0.50

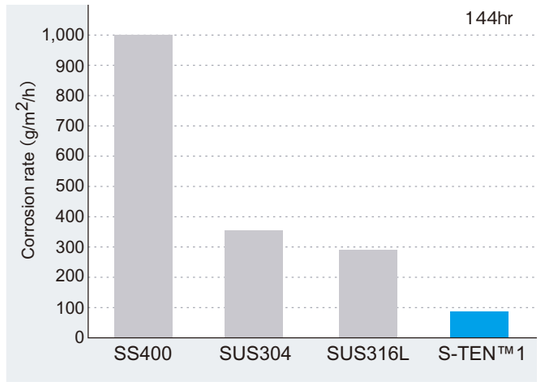
Quality property

●Corrosion resistance

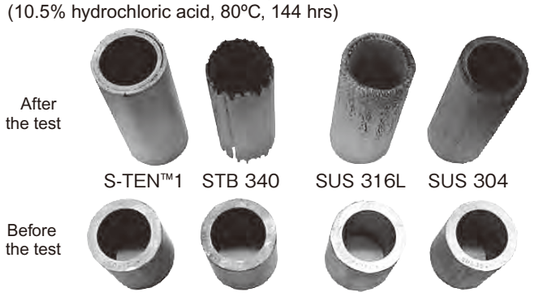
Sulfuric acid resistance (50%、70℃ H_2SO_4)



Hydrochloric acid resistance (10.5%、80℃ HCℓ)



Steel tube corrosion test sample
(10.5% hydrochloric acid, 80ºC, 144 hrs)



In such environment, this steel has a corrosion resistance that is superior to stainless steel.

●Mechanical property

	Tensile strength (MPa)	yield strength (MPa)	Elongation (%)
Specification	380mim.	230mim.	35mim.
Example	418	293	41

For more detailed properties, refer to our catalogue "Sulfuric and Hydrochloric Acid Dew-point Corrosion-resistant Steel S-TEN™ Technical Information."

CR1A

Sulfuric acid dew-point corrosion-resistant steel tubes

In a air preheater, economizer, etc., in the oil-fired boiler using waste gas generated when fuel containing sulfur combusts, sulfuric acid dew-point corrosion at low-temperature may cause corrosion problem. We also manufacture and sell CR1A, which protects corrosion using a Cr-Cu system, together with the S-TEN™1 steel tubes described at left, for these applications.

Standard : METI KA-STBA10 (with seamless tube)

Chemical composition（mass%）

	C	Si	Mn	P	S	Cu	Cr
CR1A	0.10max.	0.20～0.80	0.80max.	0.025max.	0.015～0.030	0.25～0.35	1.00～1.50

Quality property

●Mechanical property

		Dimensions (mm)	Tensile strength (MPa)	yield strength (MPa)	Elongation (%)
CR1A	Specification	—	410min.	255min.	25min.
	Example	ϕ63.5×t7.0	473	322	38

Corrosion resistance after service exposure

Condition	Material used					
	Dimensions (mm)	Code	Quantity of corrosion		Depth of corrosion	
			Average(%)	Ratio	Average(mm)	Ratio
Boiler air preheater Fuel：C heavy oil Usage condition：2,627 hrs External surface：Air Inside tube：Combustion gas	ϕ48.6×t3.6	CR1A	1.85	1.00	0.17	1.00
		Carbon steel	9.32	5.04	1.61	9.48

HCM2S™ Superior weldability and high-temperature strength 2.25Cr ferritic steel tubes

KA-STB(P)A24J1, ASTM A213 T23/A335 P23, ASME SA213 T23/SA335 P23 Code Case 2199

Developed jointly with Mitsubishi Heavy Industries, Ltd.

Features

①High-strength 2.25Cr ferritic steel tubes (tubes and large-diameter thick-wall pipes)
The strength is about 1.8 times higher than that of conventional STB(P)A24.

②Weldability is improved as compared with conventional steels. The thin wall tubes suppresses welding cracks even if post weld heat treatment.

③Matching welding consumable are available .

Application

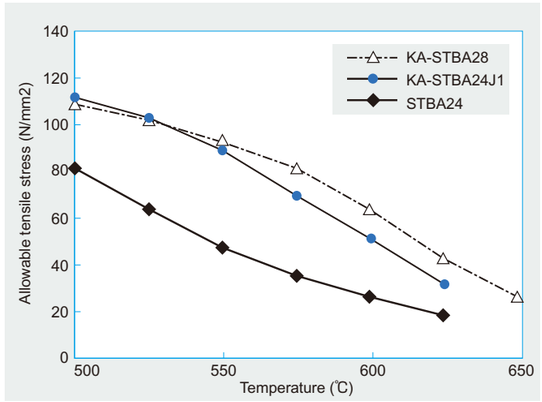
Large-diameter thick wall pipes, superheater tubes, and reheater tubes (steam at relatively low temperatures to 575℃) for thermal power generation, and heat recovery boilers

Chemical composition (mass%)

Standard	C	Si	Mn	P	S	Ni	Cr	Mo
KA-STBA24J1	0.04～0.10	0.50max.	0.10～0.60	0.030max.	0.010max.	—	1.90～2.60	0.05～0.30
ASME CC2199	ditto	ditto	ditto	ditto	ditto	0.4max.	ditto	ditto

Standard	W	V	Nb	Ti	Al	B	N
KA-STBA24J1	1.45～1.75	0.20～0.30	0.02～0.08	—	0.030max.	0.0005 ～0.0060	0.030
ASME CC2199	ditto	ditto	ditto	0.010～0.060	ditto	0.0020 ～0.0060	0.010max.

●Comparison of allowable tensile stress

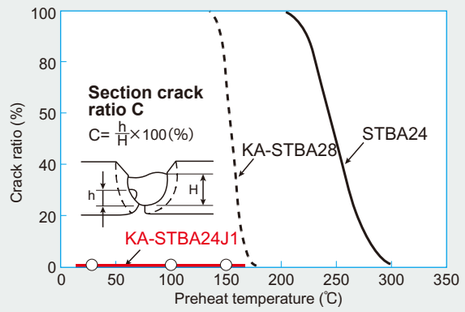


●Comparison of conventional steel regarding cost efficiency

Calculated with pressure: 24.1 MPa; steam temperature: 550 ºC; and internal diameter: 300 mm

Steel grade	KA-STPA24J1	STPA24
Allowable tensile stress (550℃, MPa)	84	48
Tube size	ϕ408×t54	ϕ504×t102
Weight ratio	47	100

y restraint weld cracking test result

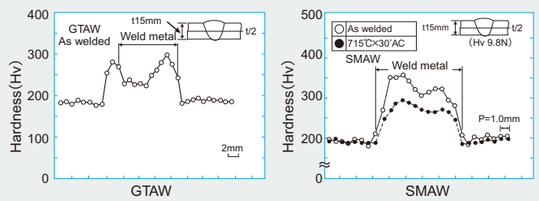


●Matching welding consumable

(mass%)

	C	Si	Mn	Cr	Ni	Mo	W	V	Nb
GTAW	0.04	0.50	0.49	2.19	0.49	0.10	1.59	0.24	0.03
SMAW	0.06	0.32	0.79	2.24	1.00	0.10	1.56	0.30	0.04

●Hardness distribution of weld joint



Gr92（NF616） Superior high-temperature strength 9Cr ferritic steel tubes, from tubes to large-diameter thick wall pipes

KA-STB(P)A29, ASTM A213 T92/A335 P92, ASME SA213 T92/SA335 P92 Code Case 2179

Features

①High-strength 9Cr ferritic steel pipes and tubes (All sizes are available, from thin-wall heating tubes to large-diameter thick-wall pipes.)
The strength is about 1.3 times higher than that of the conventional Gr91 (ASME T91/P91).
NF616 steel, with the world's highest strength, as a high-temperature ferrite steel tube, was self-developed.

②A product family that satisfies all needs for thermal power generation boilers, the chemical industry, and nuclear power.

③Matching welding consumable are available .

Application

High-temperature 9Cr ferrite steel pipes and tubes (casting), main steam pipes, reheat pipes, and heat exchanger tubes

Chemical composition (mass%)

C	Cr	Mo	W	Ni	V	Nb	N	B
0.07～0.13	8.50～9.50	0.30～0.60	1.50～2.00	≦0.40	0.15～0.25	0.004～0.09	0.030～ 0.070	0.001～ 0.006

●Comparison of 9Cr ferrite steel tube performance

Standard		KA-STPA29(Gr.92)	KA-STPA28(Gr.91)
Main chemical composition		9Cr-0.5Mo-1.8W-V.Nb B	9Cr-1Mo-V.Nb
Allowable tensile stress (interpretation of METI standard)	600℃	76MPa	62MPa
	625℃	55MPa	44MPa
	650℃	39MPa	29MPa
Room-temperature tensile property	TSmin	520MPa	590MPa
	YSmin	440MPa	410MPa
Steam oxidation scale thickness 600℃, 1,000 hrs*		71μm	69μm
Weight loss of high temperature crrosion*		90mg/cm²	98mg/cm²
Welding material	GTAW,SMAW	Matching filler	Matching filler
	SAW	Prototype	Matching filler
PWHT		ASME requirements are provided for.	ASME requirements are provided for.

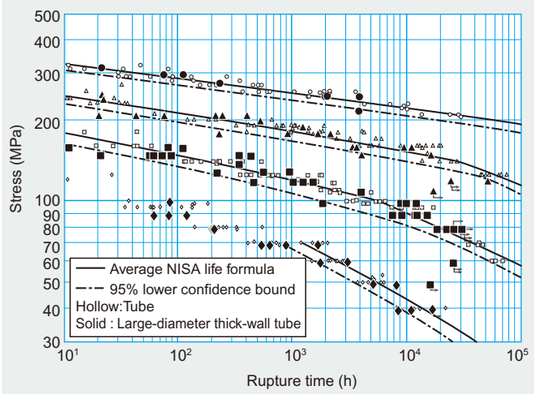
*Gas : 0.5%SO_2 + 5%O_2 – 15%Co_2 – residual N_2 Synthetic ash : 1.5mol

●Comparison of cost efficiency

	Constant inside diameter of the pipe	
	Inside diameter 325 mm	
	P92	P91
Minimum wall thickness	50mm	73mm
Volume ratio	78	100 (standard)
Cross-section shape		

Steam condition 25.0MPa×1130F［610℃］
Tube size Inside diameter 325 mm assumed
Allowable stress P92 ASME SC-I CC2170-6
P91 ASME SC-Ⅱ D

●Creep rupture strength of Gr.92 (NF616)

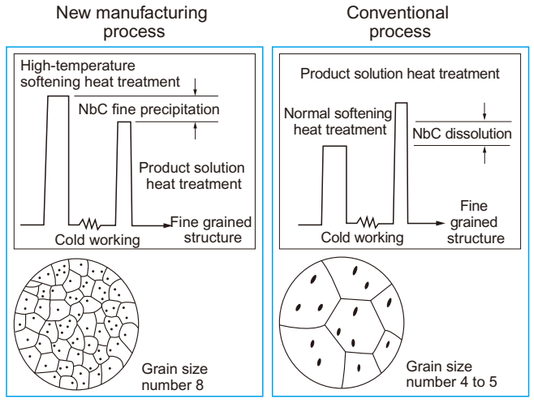


TP347HFG

High steam oxidation resistance austenitic stainless steel tube based on proprietary grain refining technology

18Cr-12Ni-0.6Nb／Equivalent steel gradesASTM A213 TP347HFG、ASME SA213 TP347HFG

①Fine-grained microstructure by Thermo-Mechanical Process, which contribute to superior steam oxidation resistance to conventional coarse grained TP347H.
②Weldability is equivalent to TP347H and matching welding consumable is available.
③Good phase stability proven by long term creep-rupture tests and actual uses.
④Global shipments of more than 7 thousand tons, for USC and biomass boilers.



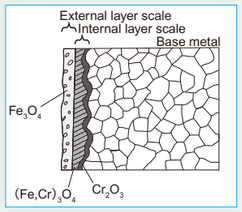
Process of fine grained structure

Chemical composition (mass%)

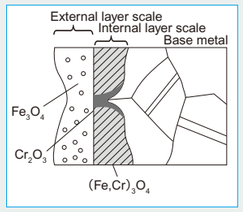
	C	Si	Mn	P	S	Cr	Ni	Nb
ASME TP347HFG	0.06～0.10	1.00max.	2.00max.	0.045max.	0.030max.	17.0～19.0	9.0～13.0	8×C～1.10

Quality property

●Mechanism for improving steam oxidation resistance using innovative grain refining technology

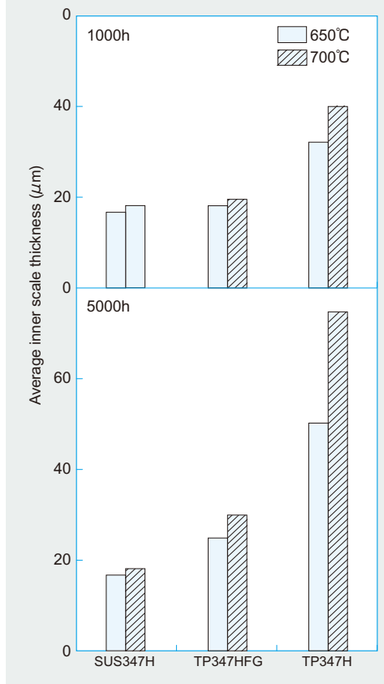


Fine-grained steel

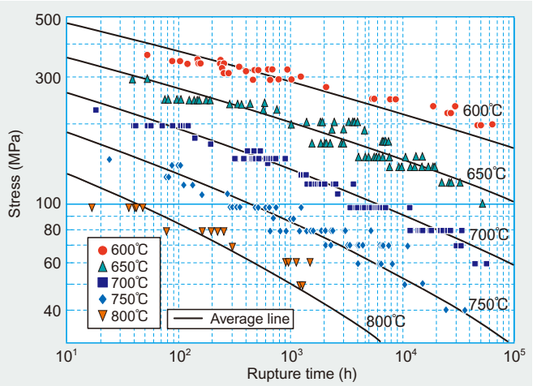


Coarse-grained steel

(TP347HFG、SUPER304H)



●Creep rupture strength



SUPER 304H™

High-strength, high steam oxidation-resistance, austenitic stainless steel tubes

18Cr-9Ni-3Cu-Nb-N／Equivalent steel grades METI KA-SUS304J1HTB、ASTM A213 S30432、ASME SA213 Code Case 2328

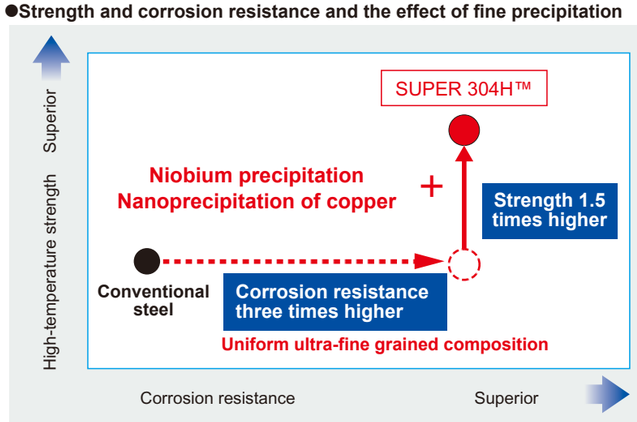
①Hightest strength among 18Cr-8Ni austenitic stainless steels utilizing Cu-rich phase.
②Fine-grained microstructure by Thermo-Mechanical Process, which contribute to superior steam oxidation resistance to conventional coarse grained TP347H.
③Superior weldability to TP347H due to smaller amount of niobium, PWHT is not mandatory, and matching welding consumable is available.
④Good phase stability proven by long term creep-rupture tests and actual operation results in USC boilers.
⑤Global shipments of more than 70 thousand tons, mainly for USC boilers.

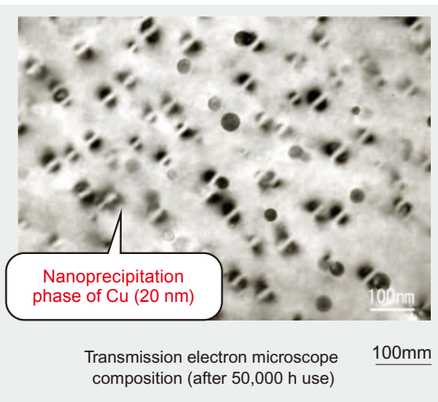
Chemical composition (mass%)

	C	Si	Mn	Ni	Cr	Cu	Nb	N
KA-SUS304J1HTB	0.07～0.13	0.30max.	1.00max.	7.5～10.5	17.0～19.0	2.5～3.5	0.30～0.60	0.05～0.12

Quality property

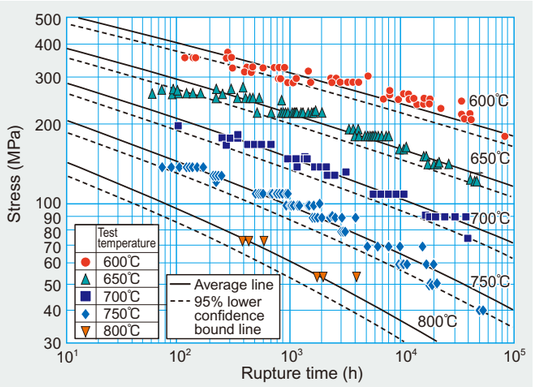
●Strength and corrosion resistance and the effect of fine precipitation



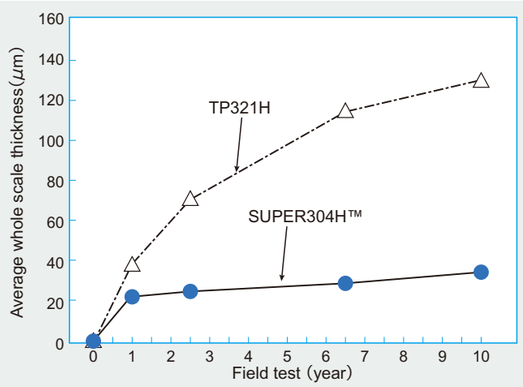


Transmission electron microscope composition (after 50,000 h use) 100mm

●Creep rupture strength



●Steam oxidation in actual boilers



XA704 High creep strength austenitic stainless steel tubes

18Cr-9Ni-2W-Nb-V-N／Equivalent steel grade　KA-SUS347J1TB、ASTM A213 TP347W、ASME SA213 Code Case 2475

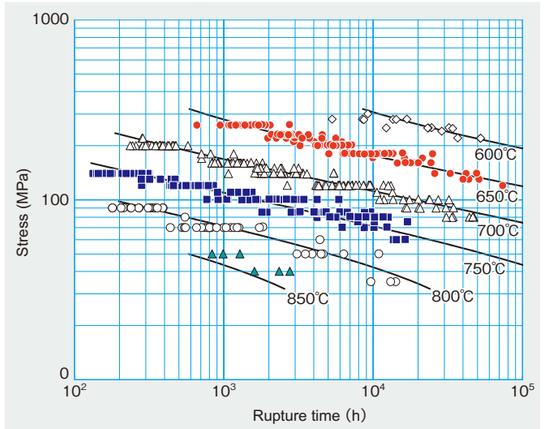
①Creep rupture strength is much higher than SUS347HTB due to V, N, and W contens.
②Excellent intergranular corrosion resistance due to lower C content.
③Good steam oxidation resistance due to fine-grained microstructure.
④Enough thermo stability for boiler tube application.
⑤Better weldability at elevated temperature than TP304H due to good phase stability.

Chemical composition (mass%)

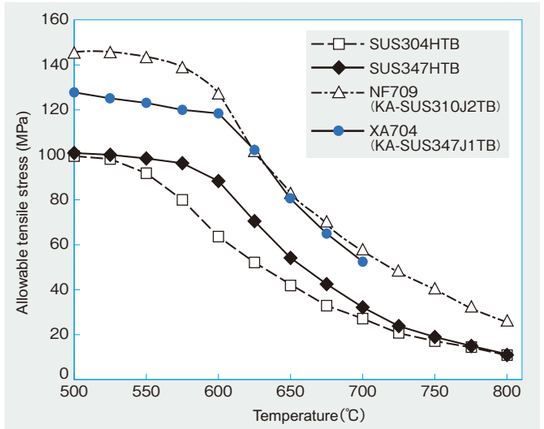
	C	Si	Mn	Ni	Cr	W	V	Nb	N
Standard value	0.05max.	1.00max.	2.00max.	8.00～11.00	17.00～20.00	1.50～2.60	0.20～0.50	0.25～0.50	0.10～0.25

Quality property

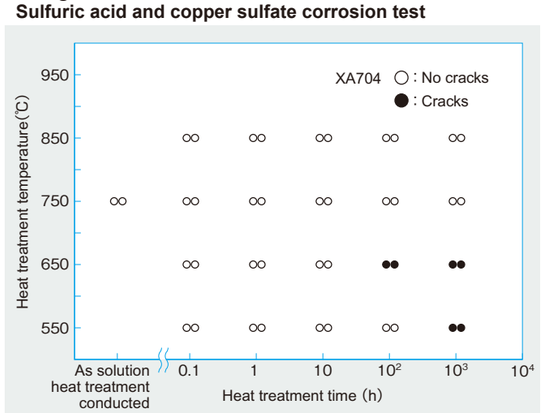
●**Creep rupture strength**



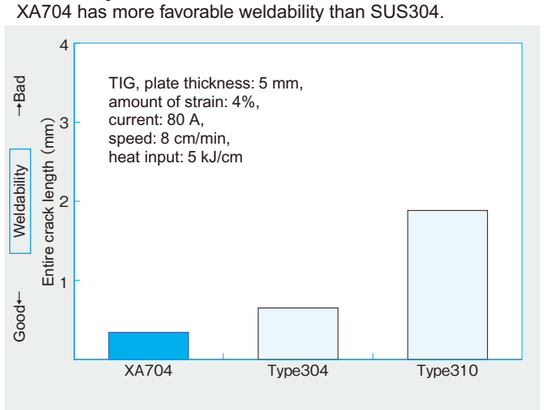
●**Comparison of allowable tensile stress**
(interpretation of the thermal power house technical standard)



●**Intergranular corrosion resistance:**
Sulfuric acid and copper sulfate corrosion test



●**Weldability: Varestraint test**
XA704 has more favorable weldability than SUS304.



NF709 High-strength and high corrosion-resistance austenitic stainless steel tubes

22.5Cr-25Ni-1.5Mo-Nb-N／
Equivalent steel grades　KA-SUS310J2TB、ASTM A213 TP310MoCbN、ASME SA213 Code Case 2581

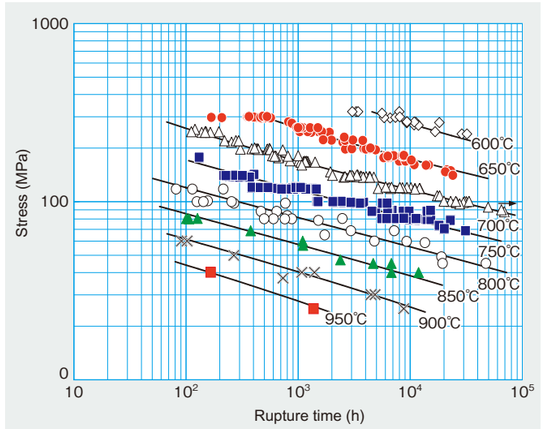
①Highest creep rupture strength among austenitic stainless steel.
②Good steam oxidation resistance due to higher Cr, Ni content.
③Better hot corrosion resistance for chloride alkaline than TP310.
④Applicable as superheater and reheater for coal fired boiler and waste to energy boiler.

Chemical composition (mass%)

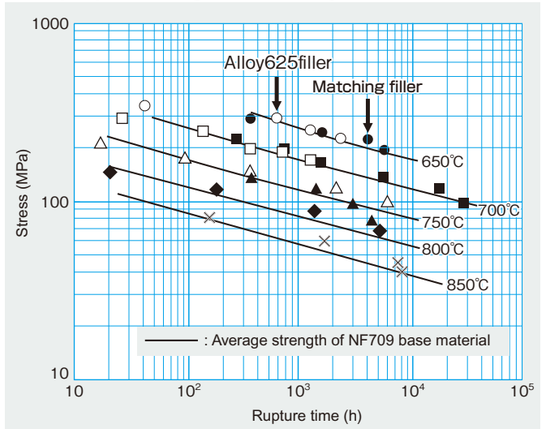
	C	Si	Mn	Ni	Cr	Mo	Nb	Ti	B	N
Standard value	0.10max.	1.00max.	1.50max.	22.00～28.00	19.00～23.00	1.00～2.00	0.10～0.40	0.20max.	0.002～0.010	0.10～0.25

Quality property

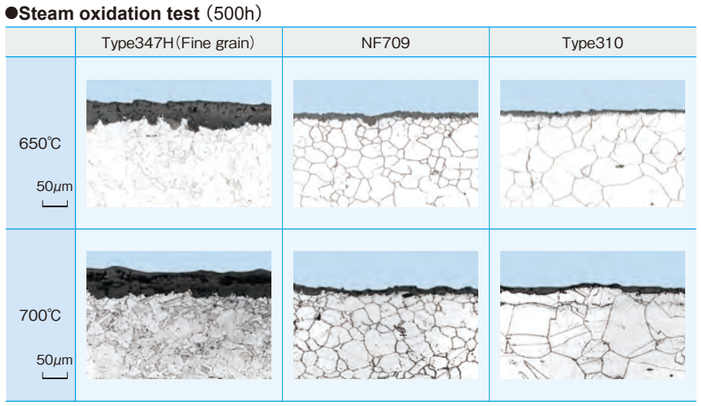
●**Creep rupture strength of NF709 base material**



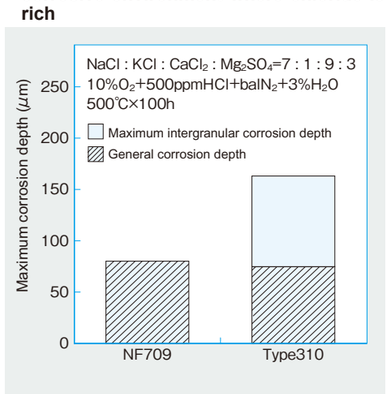
●**Creep rupture strength of TIG weld joint**



●**Steam oxidation test**（500h）



●**Comparison of corrosion resistance in a corrosive environment where chloride is rich**



HR3C 25Cr high corrosion-resistance austenitic stainless steel tubes

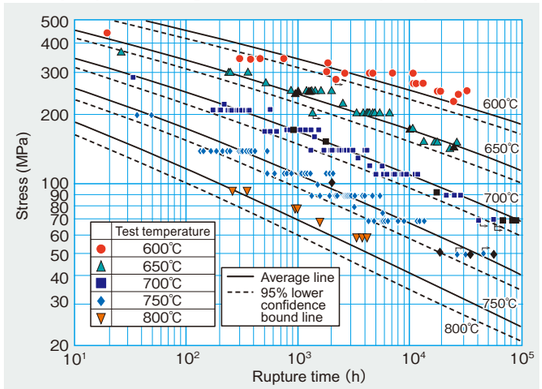
25Cr-20Ni-Nb-N／Equivalent steel grades KA-SUS310J1TB、ASTMA213 TP310HCbN、ASME SA213 TP310HCbN

①Much higher strength than conventional 310 stainless steels utilizing finely dispersed $M_{23}C_6$ and NbCrN.
②Much better steam oxidation resistance than 18Cr-8Ni austenitic stainless steels due to 25Cr-20Ni chemical composition.
③Weldability is equivalent to TP347H, and matching welding consumable is available.
④Global shipments of more than 20 thousand tons for USC, Biomass, and Waste to energy boilers.

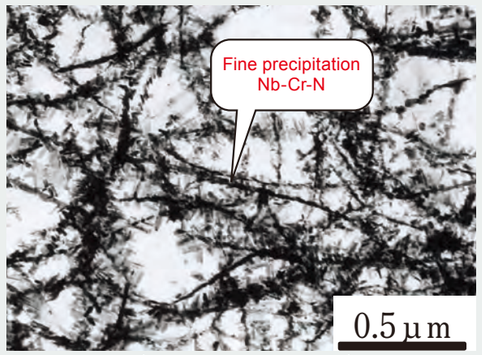
Chemical composition (mass%)

	C	Si	Mn	Cr	Ni	Nb	N
ASME TP310HCbN	0.04～0.10	1.50max.	2.00max.	24.0～26.0	19.0～22.0	0.20～0.60	0.15～0.35

●Creep rupture strength and effect of fine precipitation

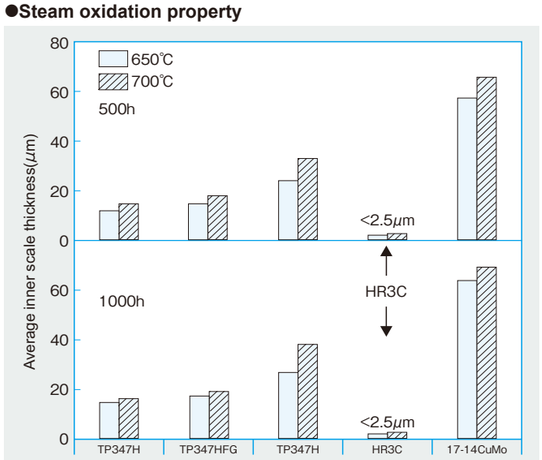


●Fine precipitation of extraction replica

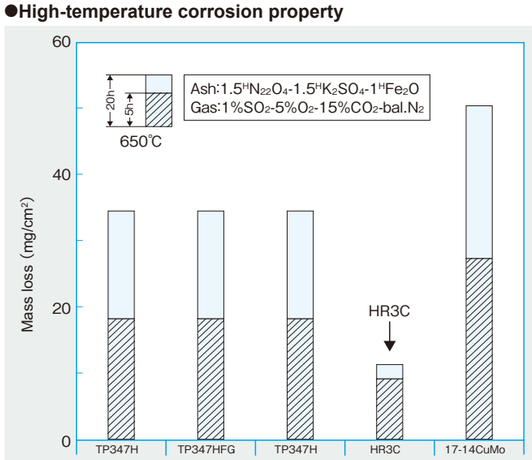


(HR3C: After 75,000 h use)

●Steam oxidation property



●High-temperature corrosion property



YUS™170 High-strength and pitting-resistant austenitic stainless steel tubes

25Cr-13Ni-0.8Mo-0.3N／Equivalent steel grades: KA-SUS309J1TB／Stainless steel plate: JIS G 4304･G 4305 SUS317J2

Features

①These exhibit pitting resistance and clearance corrosion resistance superior to SUS316 and SUS317L.
②They show superior sulfuric and hydrochloric acid resistance and can be used at higher concentration and temperature than Type316 and Type317L.
③They feature austenitic composition and superior workability and weldability. The strength at room temperature is about 1.5 times higher than that of normal austenitic stainless steel.

Application Seawater resistance tubes and superheater tubes of black liquor recovery boilers and refuse incineration boilers

Chemical composition (mass%)

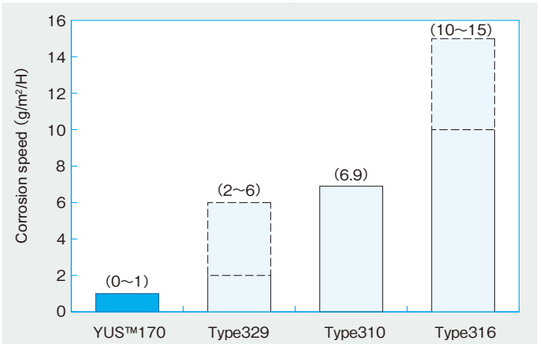
	C	Si	Mn	P	S	Ni	Cr	Mo	N
Standard value	0.06max.	1.50max.	2.00max.	0.040max.	0.030max.	12.00～16.00	23.00～26.00	0.50～1.20	0.25～0.40

Quality property

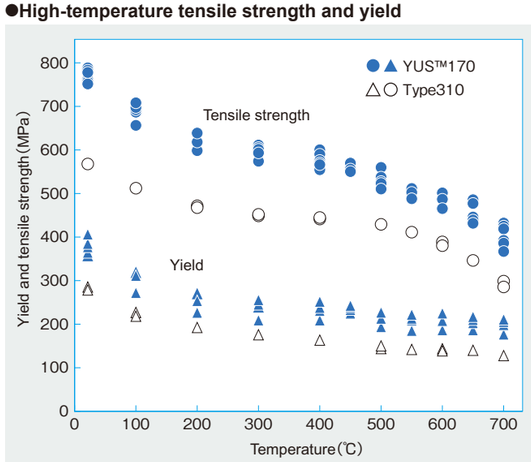
●Mechanical property

	Tensile strength (MPa)	Yield (MPa)	Elongation (%)
Standard value	690min.	345min.	40min.

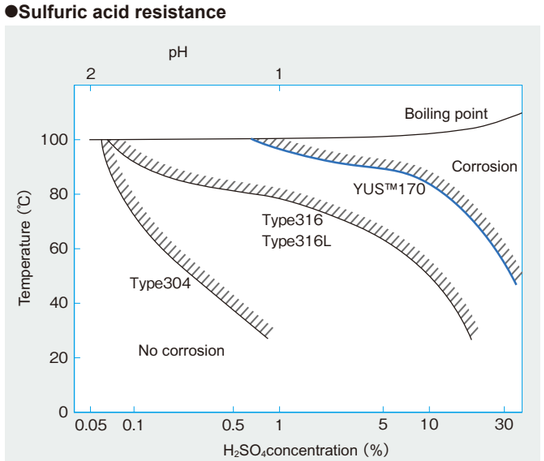
●Pitting corrosion resistance 50g/l･$FeCl_3$ + 1/20N･HCl(50℃ × 48h)



●High-temperature tensile strength and yield



●Sulfuric acid resistance



MN25R High corrosion-resistance stainless steel tubes for soda recovery boilers

25Cr-14Ni-0.8Mo-0.3N-LC-Low Si／
Equivalent steel grades: KA-SUS309J3LTB、ASTM A213 TP309LMoN、ASME SA213 Code Case 2639

Features The MN25R steel tube is a high corrosion-resistance steel tube for the superheater tubes of black liquor recovery boilers.

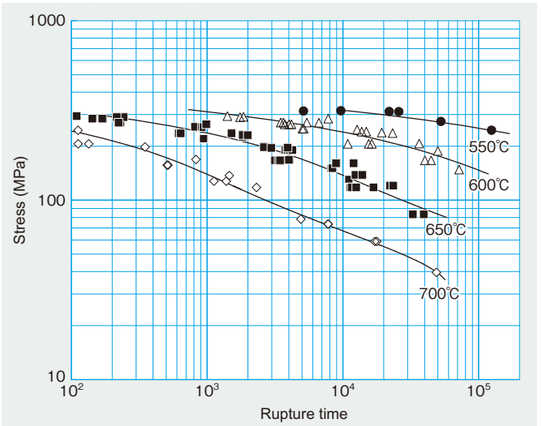
Application Superheater tubes and reheater tubes of black liquor recovery boilers

Chemical composition (mass%)

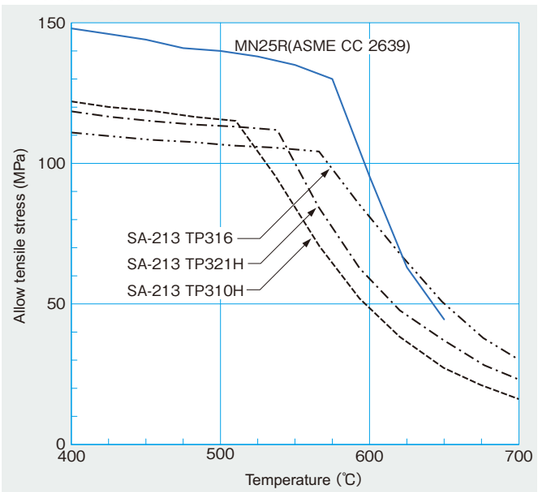
	C	Si	Mn	P	S	Ni	Cr	Mo	N
Standard value	0.025max.	0.70max.	2.00max.	0.040max.	0.030max.	13.00～16.00	23.00～26.00	0.50～1.20	0.25～0.40

Quality property

●Creep rupture strength

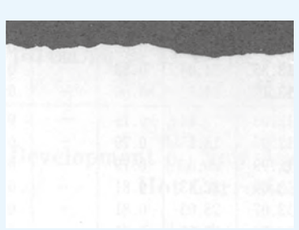
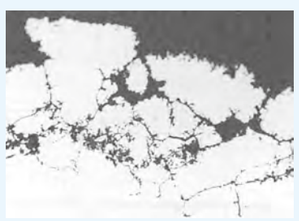
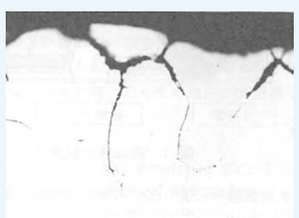


●Allowable tensile stress



●High-temperature Corrosion resistance

Ash (synthetic ash) : 75%Na_2SO_4+17%$K_3Na(SO_4)_2$+8%NaCl
Gas : 0.2%SO_2+5%O_2+10%CO_2+bal.N_2
Temperature : 550℃
Test time : 100h

Steel grade	20μm
MN25R	
Type347H	
Type310	

HR6W High-strength and high corrosion-resistance Ni-based alloy tubes and pipes for next-generation 700ºC steam A-USC boilers

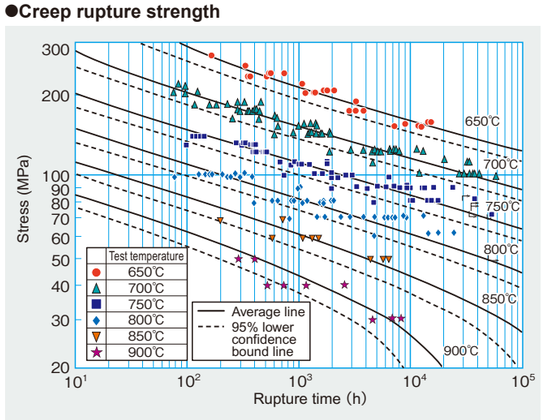
23Cr-45Ni-7W-Ti-Nb／Equivalent steel grades ASTM B167-UNS N06674、ASME SB167 Code Case 2684

①Stability of long term creep strength and superior creep rupture ductility.
②Much better corrosion resistance than 18Cr-8Ni austenitic stainless steels.
③Microstructural phase stability at elevated temperature, which contributes to superior stress relaxation properties and enough fatigue properties for various applications.
④Better formability, welder available size range, and better weldability than γ' phase present Ni based alloys.

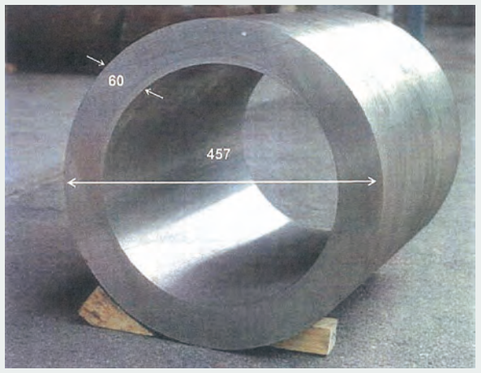
Chemical composition (mass%)

	C	Si	Mn	Cr	Fe	W	Ti	Nb	B	N	Remnant
ASME CC 2684	0.1max.	1.0max.	1.50max.	21.5～24.5	20.0～27.0	6.0～8.0	0.05～0.20	0.10～0.35	0.005～0.006	0.02max.	Ni

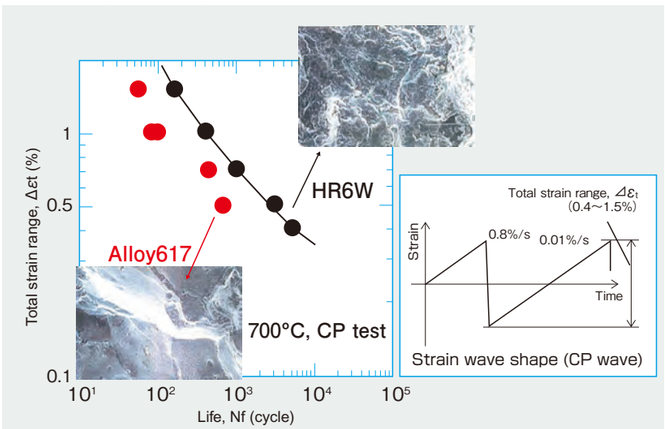
●Creep rupture strength



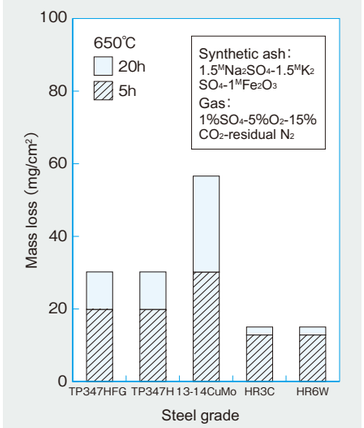
●HR6W large-diameter, thick-wall tubes



●Creep fatigue property



●High-temperature corrosion property



Available Size Range (Example)

Hot-finished seamless tubes and pipes

Nominal diameter		Outside diameter	Wall Thickness (mm)																					Outside diameter
(A)	(B)	(mm)	2.8	3	3.5	4	5	6	7	8	9	10	11	12	13	14	15	17	20	25	30	35	40	45	(mm)
25	1	34.0																							34.0
		38.1																							38.1
40	1 1/2	48.6																							48.6
50	2	60.5																							60.5
65	2 1/2	76.3																							76.3
		82.6																							82.6
80	3	89.1																							89.1
90	3 1/2	101.6																							101.6
100	4	114.3																							114.3
		(120.0)																							(120.0)
		130.0																							130.0
125	5	139.8																							139.8
		(150.0)																							(150.0)
150	6	165.2																							165.2
		(170.0)																							(170.0)
	7	190.7																							190.7
200	8	216.3																							216.3
250	10	267.4																							267.4
300	12	318.5																							318.5
350	14	355.6																							355.6
400	16	406.4																							406.4
(A)	(B)	(mm)	2.8	3	3.5	4	5	6	7	8	9	10	11	12	13	14	15	17	20	25	30	35	40	45	(mm)
Nominal diameter		Outside diameter	Wall Thickness (mm)																						Outside diameter

Remarks 1. Be aware that there is a range where manufacturing can be difficult, depending on the material properties.
2. Consult with us about ultra-thin items near the manufacturable limit beforehand.
3. Consultation regarding size for anything not in this table is also available.

Seamless forged pipe (hot finished)

Nominal diameter		Outside diameter	Wall Thickness (mm)																							Outside diameter
(A)	(B)	(mm)	20	24	30	35	40	45	50	55	60	70	80	90	100	120	140	160	180	200	220	240	(mm)
		152.4																						152.4
150	6	165.2																						165.2
	7	190.7																						190.7
200	8	216.3																						216.3
250	10	267.4																						267.4
300	12	318.5																						318.5
350	14	355.6																						355.6
400	16	406.4																						406.4
450	18	457.2																						457.2
500	20	508.0																						508.0
550	22	558.8																						558.8
600	24	609.6																						609.6
650	26	660.4																						660.4
700	28	711.2																						711.2
750	30	762.0																						762.0
800	32	812.8																						812.8
850	34	863.6																						863.6
900	36	914.4																						914.4
1000	40	1016.0																						1016.0
1100	44	1117.6																						1117.6
1200	48	1219.2																						1219.2
1300	50	1270.0																						1270.0
(A)	(B)	(mm)	20	24	30	35	40	45	50	55	60	70	80	90	100	120	140	160	180	200	220	240	(mm)
Nominal diameter		Outside diameter	Wall Thickness (mm)																					Outside diameter

Remark Consultation regarding size for anything not in this table is also available.

Available Size Range (Example)

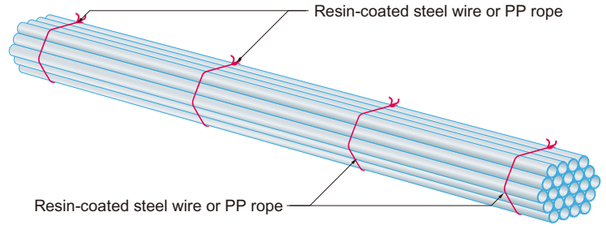
Cold-finished seamless tubes and pipes

Nominal diameter (A)	Nominal diameter (B)	Outside diameter (mm)	Wall Thickness (mm)																							Outside diameter (mm)
			1.2	1.6	2	2.6	3.2	4	4.5	5	6	7	8	9	10	11	12	13	14	15	17	20	25	30	35	
		6.0																								6.0
		8.0																								8.0
6	1/8	10.5																								10.5
10	3/8	17.3																								17.3
15	1/2	21.7																								21.7
20	3/4	27.2																								27.2
25	1	34.0																								34.0
		38.1																								38.1
32	1 1/4	42.7																								42.7
40	1 1/2	48.6																								48.6
50	2	60.5																								60.5
65	2 1/2	76.3																								76.3
		82.6																								82.6
80	3	89.1																								89.1
90	3 1/2	101.6																								101.6
100	4	114.3																								114.3
		120.0																								120.0
		130.0																								130.0
125	5	139.8																								139.8
		150.0																								150.0
150	6	165.2																								165.2
		170.0																								170.0
	7	190.7																								190.7
200	8	216.3																								216.3
250	10	267.4																								267.4
300	12	318.5																								318.5
350	14	355.6																								355.6
400	16	406.4																								406.4
(A)	(B)	(mm)	1.2	1.6	2	2.6	3.2	4	4.5	5	6	7	8	9	10	11	12	13	14	15	17	20	25	30	35	(mm)
Nominal diameter		Outside diameter	Wall Thickness (mm)																							Outside diameter

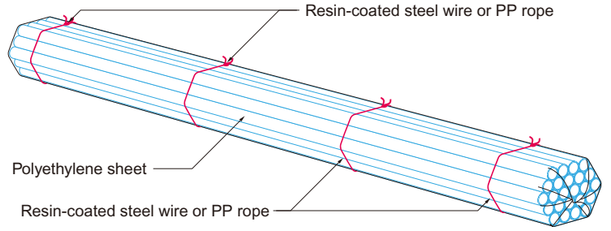
Remarks Consultation regarding size for anything not in this table is also available.

Example of Packing

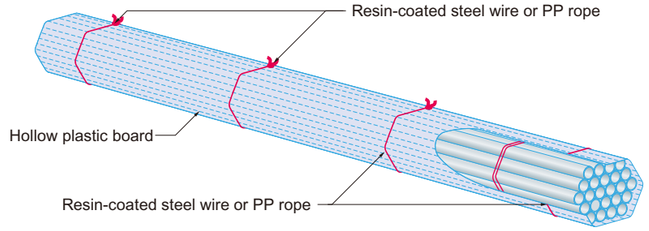
Bare packing



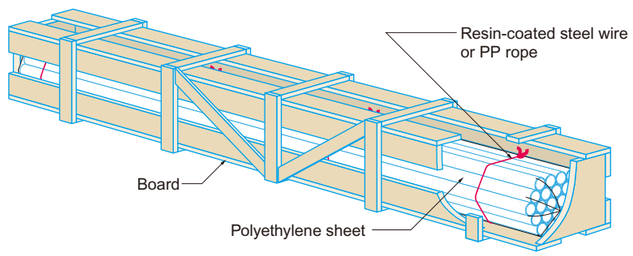
Polyethylene sheet packing



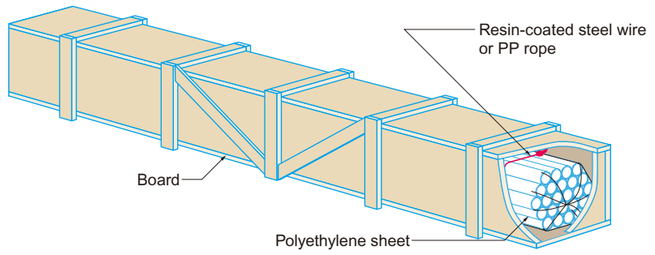
Hollow plastic board packing



Open wood box packing

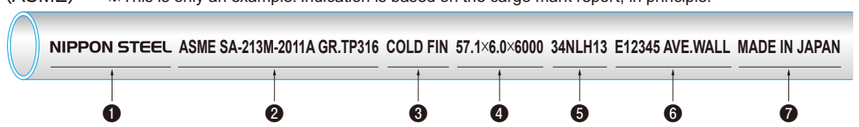


Closed wood box packing

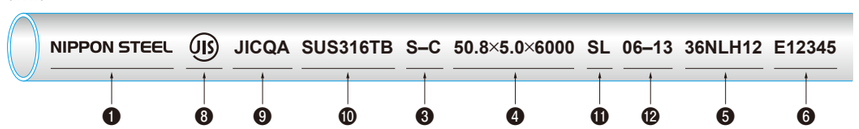


Example of Indication

〈ASME〉 ※This is only an example. Indication is based on the cargo mark report, in principle.



〈JIS〉



❶	Manufacture's band or name
❷	Standard abbreviation
❸	Manufacturing method
❹	Dimensions (outside diameter × thickness × length)
❺	Inspection number (serial number)
❻	Heat number (molten steel number)
❼	Country of origin
❽	JIS mark
❾	Certification body code
❿	Type code
⓫	Works abbreviation
⓬	Date of manufacture (month/two low-order digits of year)

Requests during orders

When ordering and inquiring about our tubes and pipes, you are requested to inform us about the following items.

1. Steel tube standard and type
2. Dimensions (outside diameter, thickness, and length)
3. Quantity
4. Delivery date and destination
5. Applications and usage condition
6. Packing type
7. Number of copies of the inspection certificate
8. With or without a witnessed inspection
9. Other and specially requested items

memo

memo