NIPPON STEEL

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SEAMLESS CASING & TUBING
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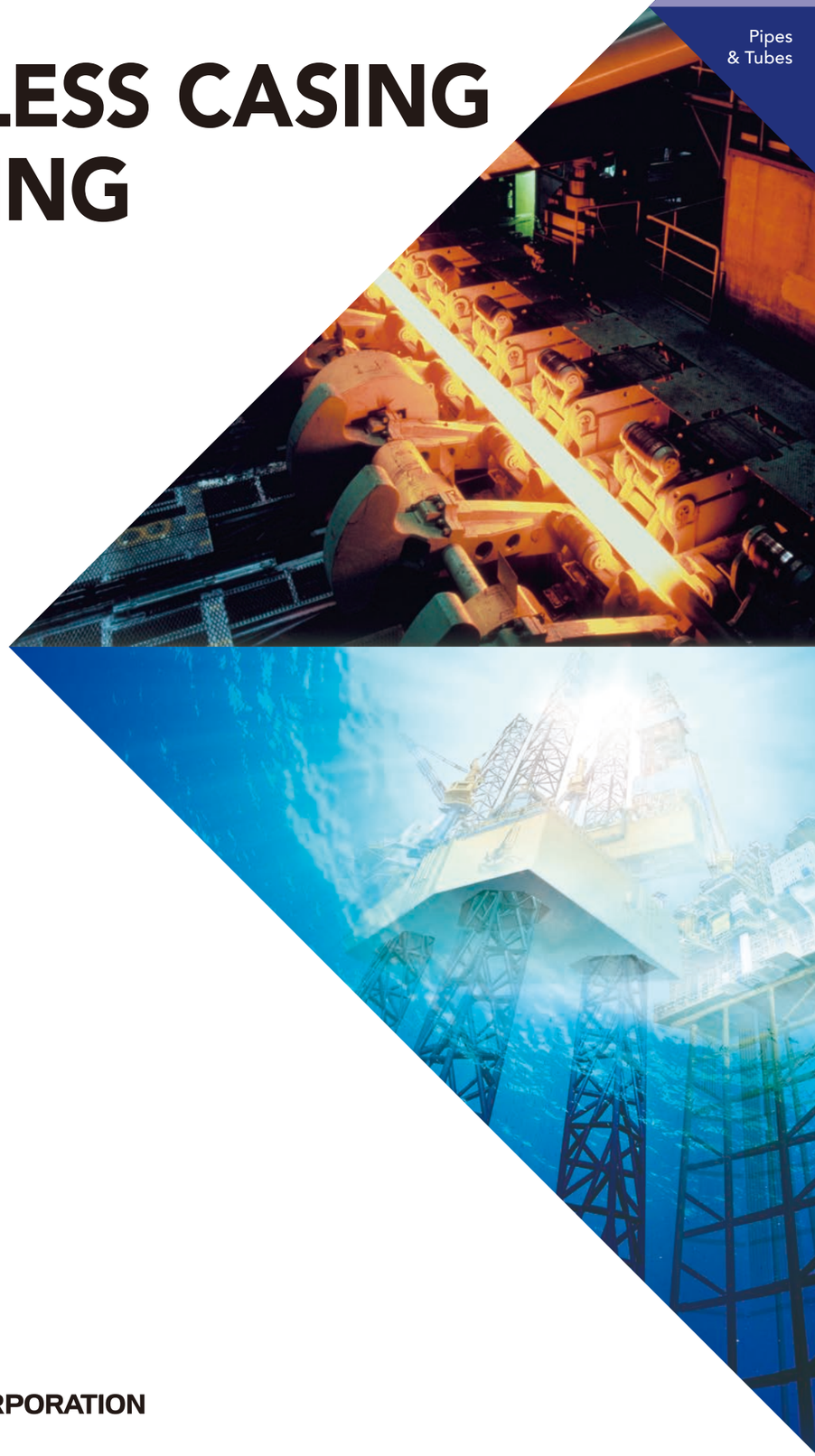
NIPPON STEEL

SEAMLESS CASING & TUBING

Pipes & Tubes



NIPPON STEEL CORPORATION

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INTRODUCTION

For more than five decades, NIPPON STEEL has been serving the needs of the oil and gas industries. All the supply records for most of the severe drilling environments indicate that NIPPON STEEL is the leader in tubular technologies. Field development where it was impossible to drill yesterday becomes a reality with NIPPON STEEL tubular products today. Customer satisfaction and reliability are the key words for our product development.

Our product line covers almost all applications from carbon steel to Ni based alloy steel with conventional API connections or advanced sealing mechanisms such as VAM premium connections. NIPPON STEEL has the widest material grades for Casing & Tubing. And as a result of continuous R&D efforts, you can find more "fit for purpose" products in this brochure.

Principles of NIPPON STEEL SEAMLESS CASING & TUBING

Quality

Quality is the most fundamental element of our Casing & Tubing business. We understand that quality leads to product reliability, which in turn leads to customer trust and that in the end, quality is the basis of our reputation. We will continue to be dedicated to maintaining and improving our quality standard.

Technology

The more severe the drilling conditions, the greater our customers' needs for cutting edge products. We understand that customers rely on the quality of our products when they drill in harsh conditions, and we are proud of our No. 1 technical position. We will continue to work through our R&D activities to develop high-end products for the future.

Customer Satisfaction

Our goal is to be more than just a superior product supplier. We intend to also be a superior solutions provider for our tubular products customers. We place importance not just on managing material sales, but also on "before" and "after service". Customer satisfaction drives our constant and growing commitment to the oil and gas industries.

FACILITIES AND LOCATIONS

NIPPON STEEL has almost all kinds of steel pipe manufacturing facilities which produce a wide range of seamless and welded steel pipe and tubes.
The main facilities are composed of our Amagasaki Steel Tube Works and Wakayama Steel Works.
These works are able to produce approximately three million metric tons of steel pipe and tubes annually.
The company also possesses facilities in affiliated companies in.
NIPPON STEEL facilities and locations are tabulated below together with their available size ranges (O.D.).

● Location of Casing and Tubing Mills

NIPPON STEEL Tube Making Equipment and Available Sizes

Tube Mills		Location of Works	Outside Diameter in Inches
Seamless (Hot Finished)	Mannesmann (2 sets)	Kainan	2 3/8 – 7
	Mannesmann	Wakayama	5 1/2 – 16 3/4
	Extrusion	Amagasaki	2 3/8 – 9 5/8
	Hollow Forging	Amagasaki	8 – 28
Cold Finished	Cold Drawn	Amagasaki	2 3/8 – 20
ERW (Hot Finished)	ERW	Hikari	12 – 24
	ERW	Nagoya	4 1/2 – 16

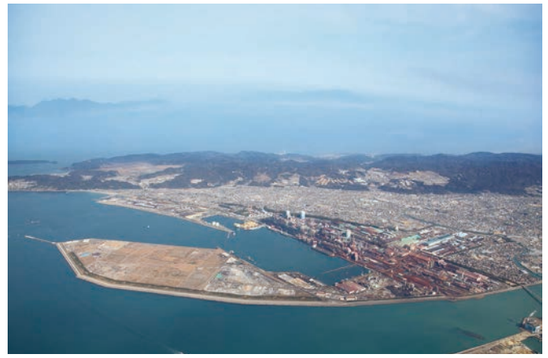
MANUFACTURING SITES

Amagasaki Steel Tube Works

The Steel Tube Works was established in 1919 as the first integrated mill in Japan for the production of high quality seamless steel tubes and pipe. Since then, the Works has specialized in high quality steel tubes and pipes. NIPPON STEEL is committed to ongoing research to improve manufacturing methods and to upgrade quality.

Wakayama Steel Works

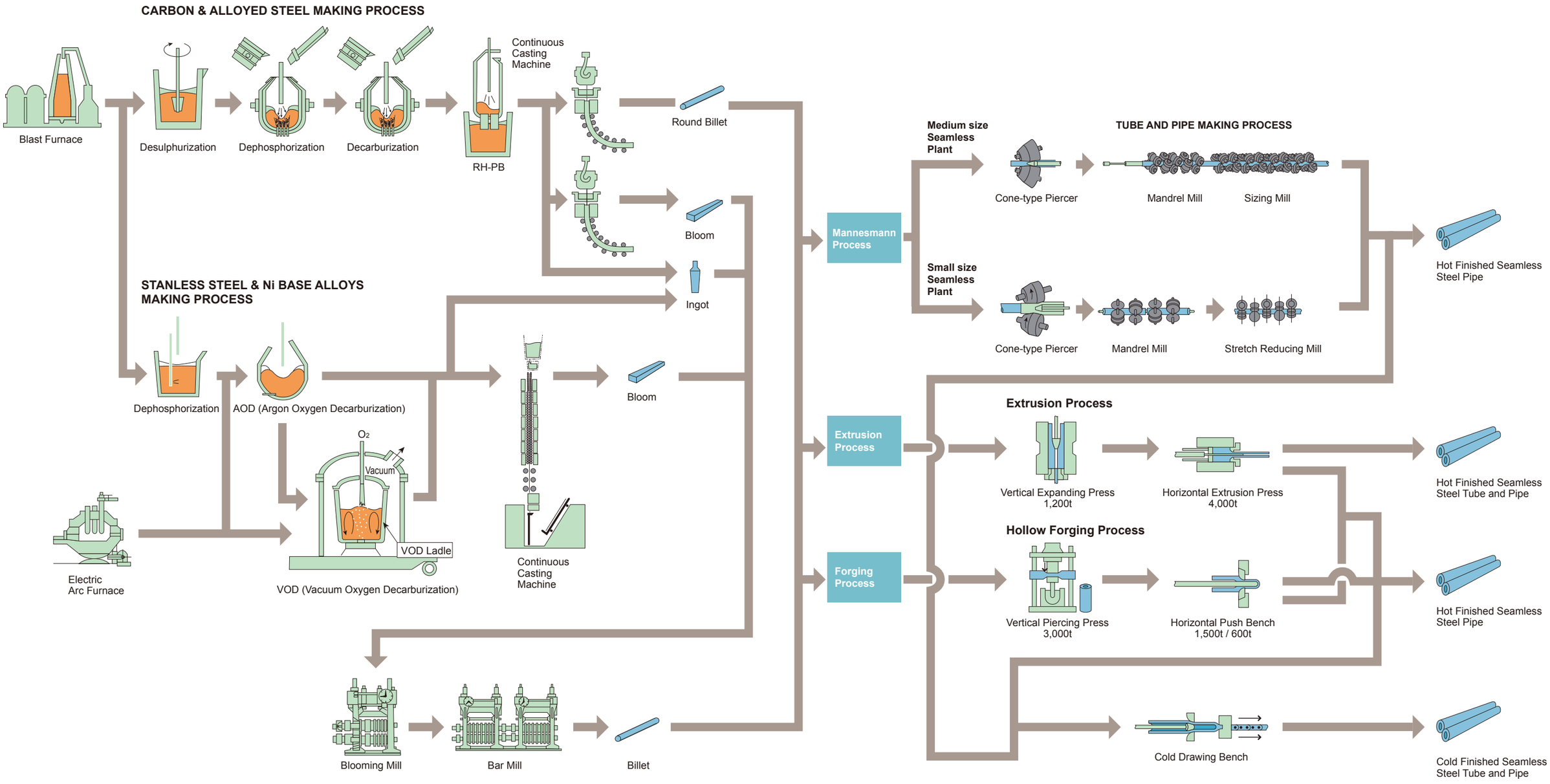
Wakayama Steel Works is the integrated supply center for seamless pipes. The steel billets are produced by a blast furnace, converter, continuous-casting machine. Then, three seamless pipe mills roll the billets into seamless pipes. Above all, the medium-size seamless mill is the most advanced in the world that is directly connected to a round CCM, combined with a cone-type piercer with high cross angle, a mandrel mill and an in-line heat treatment furnace.



Wakayama Plant

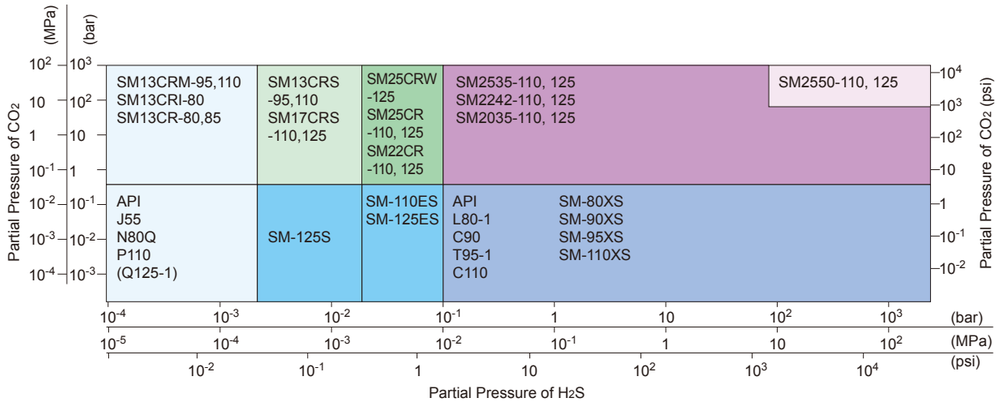
Kainan Plant

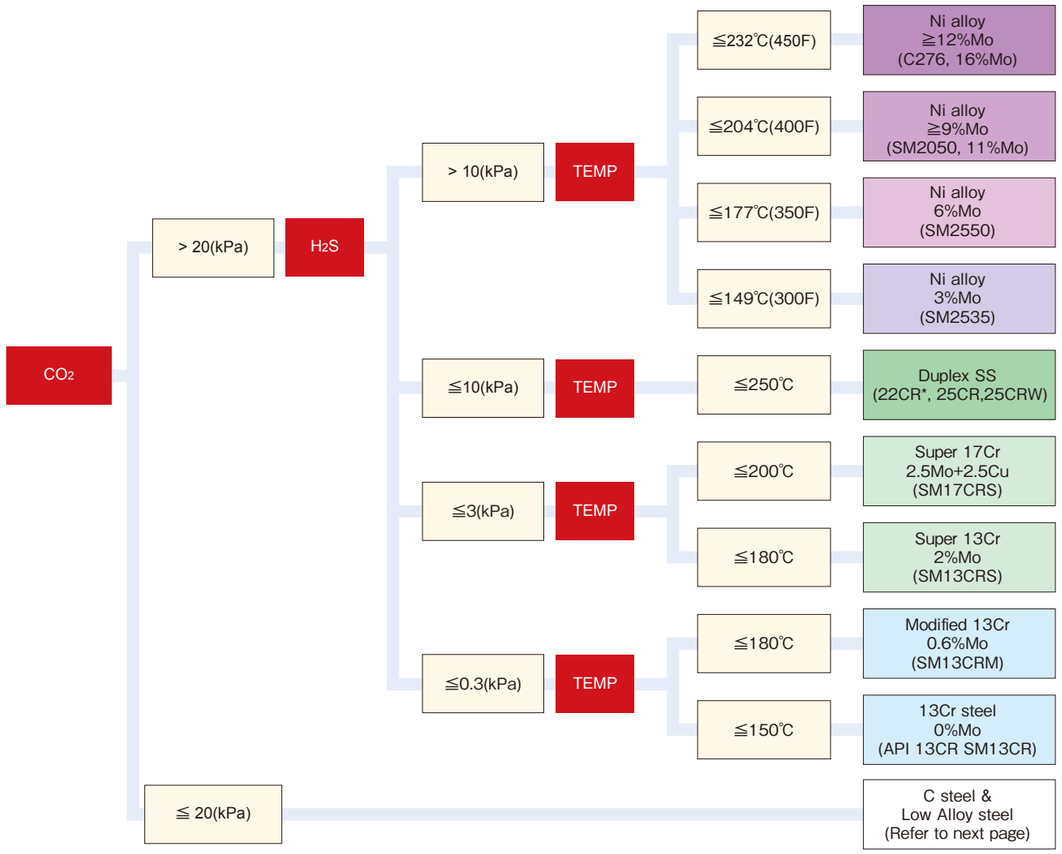
MANUFACTURING PROCESS OF SEAMLESS STEEL TUBES AND PIPES



MATERIAL SELECTION GUIDELINES

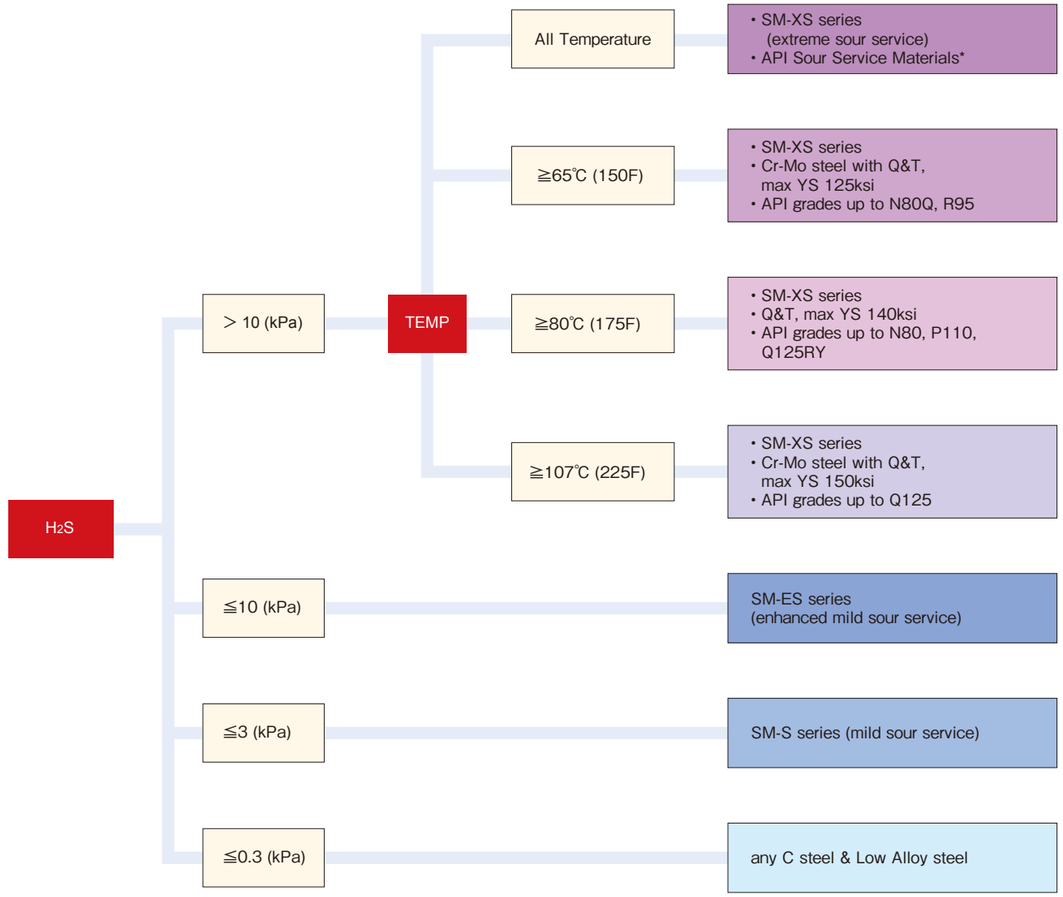
Casing & Tubing are basically selected according to PCO_2, PH_2S and temperature of the environment





1kPa= 0.145psi　　※Note: Critical temperature of 22CR=200℃

C steel & Low Alloy steel



Note : API Sour Service materials* can be applicable for any H_2S and any temperature only when performances of those grades are verified.

* : per NACE MR0175/ISO15156,
- Low grades: H40, J55 & K55
  or any low alloy steels with HRC<22 and Ni content < 1%
- Medium grades: L80-1
- High grades: C90-1 & T95-1

AVAILABLE GRADES

Min. Yield Strength (psi)	API SPEC 5CT				SM SERIES / NT SERIES										NEW SM SERIES			
	SEAMLESS & ERW				SEAMLESS & ERW										SEAMLESS			
	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GENERAL & DEEP WELL SERVICE	HIGH COLLAPSE		ARCTIC SERVICE		SOUR SERVICE			SOUR SERVICE + COLLAPSE		Wet CO_2 CORROSION WELL SERVICE	Wet CO_2-MILD SOUR CORROSION WELL SERVICE	Wet CO_2-SOUR CORROSION WELL SERVICE	
						General	Arctic Service			Mild Sour	Enhanced Mild Sour	Extreme Sour	Enhanced Mild Sour	Extreme Sour				
40,000	H40																	
55,000	J55 K55					NT-55HE												
65,000		M65																
80,000	N80Q	L80-1 L80-13CR			NT-80DE	SM-80T NT-80HE	NT-80LHE	SM-80L SM-80LL				SM-80XS		SM-80TXS	SM13CR-80 SM13CRI-80			
85,000															SM13CR-85			
90,000		C90-1										SM-90XS		SM-90TXS				
95,000	R95	T95-1				SM-95T SM-95TT NT-95HE		SM-95L SM-95LL				SM-95XS		SM-95TXS	SM13CR-95 SM13CRM-95	SM13CRS-95		
100,000																		
110,000		C110	P110			SM-110T SM-110TT NT-110HE		SM-110L SM-110LL			SM-110ES	SM-110XS	SM-110TES	SM-110TXS	SM13CRM-110 SM17CRS-110 SM22CR-110 SM25CR-110	SM13CRS-110	SM2535-110 SM2242-110 SM2035-110	SM2550-110 SM2050-110 SMC276-110
125,000				Q125-1		SM-125TT				SM-125S	SM-125ES		SM-125TES			SM17CRS-125 SM22CR-125 SM25CR-125 SM25CRW-125	SM2535-125 SM2035-125	SM2550-125 SM2050-125 SMC276-125
130,000					SM-130G SM-130CY												SM2535-140	SMC276-140
140,000					SM-140G													

Available grade: Black·····Seamless & ERW Blue·····Seamless Red·····ERW (Refer to ERW catalogue for detail information)

MECHANICAL PROPERTIES

SPECIFICATION	APPLICATION	GRADE	CHANICAL PROPERTIES							REMARKS
			Yield Strength		Tensile Strength		ELONGATION (%)	HARDNESS	△HRC	
			min ksi (MPa)	max ksi (MPa)	min ksi (MPa)					
API 5CT	GROUP 1	H40 J55 K55 N80Q R95	40 (276) 55 (379) 55 (379) 80 (552) 95 (655)	80 (552) 80 (552) 80 (552) 110 (758) 110 (758)	≧ 60 (414) ≧ 75 (517) ≧ 95 (655) ≧ 100 (689) ≧ 105 (724)		API FORMULA API FORMULA API FORMULA API FORMULA API FORMULA			
	GROUP 2	M65 L80-1 L80-13CR C90-1 T95-1 C110	65 (448) 80 (552) 80 (552) 90 (621) 95 (655) 110 (758)	85 (586) 95 (655) 95 (655) 105 (724) 110 (758) 120 (828)	≧ 85 (586) ≧ 95 (655) ≧ 95 (655) ≧ 100 (689) ≧ 105 (724) ≧ 115 (793)		API FORMULA API FORMULA API FORMULA API FORMULA API FORMULA API FORMULA	HRC ≦ 22 HRC ≦ 23 HRC ≦ 23 HRC ≦ 25.4 HRC ≦ 25.4 HRC ≦ 30	 ≦ 3 ~ 6 ≦ 3 ~ 6 ≦ 3 ~ 6	
	GROUP 3	P110	110 (758)	140 (965)	≧ 125 (862)		API FORMULA			
	GROUP 4	Q125-1	125 (862)	150 (1034)	≧ 135 (931)		API FORMULA		≦ 3 ~ 5	
SM SERIES	G GENERAL & DEEP WELL SERVICE	SM-130G SM-140G SM-130CY	130 (896) 140 (965) 130 (896)	160 (1103) 170 (1172) 140 (965)	≧ 135 (931) ≧ 150 (1034) ≧ 135 (931)		API FORMULA API FORMULA API FORMULA		 ≦ 3 ~ 5	
	T, TT HIGH COLLAPSE WELL SERVICE	SM-80T SM-95T SM-110T	80 (552) 95 (655) 110 (758)	110 (758) 125 (862) 140 (965)	≧ 100 (689) ≧ 110 (758) ≧ 125 (862)		API FORMULA API FORMULA API FORMULA			<Collapse test> Refer to Material Data Sheet on web site. www.tubular.nipponsteel.com
		SM-95TT SM-110TT SM-125TT	95 (655) 110 (758) 125 (862)	125 (862) 140 (965) 155 (1069)	≧ 110 (758) ≧ 125 (862) ≧ 135 (931)		API FORMULA API FORMULA API FORMULA			
	S MILD SOUR WELL SERVICE	SM-125S	125 (862)	140 (965)	≧ 130 (896)		API FORMULA	HRC ≦ 36		
	ES ENHANCED MILD SOUR WELL SERVICE	SM-110ES SM-125ES	110 (758) 125 (862)	125 (862) 140 (965)	≧ 115 (793) ≧ 130 (896)		API FORMULA API FORMULA	HRC ≦ 30 HRC ≦ 36		
	XS EXTREME SOUR WELL SERVICE	SM-80XS SM-90XS SM-95XS	80 (552) 90 (621) 95 (655)	95 (655) 105 (724) 110 (758)	≧ 95 (655) ≧ 100 (689) ≧ 105 (724)		API FORMULA API FORMULA API FORMULA	HRC ≦ 22 HRC ≦ 25.4 HRC ≦ 25.4		<Corrosion Test> Refer to the table on page 13.
	TES ENHANCED MILD SOUR +HIGH COLLAPSE WELL SERVICE	SM-110TES SM-125TES	110 (758) 125 (862)	125 (862) 140 (965)	≧ 115 (793) ≧ 130 (896)		API FORMULA API FORMULA	HRC ≦ 30 HRC ≦ 36		Refer to Material Data Sheet on web site. www.tubular.nipponsteel.com
	TXS EXTREME SOUR +HIGH COLLAPSE WELL SERVICE	SM-80TXS SM-90TXS SM-95TXS SM-110TXS	80 (552) 90 (621) 95 (655) 110 (758)	95 (655) 105 (724) 110 (758) 120 (828)	≧ 95 (655) ≧ 100 (689) ≧ 105 (724) ≧ 115 (793)		API FORMULA API FORMULA API FORMULA API FORMULA	HRC ≦ 22 HRC ≦ 25.4 HRC ≦ 25.4 HRC ≦ 30		<Corrosion Test> Refer to the table on page 13. <Collapse test>
	L, LL ARCTIC SERVICE	SM-80L SM-95L SM-110L SM-80LL SM-95LL SM-110LL	80 (552) 95 (655) 110 (758) 80 (552) 95 (655) 110 (758)	110 (758) 125 (862) 140 (965) 110 (758) 125 (862) 140 (965)	≧ 100 (689) ≧ 105 (724) ≧ 125 (862) ≧ 100 (689) ≧ 105 (724) ≧ 125 (862)		API FORMULA API FORMULA API FORMULA API FORMULA API FORMULA API FORMULA			
NEW SM SERIES	Wet CO_2 CORROSION WELL SERVICE	SM13CR-80 SM13CR-85 SM13CR-95 SM13CRI-80 SM13CRM-95 SM13CRM-110	80 (552) 85 (586) 95 (655) 80 (552) 95 (655) 110 (758)	95 (655) 100 (689) 110 (758) 95 (655) 110 (758) 125 (862)	≧ 95 (655) ≧ 100 (689) ≧ 105 (724) ≧ 95 (655) ≧ 105 (724) ≧ 110 (758)		API FORMULA API FORMULA API FORMULA API FORMULA API FORMULA API FORMULA	HRC ≦ 23 HRC ≦ 24 HRC ≦ 27 HRC ≦ 25 HRC ≦ 28 HRC ≦ 32		
	Wet CO_2 -MILD SOUR CORROSION WELL SERVICE	SM13CRS-95 SM13CRS-110 SM17CRS-110 SM17CRS-125 SM22CR-110 SM22CR-125 SM25CR-110 SM25CR-125 SM25CRW-125	95 (655) 110 (758) 110 (758) 125 (862) 110 (758) 125 (862) 110 (758) 125 (862) 125 (862)	110 (758) 125 (862) 135 (931) 145 (1000) 140 (965) 145 (1000) 140 (965) 145 (1000) 145 (1000)	≧ 105 (724) ≧ 110 (758) ≧ 120 (828) ≧ 130 (896) ≧ 125 (862) ≧ 130 (896) ≧ 125 (862) ≧ 130 (896) ≧ 130 (896)		API FORMULA API FORMULA API FORMULA API FORMULA 12 11 12 11 11	HRC ≦ 28 HRC ≦ 32 HRC ≦ 36 HRC ≦ 38 HRC ≦ 36 HRC ≦ 37 HRC ≦ 36 HRC ≦ 37 HRC ≦ 37		
	Wet CO_2 -SOUR CORROSION WELL SERVICE	SM2535-110 SM2535-125 SM2535-140 SM2242-110 SM2035-110 SM2035-125 SM2550-110 SM2550-125 SM2050-110 SM2050-125 SMC276-110 SMC276-125 SMC276-140	110 (758) 125 (862) 140 (965) 110 (758) 110 (758) 125 (862) 110 (758) 125 (862) 110 (758) 125 (862) 110 (758) 125 (862) 140 (965)	140 (965) 145 (1000) 165 (1138) 140 (965) 140 (965) 140 (965) 140 (965) 145 (1000) 140 (965) 145 (1000) 140 (965) 145 (1000) 160 (1103)	≧ 115 (793) ≧ 130 (896) ≧ 145 (1000) ≧ 115 (793) ≧ 115 (793) ≧ 130 (896) ≧ 120 (828) ≧ 130 (896) ≧ 120 (828) ≧ 130 (896) ≧ 115 (793) ≧ 130 (896) ≧ 145 (1000)		12 10 10 13 11 9 15 13 16 14 20 14 10	HRC ≦ 32 HRC ≦ 34 HRC ≦ 40 HRC ≦ 32 HRC ≦ 32 HRC ≦ 33 HRC ≦ 33 HRC ≦ 36 HRC ≦ 34 HRC ≦ 36 HRC ≦ 38 HRC ≦ 38 HRC ≦ 40		

SM-SERIES GRADE DESCRIPTION

1. CASING AND TUBING FOR GENERAL AND DEEP WELL SERVICE

SM-G meant for general and deep well service are remarkable for their high yield and tensile strengths while maintaining good ductility and fracture toughness.
SM-130G and SM-140G offer additional tensile and yield strengths for deep well services.

Grade	Yield Strength		Tensile Strength min psi (MPa)	Elongation min %	Impact Properties min Ave Value At 32˚F (0˚C) Ft-lb (J)
	min psi (MPa)	max psi (MPa)			
SM-130G	130,000 (896)	160,000 (1103)	135,000 (931)	API Formula	20 (27) (Specimen: 10 by 10 mm)
SM-140G	140,000 (965)	170,000 (1172)	150,000 (1034)		

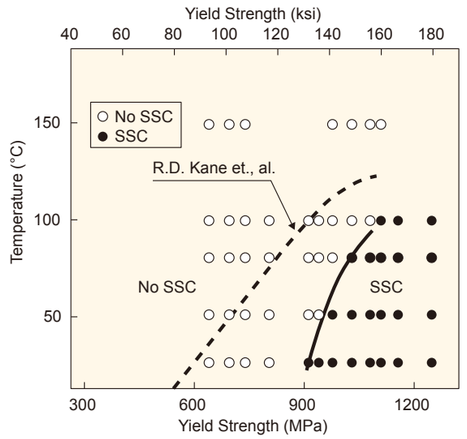
CHARACTERISTICS

1. Tensile Strength
The resistance to collapse and the longitudinal high strength requirements of well casing is becoming increasingly important with the drilling of deeper and deeper wells. SM130G and SM-140G offer the high strength properties.

2. Mechanical Properties
Mechanical properties of SM-G series are shown in above Table. SM130G and SM140G offer the required high strength properties.

Application of High Strength Grades for Deep Sour Gas & Oil Wells

The smallest amount of H_2S contamination should always be taken into consideration when looking at high strength material applications.
Fig shows the applicability of high strength steels for sour service integrating the following variables: H_2S concentration, applied stress level and temperature.
Sulfide stress corrosion cracking susceptibility increases with material strength and grades such as SM140G should never be used if H_2S is present.



2. CASING AND TUBING FOR SOUR OIL AND GAS SERVICE

In order to prevent possible sulfide stress corrosion cracking in sour gas and oil wells containing H_2S, it is necessary to use specially manufactured tubing and casing. API 5CT Group 2 grade tubing and casing have been developed and used widely for this purpose. However these may not be adequate in high concentration of H_2S.
To address this, NIPPON STEEL, after years of research and development, has succeeded in developing improved materials with higher strength and higher corrosion resistance for casing and tubing.
These are available in our SM-XS for extreme sour service, SM-ES for Enhanced mild sour service series as shown below.
NIPPON STEEL does not recommend SM sour series 100ksi and higher grade for tubing applications.
Each of these grades is produced with rigid manufacturing controls covering chemical composition, heat treatment (quenching and tempering), tensile property, hardness and microstructure.

Type	Grade	Mechanical Characteristics				SSC test			
		Yield Strength		Tensile Strength	HRC	NACE TM0177 Methode-A			DCB
		min ksi (MPa)	max ksi (MPa)	min ksi (MPa)	max.	H_2S (bar)	Solution	Applied stress	Average .K1SSC
API	C90	90 (621)	105 (724)	100 (689)	25.4	1	A	80%SMYS	—
	T95	95 (655)	110 (758)	105 (724)	25.4	1	A	80%SMYS	—
	C110	110 (758)	120 (828)	115 (793)	30.0	1	A	85%SMYS	—
Extreme Sour	SM-80XS	80 (552)	95 (655)	95 (655)	22.0	1	A	90%SMYS	—
	SM-90XS	90 (621)	105 (724)	100 (689)	25.4	1	A	90%SMYS	—
	SM-95XS	95 (655)	110 (758)	105 (724)	25.4	1	A	90%SMYS	—
	SM-110XS	110 (758)	120 (828)	115 (793)	30.0	1	A	85%SMYS	—
Extreme Sour +DCB	SM-80XSD	80 (552)	95 (655)	95 (655)	22.0	1	A	90%SMYS	30ksi√in
	SM-90XSD	90 (621)	105 (724)	100 (689)	25.4	1	A	90%SMYS	30ksi√in
	SM-95XSD	95 (655)	110 (758)	105 (724)	25.4	1	A	90%SMYS	30ksi√in
	SM-110XSD	110 (758)	120 (828)	115 (793)	30.0	1	A	85%SMYS	24ksi√in
Extreme Sour +Collapse	SM-80TXS	80 (552)	95 (655)	95 (655)	22.0	1	A	90%SMYS	—
	SM-90TXS	90 (621)	105 (724)	100 (689)	25.4	1	A	90%SMYS	—
	SM-95TXS	95 (655)	110 (758)	105 (724)	25.4	1	A	90%SMYS	—
	SM-110TXS	110 (758)	120 (828)	115 (793)	30.0	1	A	85%SMYS	—
Extreme Sour +DCB +Collapse	SM-80TXSD	80 (552)	95 (655)	95 (655)	22.0	1	A	90%SMYS	30ksi√in
	SM-90TXSD	90 (621)	105 (724)	100 (689)	25.4	1	A	90%SMYS	30ksi√in
	SM-95TXSD	95 (655)	110 (758)	105 (724)	25.4	1	A	90%SMYS	30ksi√in
	SM-110TXSD	110 (758)	120 (828)	115 (793)	30.0	1	A	85%SMYS	24ksi√in
Mild Sour	SM-125S	125 (862)	140 (965)	130 (896)	36.0	0.03	B (pH3.5)	85%SMYS	—
Enhanced Mild Sour	SM-110ES	110 (758)	125 (862)	115 (793)	30.0	0.1	B (pH3.5)	85%SMYS	—
	SM-125ES	125 (862)	140 (965)	130 (896)	36.0	0.1	B (pH3.5)	85%SMYS	—
Enhanced Mild Sour +Collapse	SM-110TES	110 (758)	125 (862)	115 (793)	30.0	0.1	B (pH3.5)	85%SMYS	—
	SM-125TES	125 (862)	140 (965)	130 (896)	36.0	0.1	B (pH3.5)	85%SMYS	—

NIPPON STEEL renewed sour service line-up since 1st October, 2012. For detailed information, please check www.tubular.nipponsteel.com

CHARACTERISTICS

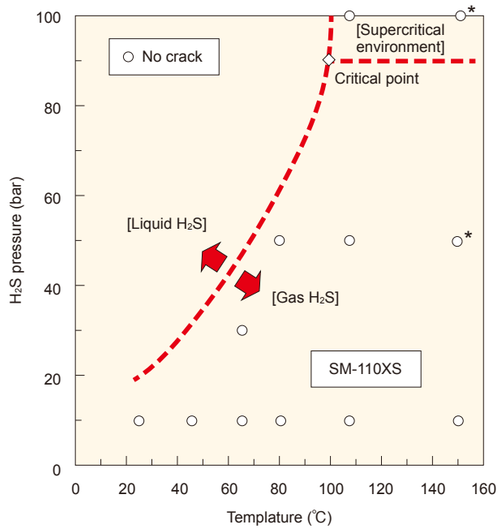
1. Materials
The chemical compositions have been carefully determined to provide resistance to sulfide stress corrosion cracking as well as to insure complete through wall hardening.

2. Heat Treatment
Quenching and tempering are conducted under rigid temperature control to assure homogeneous physical properties and microstructures.
New Higher Strength Sour Resistant Grades SM-110ES, SM-125ES, SM-110XS, SM-110TXS, have been developed.

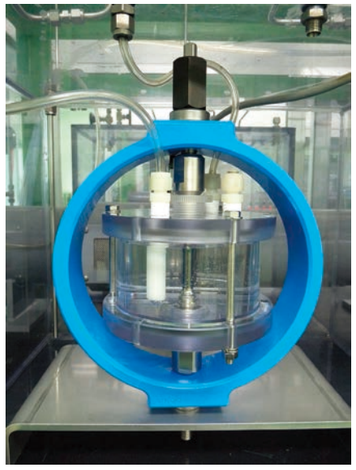
3. Micro Structure
These grades exhibit fully tempered martensite which is considered to be the most desirable for resistance to sulfide stress corrosion cracking.

4. Tensile Properties and Hardness
Yield strength is limited within a narrow range and hardness is controlled to within the predetermined maximum limit.

5. Sulfide Stress Cracking (SSC) Performance
SM sour resistant grades are designed for 85% or 90% SMYS in NACE condition.
Excellent SSC resistance has been achieved through rigorous, chemical composition, heat treatment, microstructure, tensile properties, hardness and so on.



Cracking susceptibility as a function of temperature and H_2S pressure (Method: 4 point bend test under applied stress of 90% actual YS, H_2S pressure: 10-100bar, test temperature: 24-107°C, test solution: 5%NaCl, test duration: 720h, 2160h)*: 2160h test



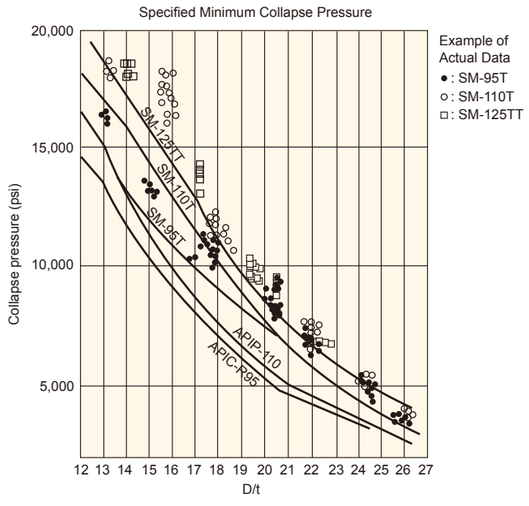
Sustain load type
Sulfide stress corrosion cracking test apparatus

3. HIGH COLLAPSE CASING FOR DEEP WELL SERVICE

NIPPON STEEL High Collapse Casing SM-T grade is a seamless product designed for deep wells where high collapse pressures are anticipated. In order to meet deep well service requirements, SM-T casing has improved collapse properties well in excess of API ratings. These properties are achieved by strict mill control incorporating a unique production technique inclusive of quenching and tempering. SM-T casing shows a very high resistance to tension load, internal pressure, and collapse. SM-TES, TXS, TXSD series are also highly resistant to sulfide stress corrosion cracking and can be used for deep and sour gas and oil service.

Grade	Yield Strength		Tensile Strength min psi (MPa)	Elongation min %	Collapse Resistance
	min psi (MPa)	max psi (MPa)			
SM- 80T	80,000 (552)	110,000 (758)	100,000 (689)	API Formula	Refer website www.tubular.nipponsteel.com or ask Nippon Steel representative
SM- 95T	95,000 (655)	125,000 (862)	110,000 (758)	API Formula	
SM- 95TT	95,000 (655)	125,000 (862)	110,000 (758)	API Formula	
SM-110T	110,000 (758)	140,000 (965)	125,000 (862)	API Formula	
SM-110TT	110,000 (758)	140,000 (965)	125,000 (862)	API Formula	
SM-125TT	125,000 (862)	155,000 (1069)	135,000 (931)	API Formula	

As wells are drilled deeper, the external pressures applied to well casings become greater. Thus, a well casing must have adequate collapse strength to withstand these horizontal pressures without deformation. For reasons of economy such casings should also be as light-weight as possible while still retaining ample collapse resistance properties.
With this in mind NIPPON STEEL has developed its SM-T High Collapse Casing. This casing was developed from experiments in which NIPPON STEEL studied the critical collapse pressure of a well casing under external pressure in relation to its longitudinal tensile strength and the geometry of its cross section.



CHARACTERISTICS

1. Unique Production Technique
The material for SM-T casing is carefully selected to insure structural homogeneity. Strict control of heat treatment and dimensional tolerances are adhered to throughout the manufacturing process.

2. Rigid Dimensional Control
Dimensional tolerances, such as roundness, straightness, O.D. and wall thickness are strictly controlled.

3. Specified Collapse Value
A collapse test is carried out on each production run of SM-T casing with the same frequency as the tensile test.

4. CASING AND TUBING FOR ARCTIC SERVICE

NIPPON STEEL SM-L grades are designed for high impact toughness at subzero temperatures, as this is experienced in arctic regions.
These properties are achieved through tight material chemistry control and specific heat treatment.
The following Tables show tensile and impact toughness properties.

Tensile Properties

Grade	Yield Strength		Tensile Strength min psi (MPa)	Elongation min % in 2 inches
	min psi (MPa)	max psi (MPa)		
SM-80L SM-80LL	80,000 (552)	110,000 (758)	100,000 (689)	
SM-95L SM-95LL	95,000 (655)	125,000 (862)	105,000 (742)	API Formula
SM-110L SM-110LL	110,000 (758)	140,000 (965)	125,000 (862)	

Impact Toughness Properties (Charpy impact value)

Grade	Size of Specimen mm	Min. Average Value of Each Set of Three Specimens ft-lb (J)	Min. Value of One Specimen Only of a Set ft-lb (J)
SM-80L SM-95L SM-110L	10 by 10 10 by 7.5 10 by 5 10 by 2.5	20 (27) 15 (20) 10 (14) 5 (7)	15 (20) 11 (15) 8 (11) 4 (5)

Test temperature : −50 F (−46°C)

Grade	Size of Specimen mm	Min. Average Value of Each Set of Three Specimens ft-lb (J)	Min. Value of One Specimen Only of a Set ft-lb (J)
SM-80LL SM-95LL SM-110LL	10 by 10 10 by 7.5 10 by 5	23.1 (31) 18.5 (25) 12.7 (17)	15.4 (21) 12.3 (17) 8.5 (12)

Test temperature : −67 F (−55°C)

CHARACTERISTICS

1. Material
Special steel is used in order to obtain sufficient resistance to low temperature impact.

2. Heat Treatment
Both casing and couplings are quenched and tempered with special care.

3. Impact Properties
Refer below table.

NEW SM-SERIES

1. 13CR, Super 13CR, Super 17CR and Duplex Stainless Steel

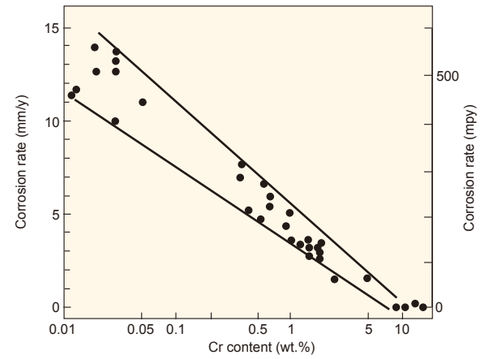
1.1 Chemical composition

Grade	Chemical composition (wt %)								
	C	Si	Mn	Cu	Ni	Cr	Mo	W	N
SM13CR	≦ 0.22	≦ 1.00	≦ 1.00	≦ 0.25	≦ 0.5	12.0 ~14.0	—	—	—
SM13CRI	≦ 0.03	≦ 0.50	≦ 1.50	—	1.5 ~3.0	10.5 ~12.5	0.2 ~0.4	—	—
SM13CRM	≦ 0.03	≦ 0.50	≦ 1.00	—	4.0 ~6.0	11.0 ~14.0	0.2 ~1.2	—	—
SM13CRS	≦ 0.03	≦ 0.50	≦ 0.50	—	5.0 ~6.5	11.5 ~13.5	1.5 ~3.0	—	—
SM17CRS	≦ 0.03	≦ 0.50	≦ 0.50	2.0 ~3.0	4.5 ~5.5	16.0 ~18.0	2.0 ~3.0	—	—
SM22CR	≦ 0.03	≦ 1.00	≦ 2.00	—	4.5 ~6.5	21.0 ~23.0	2.5 ~3.5	—	0.08 ~0.20
SM25CR	≦ 0.03	≦ 0.75	≦ 1.00	0.2 ~0.8	5.5 ~7.5	24.0 ~26.0	2.5 ~3.5	0.10 ~0.50	0.10 ~0.30
SM25CRW	≦ 0.03	≦ 0.80	≦ 1.00	0.2 ~0.8	6.0 ~8.0	24.0 ~26.0	2.5 ~3.5	2.01 ~2.50	0.24 ~0.32

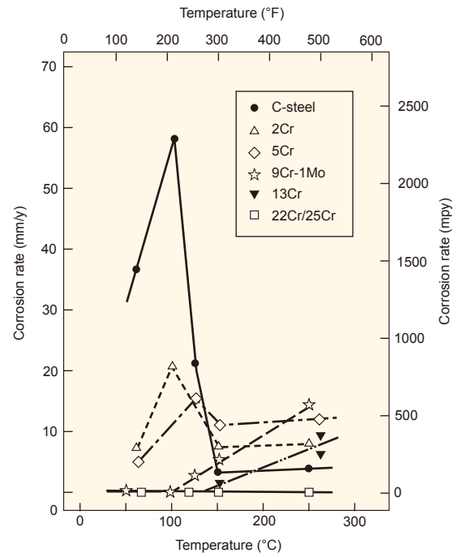
1.2 CO_2 Corrosion Resistance

(1) High Cr steels such as 13Cr stainless steels are resistant to CO_2 corrosion and have been used widely, and successfully in wells containing CO_2 and CL^-.

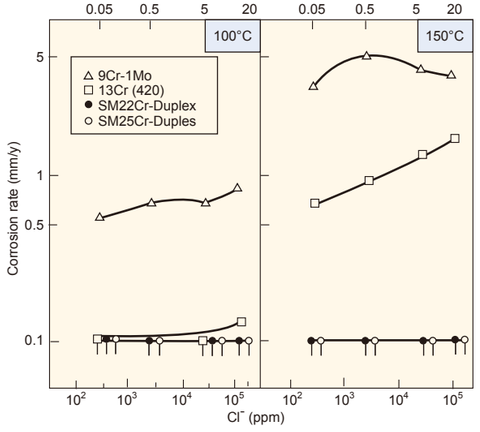
(2) Effect of Cr content and temperature on CO_2 corrosion are shown in following Figures. For 13CR & 13CRI critical temperature is 150°C and for 13 CRM & 13CRS that is 180°C. Duplex stainless steels (25Cr) have excellent corrosion resistance up to a temperature of 250°C.



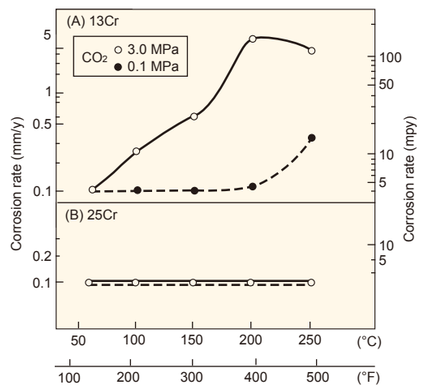
Effect of Cr content of commercial tubular goods on corrosion rate by loop tester
(Synthetic sea water, CO_2 partial pressure 0.1 MPa (60°C), test temperature 60°C, test duration 150h, flow velocity 2.5 m/s, specific volume : 800 cc/cm^2)



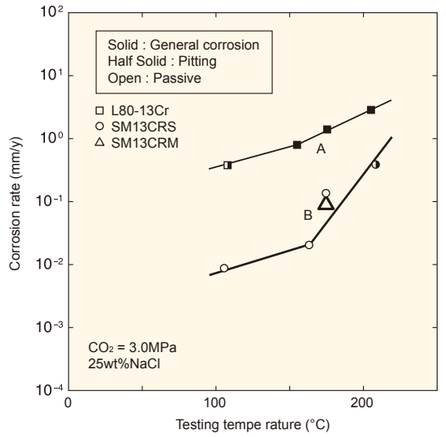
Effect of temperature on corrosion rate by autoclave
(Synthetic sea water, CO_2 partial pressure ; 3.0 MPa (R.T.), test duration 72h, flow velocity 2.5 m/s, specific volume : 42 cc/cm^2)

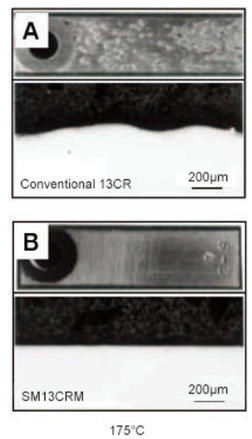


Effect of Cl^- low concentration on the corrosion rate of Cr steels at 150°C in the autoclave. (3.0MPa CO_2 at 25°C, test duration 96hr, flow velocity 2.5 m/s)

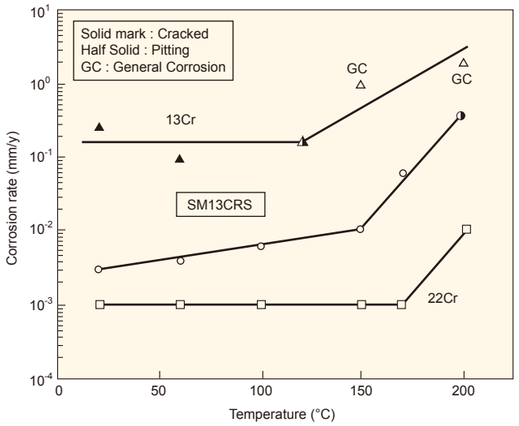


Effect of CO_2 partial pressure and temperature on corrosion rate of Cr steel
(5% NaCl, CO_2 3.0 and 0.1 MPa at 25°C, test duration 96hr, flow velocity 2.5 m/s)

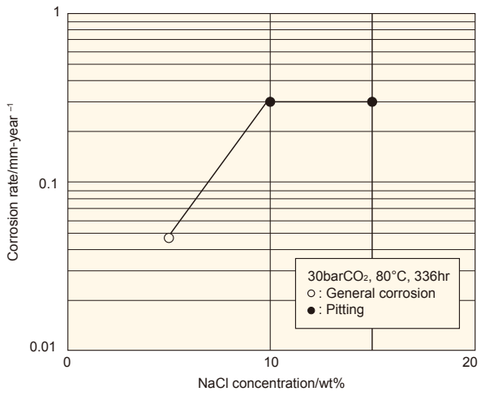




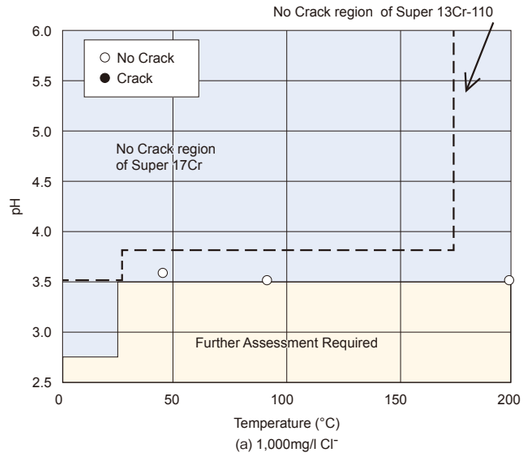
Effect of temperature on corrosion rate of conventional 13CR, SM13CRS and SM13CRM in CO_2 environment
(3.0MPa (450psi) CO_2, 150,000ppm Cl^-)

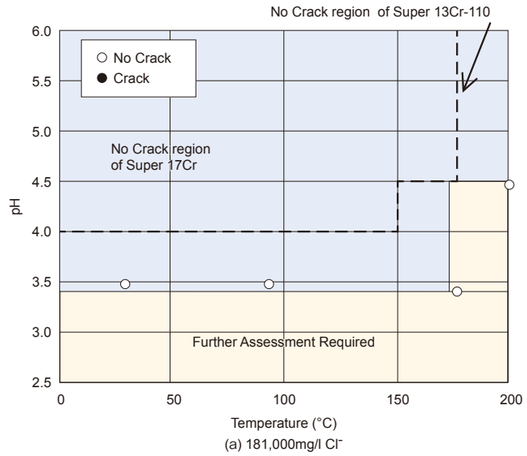


Effect of temperature on corrosion resistance of SM13CRS
(5%NaCl + 3.0MPa (450psi) CO_2 + 0.001MPa (0.15psi) H_2S)



The reration of pitting occurrence and NaCl concentration
(Conventional 13Cr)

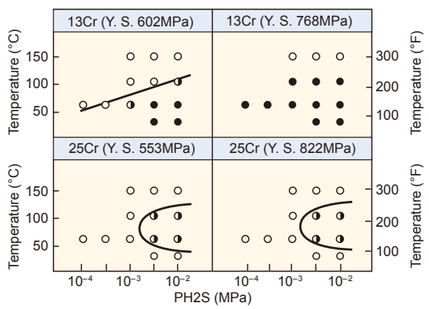




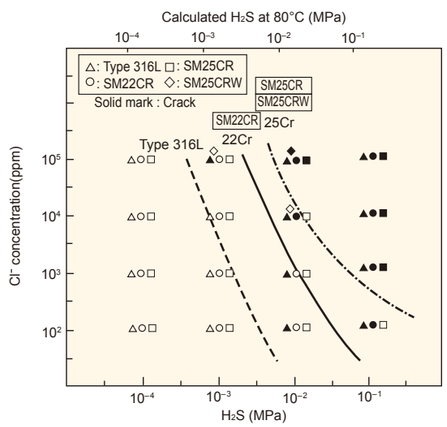
Effect of pH and Temprature on EAC Susceptibility of Super 17Cr-125 in 0.001MPa H_2S+CO_2
(Test Method: NACE Method A in 0.001MPa H_2S+0.099MPa CO_2 at RT, 4PB in 0.001MPa H_2S +3MPa CO_2 at temperature ≧ 90°C)

1.3 Sulfide Stress Corrosion Cracking (SSCC) Resistance

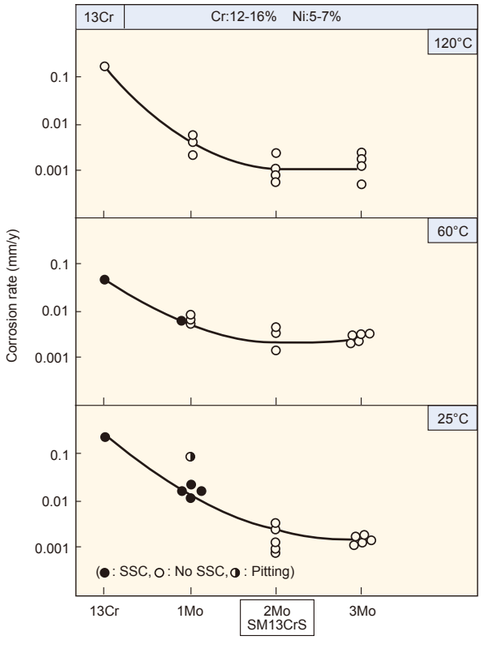
(1) 13CR has a high SSCC susceptibility as shown in below fig; 13CR usage is not advisable for usage in environments containing a small amount of H_2S (≦ 0.003bar).
(2) 13CRS has good SSCC resistance in environments containing up to 0.03bar H_2S.
(3) Duplex stainless steels (SM22CR, SM25CR, SM25CRW) are recommendable over marternsitic stainless steel (SM13CRS) in a small amount of H_2S.



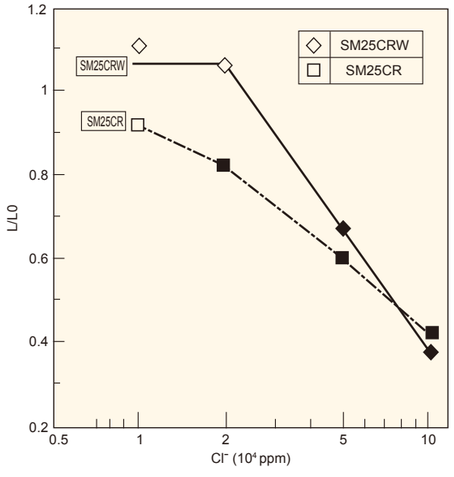
Effect of H_2S partial pressure and temperature on the SSCC susceptibility.
5% NaCl, 3.0MPa CO_2 + H_2S at 25°C (77°F), test duration 336h, flow velocity 2.5m/s, 1σy with notch



SCC susceptibility of duplex stainless steel in Cl^--H_2S environment.
○: No SCC, ●: SCC
(SSRT method ; 80°C, strain rate 4.2 x 10^{-6}/s)(annealed)



Effect of Mo content on corrosion rate and SSCC. <SM13CRS>
(5% NaCl + 3.0MPa (450psi) CO_2 + 0.001MPa (0.15psi) H_2S
4-point bent beam with notch, 1σy, 336h)



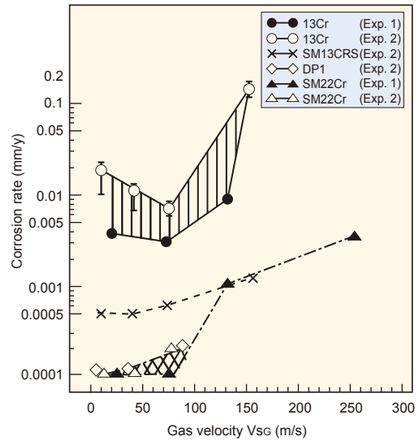
SCC susceptibility of duplex steel in Cl^--H_2S environment.
○: No SCC, ●: SCC
(SSRT method ; 80°C, Calculated H_2S 0.015MPa, strain rate 4.2 x 10^{-6}/s)

1.4 Erosion Properties

(1) 13CR, Super 13CR and Duplex stainless steels have superior erosion properties.

Effect of Flow velocity (Field test results)
Average test conditions in the DFT (Dynamic Field Tester) experiments 1 (Test duration: 3672h) and 2 (Test duration: 4493h)

Experiment	Internal diameter (mm)	Gas flow rate (m^3/h)	Pressure		Temperature		Gas velocity (m/s)	Flow pattern
			(psi)	(MPa)	(F)	(K)		
1	52	9000	1960	13.8	190	361	17.6	Transition Annular mist
	27	9000	1917	13.5	190	361	66.6	Annular mist
	20	9000	1775	12.5	188	360	131.4	Annular mist
	15	9000	1661	11.7	188	360	250.5	Annular mist
2	52	7860	1755	12.1	181	355	10.6	Transition
	27	7860	1726	11.9	175	352	39.7	Annular mist
	20	7860	1598	11.1	175	352	78.2	Annular mist
	15	7860	1406	9.9	171	350	157.1	Annular mist



Effect of flow velocity on corrosion rate of 13Cr, SM13CRS, DP1, and SM22Cr steels in the DFT experiments 1 and 2.

2. $H_2S+CO_2+Cl^-$ CORROSION (Ni BASE ALLOYS)

High Alloy Materials become necessary where severe well conditions with high concentrations of H_2S, CO_2 and Cl^- brines are encountered.

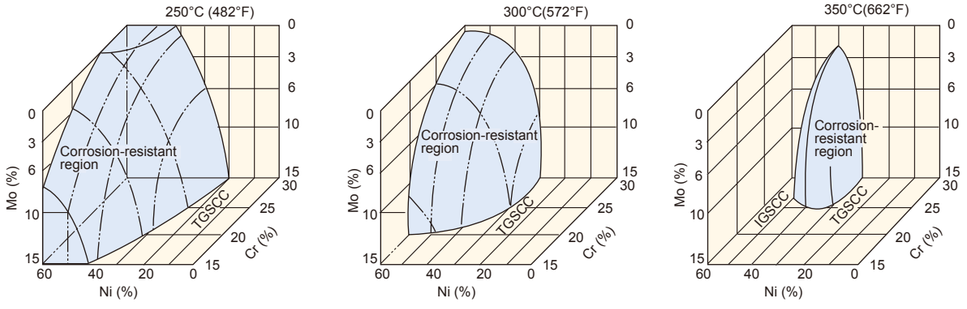
(1) High Ni corrosion resistant alloys for OCTG feature a single austenitic phase. Strength is developed through cold working.
Addition of essential alloying elements such as Cr, Ni, Mo determines the corrosion resistance properties.

(2) Resistance to general (weight loss) corrosion and localized (pitting and crevice) corrosion is achieved by the formation of a stable passivation film on the material surface.

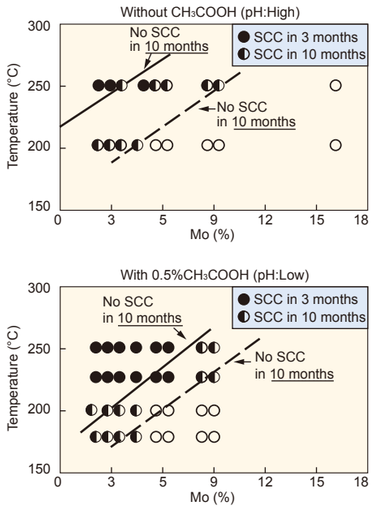
(3) The effect of fundamental elements on corrosion behaviors are shown in the following Figures.
These can be recapped as follows.
- Application limit temperature is strongly depending on Mo content in the Ni Base Alloys.
- In combined H_2S, CO_2, Cl^- media, the basic minimal chemistry of Cr ≧ 18%, Ni ≧ 28%, Mo ≧ 3% is required.
- Hydrogen embrittlement susceptibility increases with material chemistries exceeding 60% Ni.

(4) Elemental S is very aggressive to SCC. SM2050 and SMC276 is applicable depending on environmental temperature.

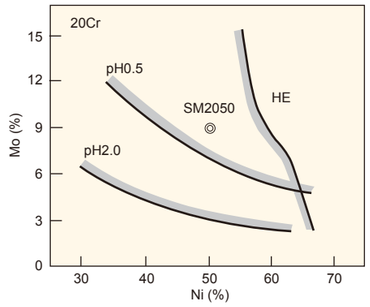
Grade	Chemical Composition (mass %)									
	C	Si	Mn	Cu	Ni	Cr	Mo	Ti	W	Fe
SM2535	≦ 0.03	≦ 0.50	≦ 1.00	≦ 1.5	29.5 ~36.5	24.0 ~27.0	2.50 ~4.00	—	—	Bal
SM2242	≦ 0.05	≦ 0.50	≦ 1.00	1.50 ~3.00	38.0 ~46.0	19.5 ~24.0	2.50 ~4.00	≦ 1.20	—	Bal
SM2035	≦ 0.03	≦ 0.75	≦ 1.00	≦ 0.07	33.0 ~38.0	20.5 ~23.5	4.00 ~5.00	—	0.20 ~0.80	Bal
SM2550	≦ 0.03	≦ 1.00	≦ 1.00	≦ 1.20	47.0 ~54.0	23.0 ~26.0	6.00 ~9.00	≦ 0.69	≦ 3.0	Bal
SM2050	≦ 0.03	≦ 0.50	≦ 1.00	≦ 2.00	49.0 ~53.0	19.0 ~23.0	10.1 ~12.0	—	≦ 1.50	Bal
SMC276	≦ 0.01	≦ 0.08	≦ 1.00	Co ≦ 2.5	Bal	14.5 ~16.5	15.0 ~17.0	V ≦ 0.35	3.0 ~4.5	4.0 ~7.0



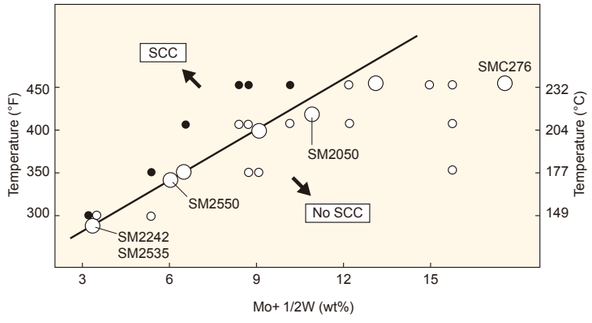
Corrosion resistant region of Fe-Cr-Ni-Mo alloy (20% NaCl+0.5% CH_3COOH, 1.0 MPa H_2S-1.0MPa CO_2-pH 2)



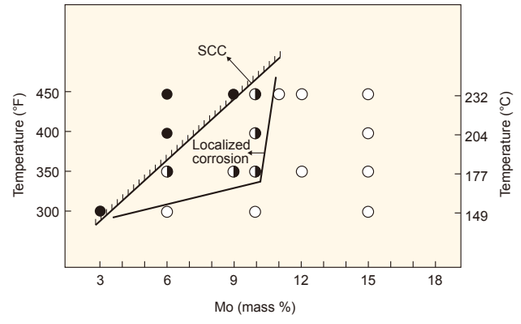
Effect of Mo and temperature on SCC resistance
(C ring test, 20% NaCl, 1MPa H_2S +1 MPa CO_2, 100% YS)



Corrosion resistant region–pH–alloying element
(1) Corrosion resistance pH 2 ; No SCC and C.R. ≦0.05 mm/y,
(2) Environment, SCC : 20% NaCl +0.5% CH_3COOH–1.0 MPa H_2S –1.0 MPa CO_2 –250°C, HE : NACE TM01-77 solution, Iron coupling/400°C ×1,000h aging)



Relationship between testing temperature and Mo+½W content of Ni Base Alloys in H_2S-CL^- environment in the SSRT tests.
(SSRT test condition ; 25% NaCl-0.5% CH_3COOH, 0.7MPa H_2S, E=4.0×$10^{-6}S^{-1}$)



The relationship between testing temperature and Mo content of Ni-base alloys in an elemental S-containing sour environment.
(25% NaCl+1g / S, 1.0MPaH_2S+1.0MPaCO_2, 4PB with notch Applied Stress; 100% SMYS(110ksi), 336h)

3. Guidelines concerning Brines acceptability for 13CR, 17CRS, 13CRS, 13CRM, Duplex stainless and CRA steel

The below guidelines are based on laboratory testing excluding O_2 contamination or usage of common brine additives such as corrosion inhibitors, biocide, oxygen scavengers, etc. Consequently the brine “package” suitability and long term stability needs to be carefully ascertained prior to usage.

	PH※1	C-steel	13CR	17CRS, 13CRS, 13CRM	22Cr (Duplex s.s.)	
		Corrosion※2	Corrosion※3	SCC※5	Pitting※4	SCC※5
NaCl	B	B	A	A	B	A
$CaCl_2$	A	B	B	C	C	C
$MgCl_2$	C	A	B	C	C	A
$ZnCl_2$	C	C	C	C	A	A
NaBr	A	A	A	A	B	—
$CaBr_2$	A	B	B	A	B	A
$MgBr_2$	B	B	B	—	B	—
$ZnBr_2$	C	C	C	—	A	A

(1g/m²/h=1.1mm/year)

※1) In 60°C, 0.1MPaCO_2
A : pH≧4
B : 3＜pH＜4
C : pH≦3

※2.3) Autoclave test 150°C, 0.4MPaCO_2
※2)
A : C.R.≦1g/m²/h
B : 1＜C.R.≦10
C : C.R.＞10

※3)
A : C.R.≦0.1
B : 0.1＜C.R.≦1.0
C : C.R.＞1.0

※4) Pitting potential
A : Vp≧0.3V
B : 0＜Vp＜0.3
C : Vp≦0

※5)
A : Crack Free
C : Crack

Brines identified with A are acceptable for Completion & packer fluid applications.
Brines identifided with B may be acceptable for short term completion fluid applications.
Brine applications identified with C are NO GO areas.
Addition of corrosion inhibitor, biocide, and oxygen scavenger is recommended but these additives long term stability will be carefully ascertained prior to usage.

Whenever possible an oil base solids free packer fluid will be preferred.

4. Mechanical and Thermal Properties

Mechanical properties

		Specific Gravity (x10³ kg/m³)	Young' Modulus (GPa)				Poisson's Ratio			
No	Grade	25°C	25°C	100°C	200°C	250°C	25°C	100°C	200°C	250°C
1	SM-95XS	7.80	213	209	203	200	0.30	0.29	0.29	0.28
2	SM-110XS	7.75	212	209	203	200	0.30	0.30	0.29	0.29
3	SM-125S	7.80	212	209	203	200	0.30	0.30	0.29	0.29
4	SM13CR-80	7.71	221	217	211	208	0.30	0.29	0.29	0.29
5	SM13CRM-110	7.68	204	202	196	192	0.29	0.30	0.30	0.29
6	SM13CRS-95	7.73	203	200	194	190	0.30	0.30	0.30	0.29
7	SM13CRS-110	7.72	202	198	193	189	0.30	0.29	0.30	0.29
8	SM17CRS-110/125	7.80	194	190	184	181	0.32	0.31	0.29	0.31
9	SM22CR-110	7.85	198	194	184	189	0.25	0.24	0.23	0.24
10	SM25CR-110	7.85	191	184	177	193	0.26	0.25	0.24	0.27
11	SM25CRW-125	7.85	200	198	191	188	0.27	0.27	0.27	0.27
12	SM2535-110	8.07	205	194	189	187	0.31	0.29	0.30	0.30
13	SM2242-110	8.14	210	197	184	187	0.31	0.29	0.28	0.29
14	SM2035-110	8.10	203	194	181	177	0.32	0.30	0.31	0.30
15	SM2550-110	8.29	211	195	186	185	0.31	0.29	0.29	0.28
16	SM2050-110	8.58	216	201	192	196	0.33	0.31	0.31	0.31
17	SMC276-110	8.87	220	207	197	196	0.33	0.31	0.31	0.31

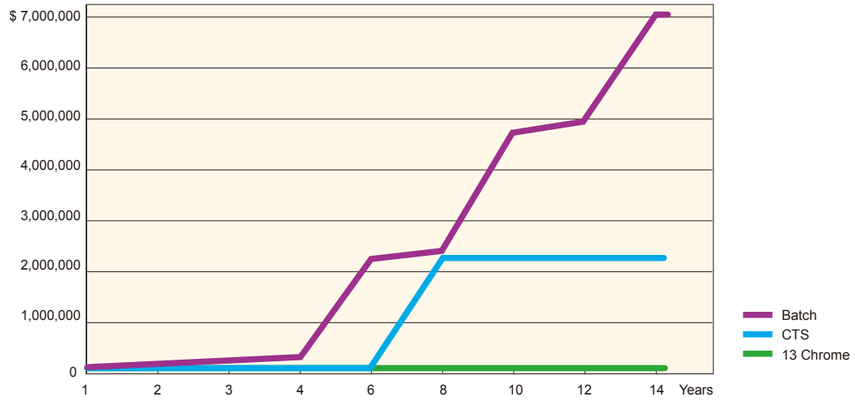
Thermal properties

		Thermal expansion (x10⁻⁶ / deg-C)			Thermal Diffusivity (x10⁻⁶ m² /s)				Heat Capacity (x10⁶ J/m³ /deg-C)				Thermal Conductivity (W/m /deg-C)				Specific Heat (J/kg /deg-C)			
No	Grade	25-100°C	25-200°C	25-250°C	25°C	100°C	200°C	250°C	25°C	100°C	200°C	250°C	25°C	100°C	200°C	250°C	25°C	100°C	200°C	250°C
1	SM-95XS	12.4	12.8	13.0	12.30	11.90	10.60	9.96	3.61	3.83	4.15	4.34	44.4	45.6	44.0	43.3	463	492	535	562
2	SM-110XS	12.3	12.6	12.8	11.90	11.50	10.30	9.74	3.49	3.72	3.97	4.17	41.5	42.8	40.9	40.6	450	481	516	543
3	SM-125S	12.3	12.8	13.0	12.60	12.00	10.80	10.20	3.50	3.66	3.89	4.08	44.1	43.9	42.0	41.6	449	470	502	528
4	SM13CR-80	10.9	10.9	11.0	7.74	7.70	7.02	6.75	3.48	3.64	3.93	4.11	27.0	28.0	27.6	27.7	452	473	512	537
5	SM13CRM-110	10.7	10.8	11.0	4.78	4.99	5.06	5.07	3.38	3.62	3.96	4.13	16.2	18.0	20.0	20.9	440	472	518	542
6	SM13CRS-95	10.9	11.0	11.1	4.67	4.85	4.97	5.00	3.39	3.67	3.98	4.12	15.8	17.8	19.8	20.6	438	476	517	537
7	SM13CRS-110	10.7	10.8	10.9	4.67	4.87	4.99	5.00	3.37	3.46	3.72	3.87	15.7	16.8	18.5	19.3	436	449	484	504
8	SM17CRS-110/125	11.0	11.2	11.4	4.41	4.67	4.80	4.80	3.44	3.67	4.03	4.23	15.2	17.1	19.3	20.3	441	472	519	546
9	SM22CR-110	12.5	12.8	13.3	3.59	4.16	4.39	4.38	3.77	4.12	4.52	4.73	13.7	16.2	18.1	19.3	468	496	526	562
10	SM25CR-110	12.5	12.7	13.0	3.59	4.14	4.45	4.65	3.86	4.61	4.98	5.36	13.1	16.0	18.3	20.5	465	492	524	562
11	SM25CRW-125	13.0	13.2	13.5	3.33	3.64	3.93	3.99	3.93	4.25	4.55	5.08	13.0	15.3	17.7	19.9	498	536	574	636
12	SM2535-110	14.5	14.9	14.9	2.96	3.26	3.71	4.04	3.75	3.99	4.23	4.39	10.8	12.4	14.7	16.6	453	471	491	509
13	SM2242-110	14.6	14.7	14.9	2.83	3.15	3.71	4.16	3.68	3.96	4.31	4.52	10.4	12.0	14.7	17.1	452	467	487	505
14	SM2035-110	14.8	14.8	14.8	2.91	3.16	3.54	3.96	3.82	3.93	4.17	4.39	10.7	12.0	14.0	16.3	454	469	488	509
15	SM2550-110	14.0	14.1	14.2	2.81	3.07	3.50	4.19	3.75	4.18	4.23	4.52	10.3	11.7	13.9	16.3	442	460	480	469
16	SM2050-110	13.2	13.5	13.6	2.79	3.03	3.58	3.90	3.74	4.00	4.21	4.41	10.1	11.5	13.9	15.6	421	442	452	466
17	SMC276-110	12.2	12.4	12.5	2.69	2.90	3.46	3.74	3.67	4.09	4.14	4.27	9.5	10.6	13.2	14.9	399	413	430	449

Note : 1cal/cm·s·C=360kcal/m·h·°C=419W·m^{-1}·C^{-1}

5. Cost Comparison with 13 Chrome

Example

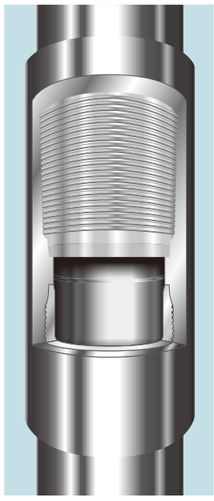


Batch: $7,016,485.00
(Chemical Inhibition Batch Treating)
CTS: $2,779,800.00
(Continuous Treating System)
13 Chrome: $289,000.00
(The economics are dated and the reader is cautioned to compare current prices.)

Source of reference:
Debbie A. Baudoin, David K. Barbin and Jim Skogsberg,
"Experiences with 13Cr for mitigating CO_2 corrosion in the oilfield
Case histories: The Gulf of Mexico and inland gas wells",
Corrosion 95, paper No.639 (1995)

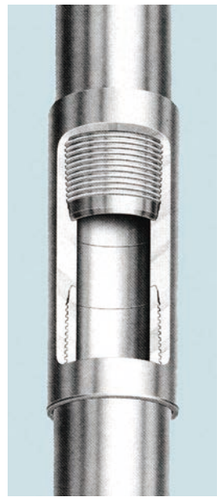
FEATURES OF PREMIUM CONNECTIONS

VAM®21



- Newly patented sealing system with 14° tapered metal to metal seal including VAM stabilizerTM provides gall free gas tightness which is as strong as pipe body, even under the most severe condition such as High pressure and High temperature well as true tubing application in casing sizes (9 5/8"-13 3/8").
- VAM stabilizerTM composes double taper guides for good make up condition, reverse angle torque shoulder and extended lip which can sustain most severe collapse and compression load and results in superior sealing performance and structural resistance under severe combined load condition.
- Innovative thread form with cylindrical crest and root for stable stabbing, no-cross threading and self alignment can be obtained. Hooked thread design increase resistance to jumping out and decrease hoop stress on coupling under higher bending and tension/ compression, making this connection suitable for application in long deviated or horizontal well.
- A fully cleared internal profile with tight tolerance minimizes gas flow turbulence, no interference with well bore operations and no invitation to wear.
- Special coupling with 80% and 90% tensile efficiency are available.

VAM®TOP



- Newly patented sealing system with 20° or 14° tapered metal-to-metal seal provides gall-free gas-tightness which maintains their integrity, even under the most severe condition as true tubing application in casing sizes (23/8"~14").
- Hooked thread design increases resistance to jumping-out and decrease hoop stress on coupling under higher bending and tension/ compression, making this connection suitable for application in long deviated or horizontal well.
- Reverse angle torque shoulder results in superior sealing performance and structural resistance under severe combined load condition.
- Streamlined internal profile with tight tolerance minimize gas flow turbulance.
- High compression version (VAM TOP HC) is available.
- High torque version (VAM TOP HT) provides reinforced torque capacity for liner application where high torque is anticipated.
- Special coupling with 80% and 90% tensile efficiency are available.

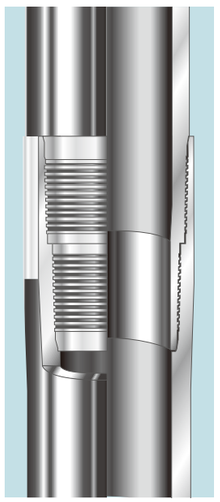
DINO VAM®

- A make-up arrestor positions the coupling accurately on the mill end.
- Pin to pin torque shoulder for positive torque stop on the field end allows overtorque and compression resistance.
- Modified hook thread profile, with -9°reverse angle on the load flank and +20°on the stabbing flank which provides superior load carrying performances.
- Increased thread taper, combined with a wider thread profile which allows deep stabbing with no cross-threading.
- Increased thread pitch to reduce make-up time.
- Jump-out free.
- Special thread design to offer superior thread sealing performances.
- Vanishing threads, fully covered.
- 100% tensile efficiency for all sizes with standard API Buttress OD.
- Pins shoulder, thereby providing a smooth bore ID to minimize turbulence and energy losses.
- Pins shoulder, thereby providing high compression resistance and immunity to jump-in.

VAM®HW ST

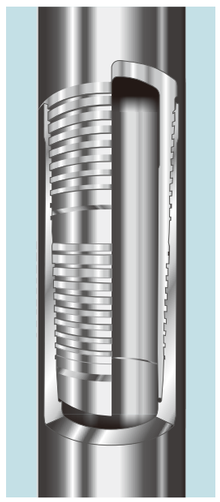
- Ideally suited to controlled-yield material
- T&C design for controlled-yield material with no cold working or upsetting that could alter metallurgy.
- Self energizing metal-to-metal seal with 50% taper provides pressure integrity to API minimum-yield.
- Tensile efficiency equals 100%
- Hook threads with 3°reverse angle and proper thread length prevent jump-out under tension or bending, and reduce tensile hoop stresses.
- Smooth bore for turbulence-free flow. The VAM HW ST is the ideal connection for extra-heavy casing application.

VAM® SLIJ-II



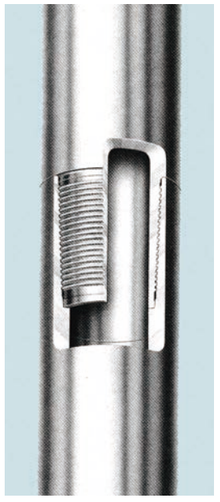
- Optimized clearance with 70% to 80% tension efficiencies of the pipe body yield.
- Combination of internal and external seals provides pressure ratings equal or greater than pipe body ratings.
- Excellent compression ratings of 70% of joint strength by 90 degree middle torque shoulder and thread form.
- User friendly, deep stab, withstand severe excess of thread compound.
- The negative 10 degree hooked thread locks the connection and prevent jump-out under high tension.

VAM® HTF



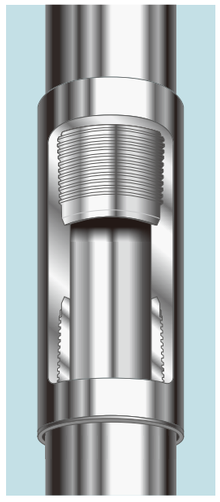
- The extreme high torque strength permits pipe rotation in deviated wells without structural failure.
- The connection OD and ID are 100% flush to the pipe body provides maximum clearance.
- Combination of internal and external seals provides pressure ratings equal or greater than pipe body ratings.

VAM® FJL



- 15°hooked thread for optimal load transmission and resistance to “jump out.”
- Independent metal-to-metal multi-seal arrangement for excellent gas-tight performance with burst and collapse pressure ratings equivalent to the pipe body.
- External torque shoulder for easy running.

VAM® TOP HC



- Based on the same concept of VAMTOP sealing system, thread profile and torque shoulder shape, VAMTOP HC maintain high performance meeting to ISO13679 Class 4 application
- The torque shoulder dimension of VAMTOPHC is significantly larger than VAMTOP and with a mixture of reduced torque, this enables the connection to withstand extreme compression. VAMTOPHC is 100% compression connection rating with 100% VME ellipse.
- Special clearance/special bevel of VAMTOP HC is consulted case by case.
- Size availability is from 4-1/2” to 7-3/4”.
- 4-1/2” VAMTOPHC is not compatible with 4-1/2” VAMTOP connection.

MATERIAL AND CONNECTION DESIGN

CUSTOMER

Well Information

- Well Condition
- Well Operation
- Running Condition

NIPPON STEEL

Material Selection

SEARCH DATABASE
- Application Records
- Failure Records
- Expert System

ECONOMICAL EVALUATION
- Analysis Profitability of Selected Material

String Design

STRESS ANALYSIS
- Under Anticipated Load Conditions

Connection Design

CAD SYSTEM
FEM ANALYSIS
PHYSICAL TESTS
- Make & Break Tests
- Leak Resistance Evaluation Test
- Thermal Cycle Tests
- Measurment of the Stress
- Failure Tests
- Fatigue Tests

Material Design & Evaluation

MATERIAL EVALUATION
- Evaluation under Simulated Well Condition
  - ・Production
  - ・Acidizing
  - ・Completion, Packer Fluids
- Material Combination with DHE

NEW MATERIAL DESIGN

API AND NIPPON STEEL PROPRIETRY STEEL GRADES COLOR CODE CHART

Strength \ Application	API	High Collapse	Sour Service	High Collapse and Sour Service		Low Temperature	Deep Well	Martensitic Stainless Steel	Duplex Stainless Steel	Austenitic Stainless Steel
55 ksi	J55 Tubing J55 Casing K55									
80 ksi	N80Q L80-1 L80 13Cr	SM-80T	SM-80XS (D)	SM-80TXS (D)		SM-80L SM-80LL		SM13CR-80 SM13CRI-80		
85 ksi								SM13CR-85		
90 ksi	C90-1		SM-90XS (D)	SM-90TXS (D)						
95 ksi	R95 T95-1	SM-95T SM-95TT	SM-95XS (D)	SM-95TXS (D)		SM-95L SM-95LL		SM13CR-95 SM13CRM-95 SM13CRS-95 SM13CRS-95 (ISO 13680)		
110 ksi	P110 C110	SM-110T SM-95TT	SM-110ES SM-110XS (D)	SM-110TES SM-110TXS (D)		SM-110L SM-110LL		SM13CRI-110 SM13CRM-110 SM13CRS-110 SM13CRS-110 (ISO 13680)	SM22CR-110 (ISO 13680) SM25CR-110 (ISO 13680)	SM2535-110 (ISO 13680) SM2242-110 (ISO 13680) SM2035-110 (ISO 13680) SM2550-110 (ISO 13680) SM2050-110 (ISO 13680) SMC276-110 (ISO 13680)
125 ksi	Q125-1	SM-125TT	SM-125S SM-125ES	SM-125TES					SM22CR-125 (ISO 13680) SM25CR-125 (ISO 13680) SM25CRW-125 (ISO 13680)	SM2535-125 (ISO 13680) SM2242-125 (ISO 13680) SM2035-125 (ISO 13680) SM2550-125 (ISO 13680) SM2050-125 (ISO 13680) SMC276-125 (ISO 13680)
130 ksi							SM-130G SM-130CY			
140 ksi							SM-140G			SM2535-140 (ISO 13680) SMC276-140 (ISO 13680)

Color identification shall be applied on either coupling or pipe body at manufacture's option in accordance with above instruction.

Note : These materials may be supplied without color coding to avoide chrolide contamination.

INQUIRY AND/OR ORDER DETAIL

You are requested to specify your conditions for the following items on your order sheet.

Applicable specification, grade and type:
(Ex.) Nippon Steel SM-95XS
Nippon Steel SM-95T
Nippon Steel SM2535-110
Type of pipe : Casing or Tubing
Type of ends : Threaded or Plain End
Round (Short, Long), Buttress (casing) or Premium joint; VAM TOP, VAM TOP HC, VAM TOP HT or DINO VAM (casing or tubing)
Size (outside diameter)
Weight per foot or wall thickness
Range length (Range-1, 2, 3)

Quantity
Delivery date, shipping instructions and requirements of mill inspection.
If you have any special requirements, please specify the details accordingly.

Hydrostatic test pressure
Non-destructive inspection
Type of joint (other than regular coupling)
Special clearance coupling (same or higher grade)
Special bevelled coupling
Special designed joints
(VAM TOP, VAM TOP HC, VAM TOP HT, VAMFJL, VAM HWST, DINO VAM)
Coupling make-up (other than regular power tight):
Torque turn device or hand tight
Special drift or alternative drift (API 5CT)

(EXAMPLE)

ABC CO 1234-90

Specification : Nippon Steel SM2535-110
Type of pipe : Tubing
Type of end : VAM TOP
Size. weight : 3-1/2” * 9.2# Range 2
Quantity : 12000ft
Delivery : xxx.xxx.xxx on site shipping mark as per attached sheet
Mill inspection : Mill final inspection (No third party inspection)