



MarineCop™

(Cargo Oil Pipes)
1%-Cr Containing Steel Pipes for Crude Oil Tankers



JFE Steel Corporation

INTRODUCTION

In response to the needs of shipbuilders and operators of crude oil tankers, JFE Steel has developed MarineCop™ (Cargo Oil Pipe), a TMCP-type 1%-chrome containing steel pipe with excellent weldability, corrosion resistance, and abrasion resistance.

This product manufactured based on years of experienced technologies and complete quality control of JFE Steel, demonstrates excellent corrosion resistance even in severe conditions under crude-oil sludge.

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FEATURES AND CHARACTERISTICS

JFE Steel revolutionized cargo oil piping for crude oil tankers

● No Coating, Ease to Fabrication

- No coating makes it possible to use welding-sleeve couplings and on-site welding during fabrication.
- No damage to coating films reduces the maintenance cost.
- Excellent corrosion resistance can be maintained even without coating.

● Shortened Fabrication Time

- Number of girth welds can be decreased by applying long pipes. Excellent weldability reduces cost.

● Easier On-site Welding, Superior Weldability

- Excellent weldability based on low C content, low Pcm assured by JFE Steel's integrated steel manufacture process best suit to your girth welding without pre-heating.

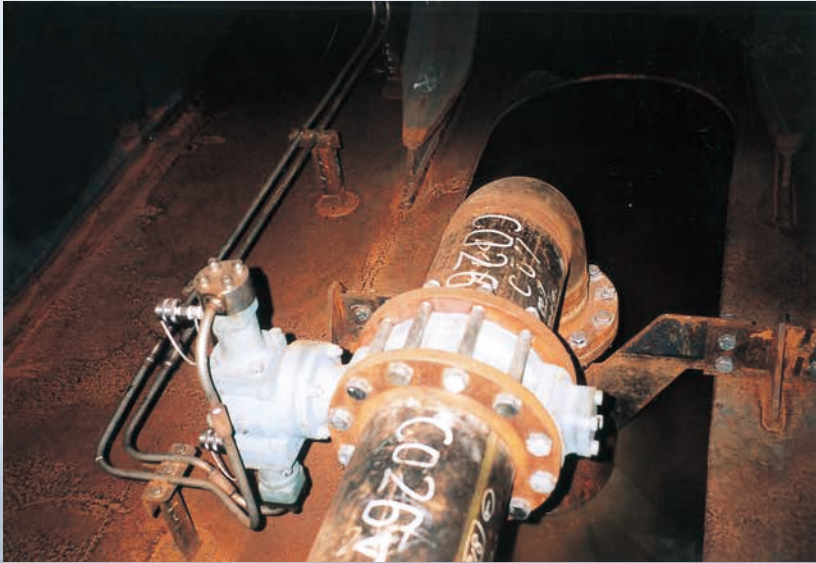
● Excellent Resistance to Corrosion and Corrosive Abrasion, and Excellent Quality

- Clean steel of low S, low P, and low C provides superior corrosion and corrosive-abrasion resistance to crude oil and sea-water.

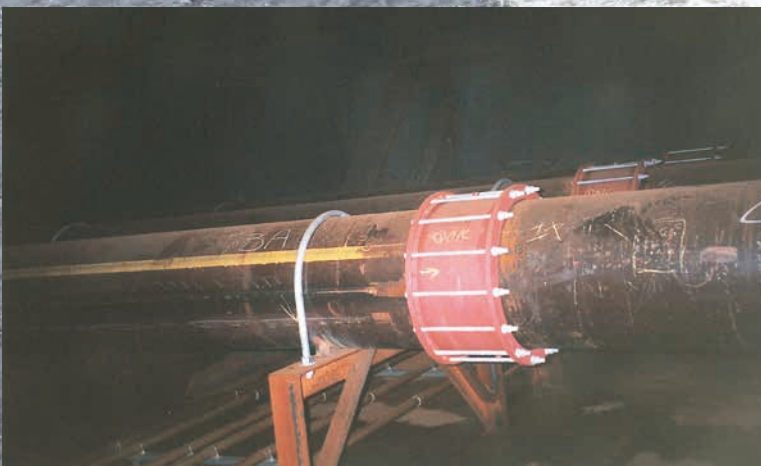
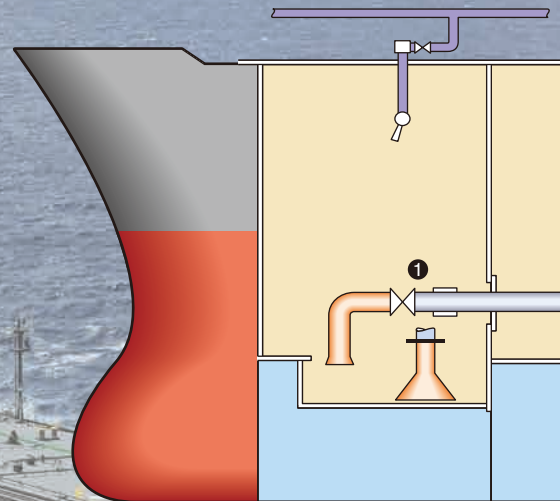
● Wide Available Size Range

- With a wide availability of sizes to choose from, MarineCop™ allows optimum selection of outside diameter (including odd size), wall thickness and length to best meet customers' requirement.

TYPICAL APPLICATIONS



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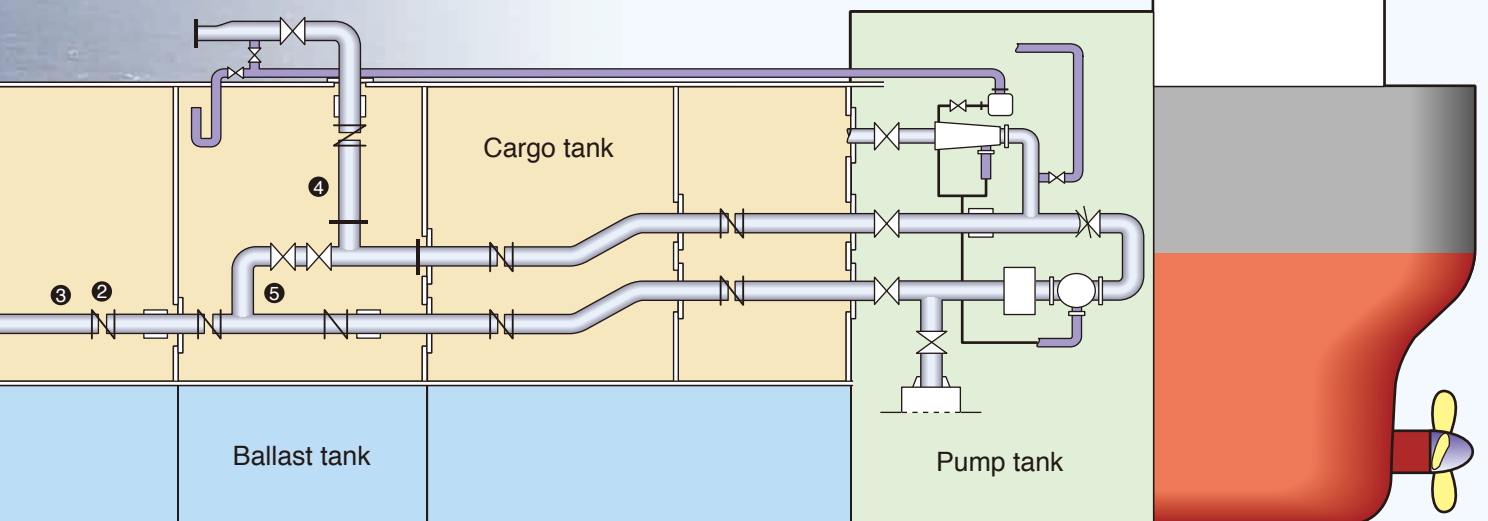
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③



④



⑤

TYPICAL APPLICATIONS

- ①: Piping in the cargo tank
- ②: Piping in the cargo tank
- ③: Piping in the cargo tank
- ④: Loading line piping in the cargo tank
- ⑤: Main suction line piping in the cargo tank

SPECIFICATIONS OF MarineCop™



● Comparison of Performances

Addition of 1% chromium increases material hardness and provides excellent resistance to corrosive abrasion by crude-oil sludge.

Comparison of Performances

Product type Performance	STPY400	Cast Steel Pipe (1%Cr)	MarineCop™
Seawater Corrosion Resistance	△	○	◎
Corrosive-abrasion Resistance	△	◎	◎
On-site Weldability	◎	△	◎

◎ : Excellent
○ : Good
△ : Fair

Note: All comparisons were made without coating.

● Specification

Chemical Composition (standard)

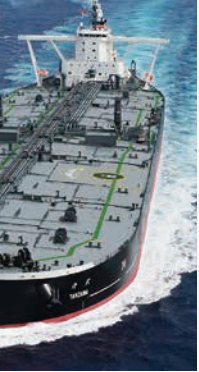
(Unit: WT%)

Trade Name	C	Si	Mn	P	S	Cr
MarineCop™	≤0.08	≤0.55	0.9 – 1.2	≤0.030	≤0.005	0.80 – 1.30

Mechanical Properties

Trade Name	Tensile Strength N/mm ²	Yield Strength N/mm ²	Elongation %*1)
MarineCop™	≥400	≥245	≥18

*1) Elongation shall be evaluated by using the No.5 test piece in JIS Z 2241.



SIZE AVAILABILITY

● Available size range of MarineCop™

JFE Steel can supply a wide range of sizes to satisfy customer needs.

Nominal Size A/B		Outside Diameter (mm)	Thickness (mm)													
JIS A	JIS B		0.0	2	4	6	8	10	12	14	16	18	20	22	24	26
65	2 1/2	76.3	<div>ERW Pipe: Max. Length 14.0 m</div>													
80	3	89.1														
100	4	114.3														
125	5	139.8														
150	6	165.2														
200	8	216.3	<div>ERW Pipe: Max. Length 18.3 m</div>													
250	10	267.4														
300	12	318.5														
350	14	355.6														
400	16	406.4														
450	18	457.2	<div>UOE Pipe: Max. Length 18.3 m</div>													
500	20	508.0														
550	22	558.8														
600	24	609.6														
650	26	660.4														
700	28	711.2														
750	30	762.0														
800	32	812.8														
850	34	863.6														
900	36	914.4														
950	38	965.2														
1000	40	1016.0														

ERW Pipe:
Max. Length 14.0 m

ERW Pipe:
Max. Length 18.3 m

UOE Pipe: Max. Length 18.3 m

MANUFACTURING PROCESSES



● Electric Resistance Welding Steel Pipe

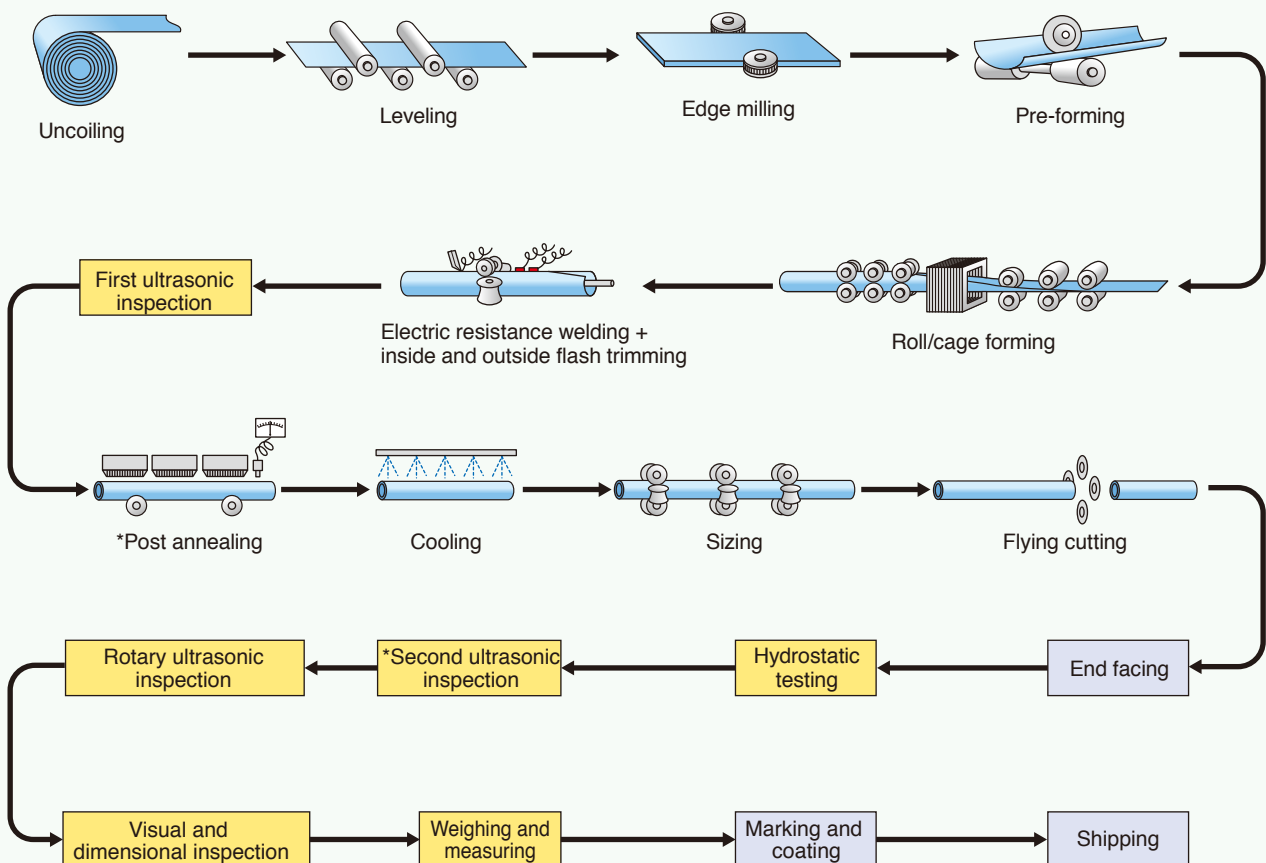
Steel strip in coil, which has been slit into the required width from wide strip, is formed by a series of forming rolls into a shell. The longitudinal edges are continuously welded by high frequency resistance/induction welding.

The weld of the shell is then electrically heat treated, sized, and cut to specified lengths by a flying cut-off machine. The cut pipe is straightened and squared at both ends. Ultrasonic inspection or hydrostatic testing is conducted before shipping.

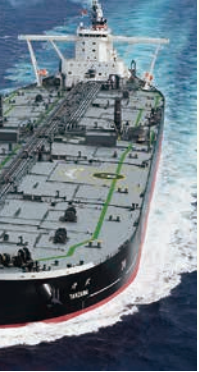


High frequency resistance welder

Manufacturing Process (24" ERW Mill in East Japan Works/Keihin)



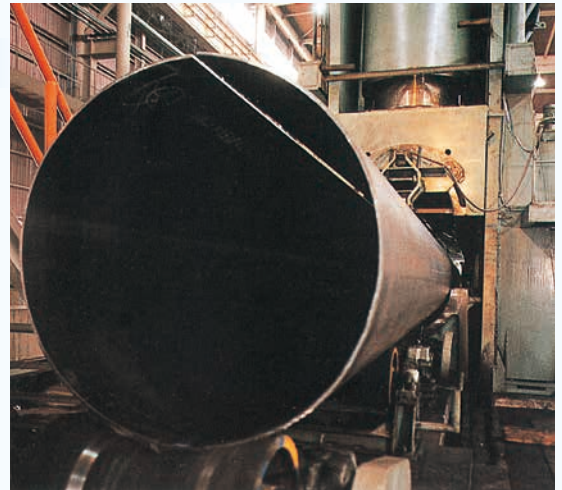
Note: Processes marked by an asterisk are conducted according to specification and/or customer requirements. Highlighted in yellow are inspection processes.



● UOE Steel Pipe

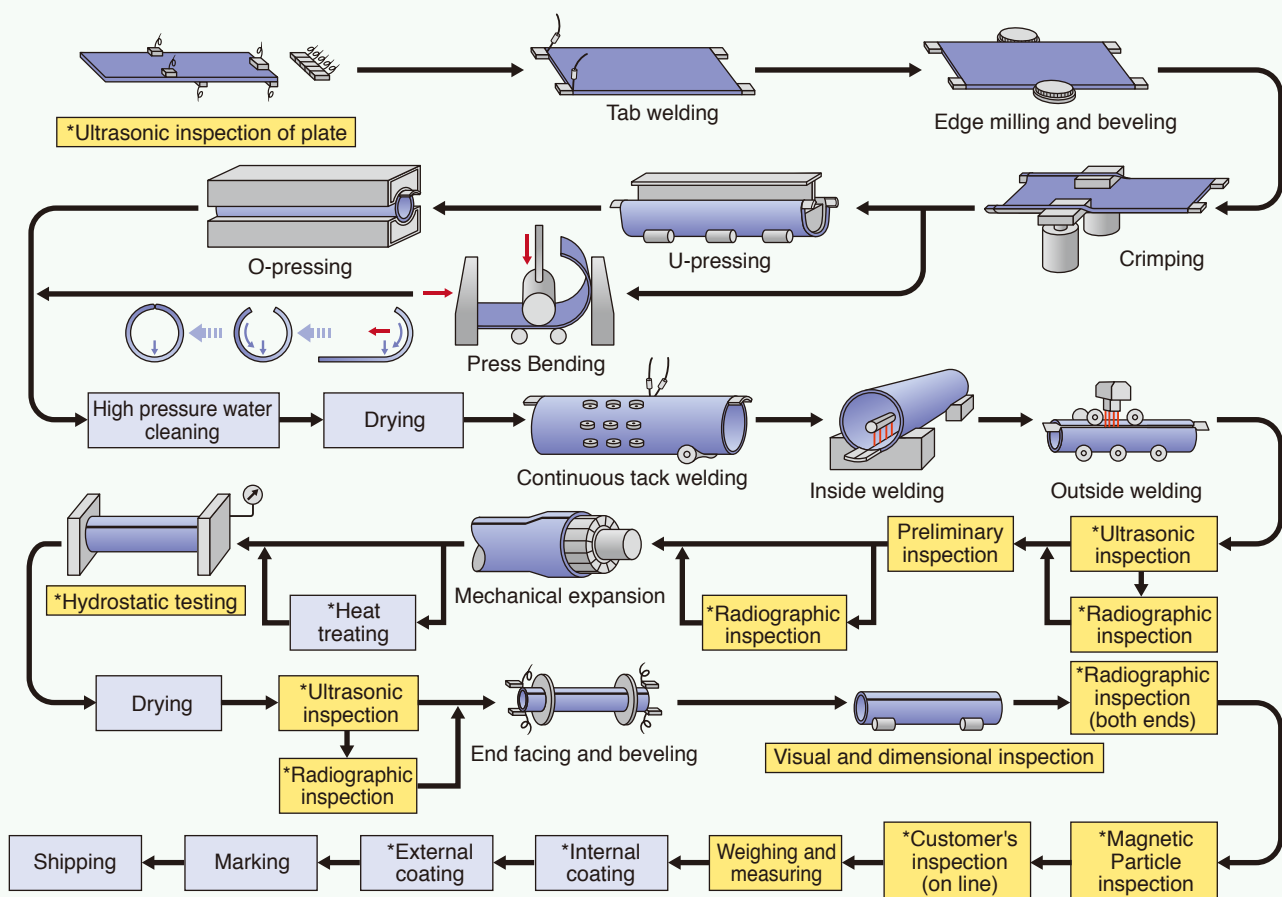
UOE mill at West Japan Works (Fukuyama) uses heavy and medium plates. Both longitudinal edges of the plates are trimmed and beveled before forming, by the two-step process; first into a U-shape and then an O-shape.

O-shaped plates are given a tentative tack weld before finally being seam-welded from both inside and outside by submerged arc welding. Welded pipes are subjected to mechanical expansion to the final dimension and sent to finishing and inspection processes. Finished pipes are subjected to visual and dimensional inspection, and non-destructive testing such as ultrasonic inspection.



O Press

Manufacturing Process



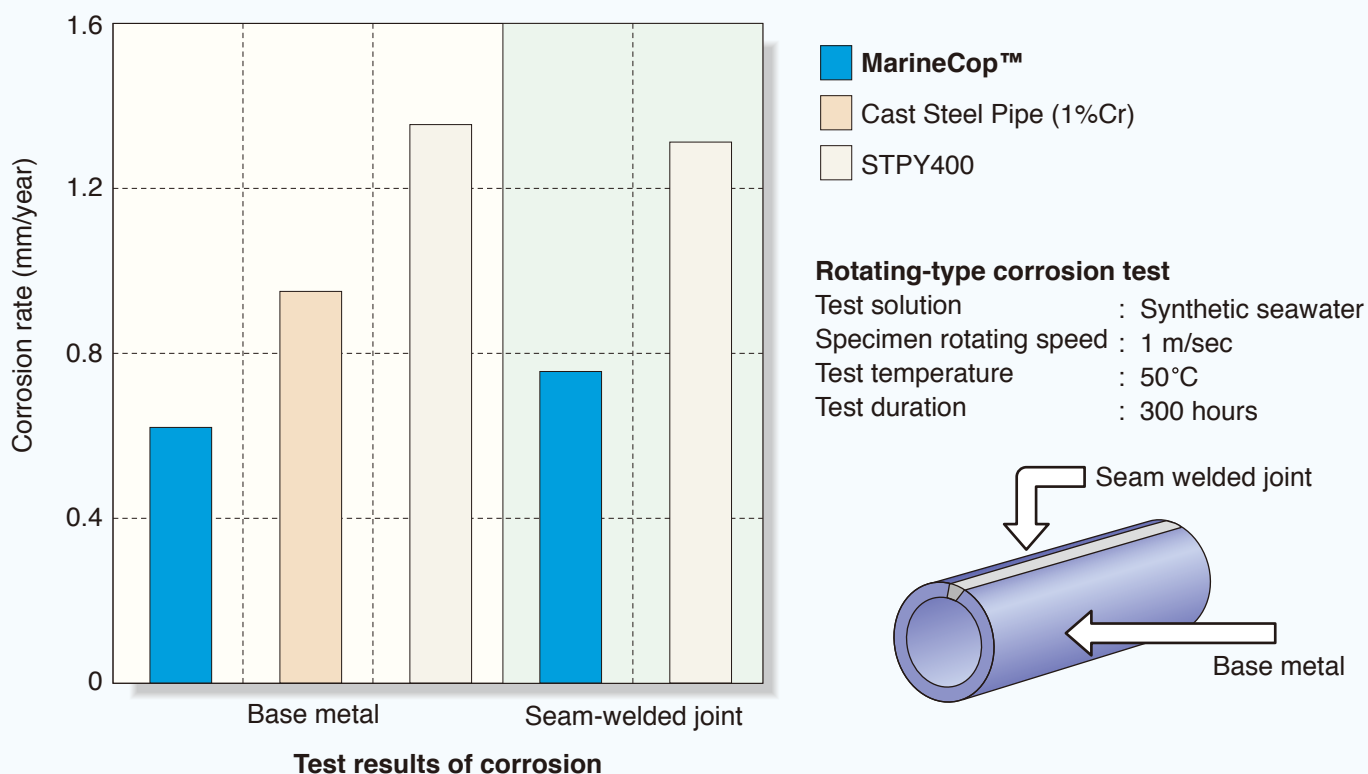
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PERFORMANCE OF MarineCop™



● Corrosion Resistance in Seawater

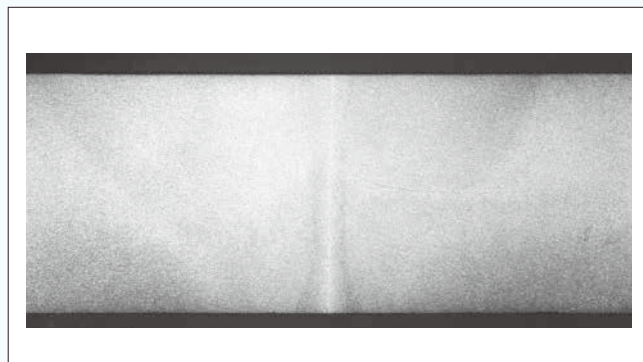
MarineCop™ has far superior corrosion resistance in sea water than the other steel pipes.



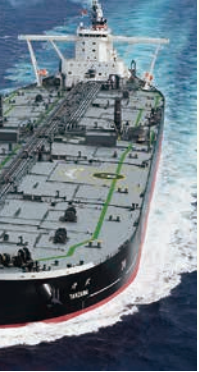
Seam-welded joints have corrosion resistance similar to base metal, showing no selective corrosion.



Macro-structure of cross-section of UOE steel pipe after corrosion test



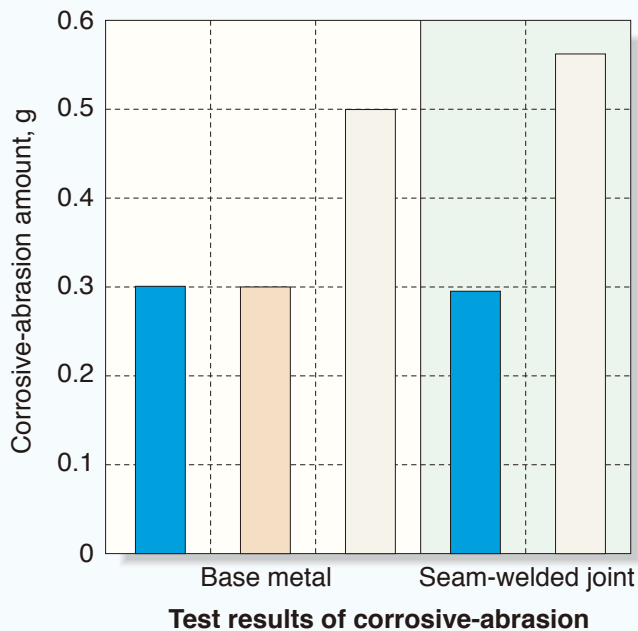
Macro-structure of cross-section of ERW steel pipe after corrosion test



● Corrosive-abrasion Resistance in Seawater

■ Abrasion in Seawater Containing Silica Sand

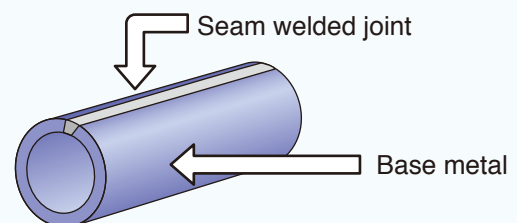
Base metals of MarineCop™ and 1%-Cr cast steel pipe have approximately same corrosion rate, while STPY shows nearly twice as much corrosion rate.



■ MarineCop™
■ Cast Steel Pipe (1%Cr)
■ STPY400

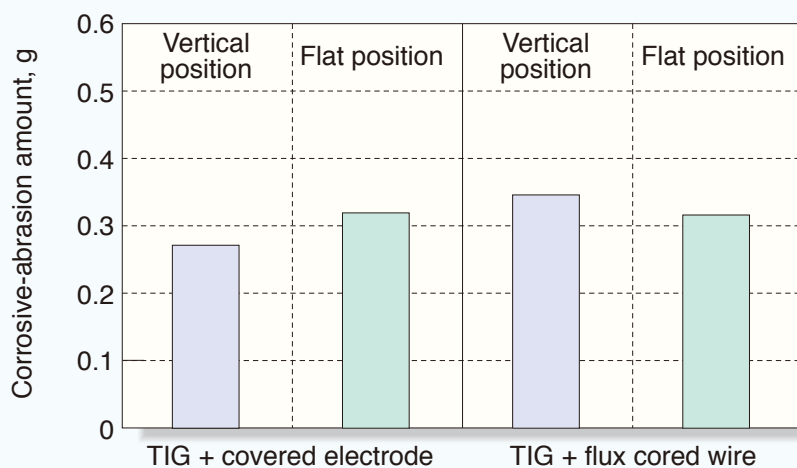
Rotating-type corrosive-abrasion test

Test solution : Synthetic seawater + silica sand
 Specimen rotating speed : 1 m/sec
 Test temperature : 50°C
 Test duration : 24 hours

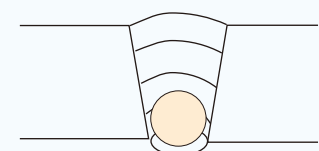


■ Quality difference by welding position

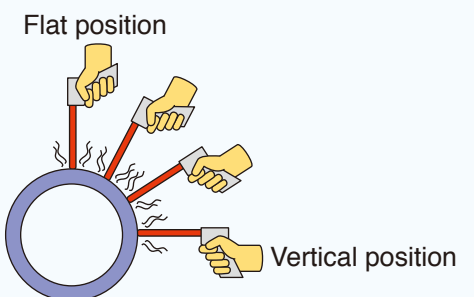
Performance of welded joints are the same regardless of welding positions.



Test results of corrosive-abrasion circumferentially welded joint



Location of the test piece



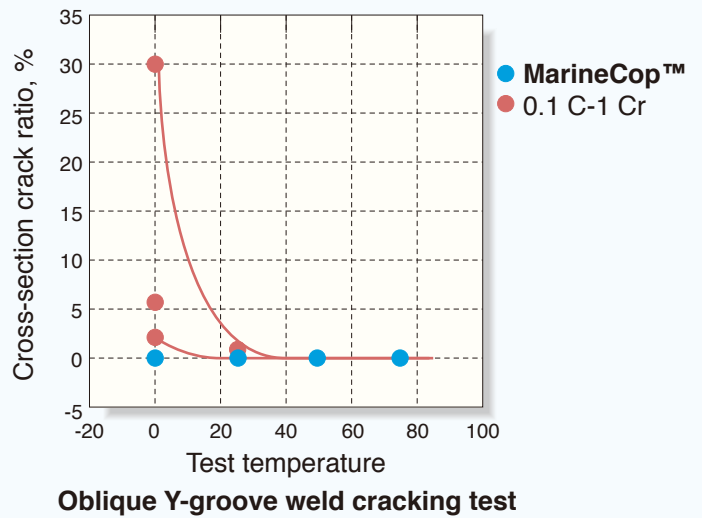
Position of welding



● Weldability

MarineCop™, with minimum carbon content, has excellent mechanical properties of the heat-affected zone (HAZ) such as less hardening and excellent resistance to low-temperature cracking, which make welding possible under the same conditions as STPY.

■ On-site weldability:



■ Welding consumables

Chemical composition of welding consumables

(Unit : WT%)

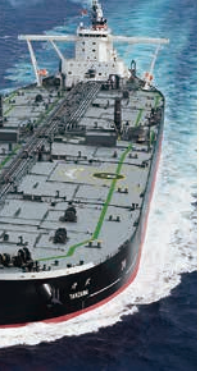
Type	Trade name	Example of chemical composition				
		C	Si	Mn	Cr	Other elements
Covered electrode	LB-O52K	0.05	0.51	0.65	1.18	P, S, Cu, Ni
Flux cored wire	DW-O52K	0.03	0.50	1.12	1.15	
TIG welding electrode	TG-S52K	0.08	0.77	1.48	1.10	

Note: Trade names are for KOBELCO products.

■ Examples of welding conditions

Examples of circumferential welding of pipe

Shape of groove	Pass	Welding method	Wire electrode	Pre-heating	Welding current (A)	Arc voltage (V)	Welding Speed (cm/min)	Shield gas
	1	TIG	TG-S52K φ2.4 mm	not	120	14	25	100% Ar 20 – 25 l/min.
	2	TIG		not	180	20	200	
	3	MAG	DW-O52K φ1.2 mm	not	180	24	200	100%CO ₂ 20 – 25 l/min.
	4	MAG		not	260	31	280	
	5	MAG		not	260	31	190	

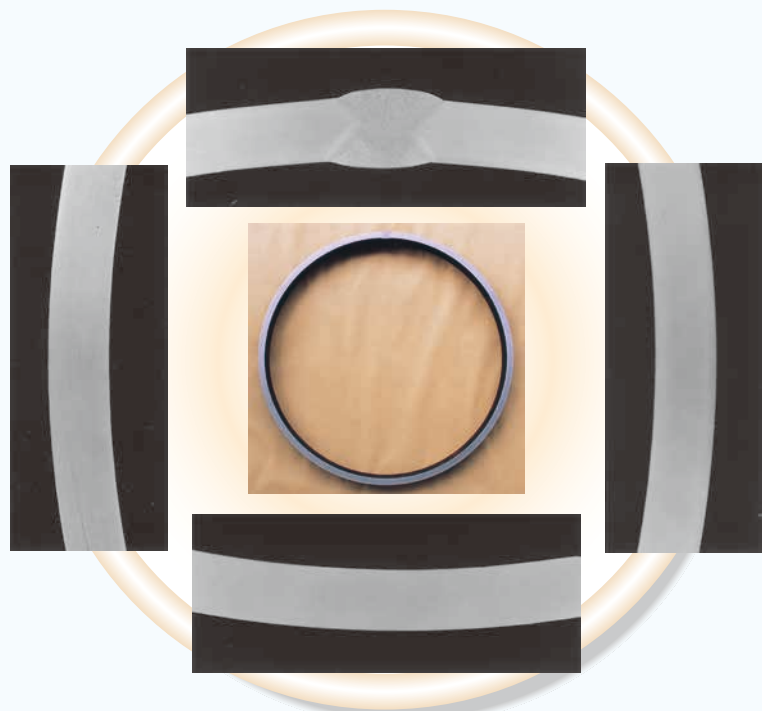


● Corrosion on Cargo Oil Pipes for Crude Oil Tankers

The state of corrosion on MarineCop™ after served in a crude oil tanker is shown below;
(Test period: 1995-1998, Ship name: BENETIA, Pipe tested : ϕ 550A \times 15.0t)

■ State of corrosion:

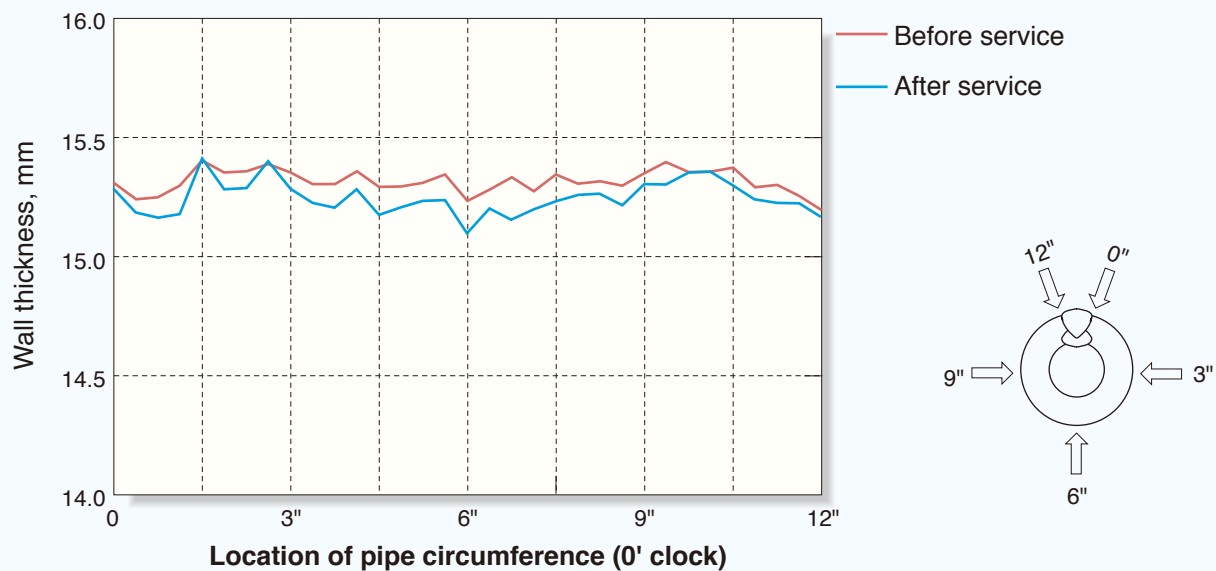
As shown by the macro-structures of cross-sections, neither welded zone nor base metal has selective corrosion.



Macro-structure of cross-section

■ State of corrosive abrasion

As shown below, there is no significant reduction in wall thickness due to corrosive abrasion after actual service.





● Results of Investigation of Corrosion on Cargo Oil Pipes for Crude Oil Carriers

■ Outline of investigated ship

Very large crude oil carrier (VLCC)
 Year of completion: 2002
 DWT: approx. 300,000 MT
 Investigation timing: After 17.5 years

■ Outline of investigated steel pipes

Cargo oil pipes: Piping in cargo oil tank (COT)
 OD762.0 mm × t16 mm
 Piping on deck
 OD660.4 mm × t13 mm

■ Investigation method

- Visual inspection of inside and outside of steel pipes
- Ultrasonic test of pipe wall thickness
 (12 points in circumferential direction at 5 m intervals
 + 4 points in circumferential direction at 1 m intervals)

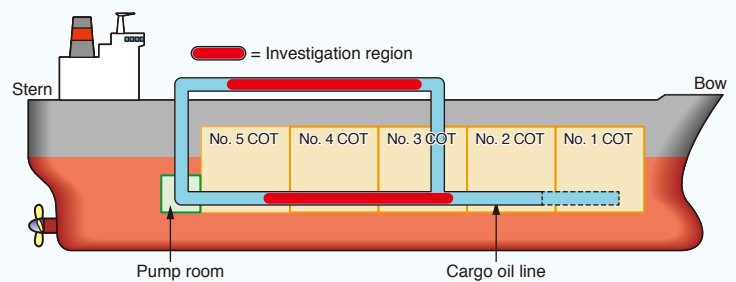


Fig. Schematic diagram of side view of investigated ship

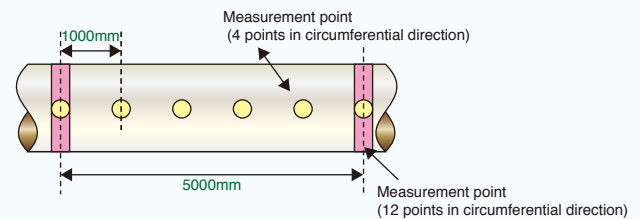


Fig. Intervals of pipe wall thickness measurements

■ Investigation results ① Piping in cargo oil tank (COT) (17.5 years in service)



External appearance
 (17.5 years in service)



Inside surface of cargo oil pipe
 (15 years in service)



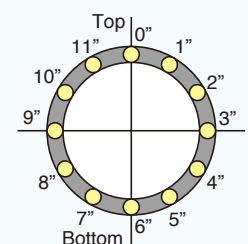
Inside surface of cargo oil pipe
 (17.5 years in service)

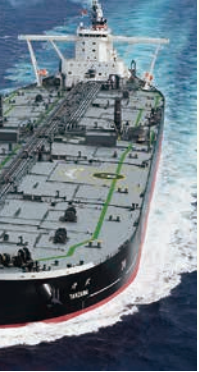
* In total investigated pipe length of 102 m, only 23 spots with pitting corrosion were detected (depth: 1.0 mm to 3.5 mm; in all cases, the level of corrosion did not require repair).

Results of ultrasonic test of pipe wall thickness (average)

Measurement position	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
Remaining thickness (mm)	15.4	15.5	15.4	15.4	15.5	15.5	15.4	15.5	15.4	15.4	15.4	15.4

Average remaining thickness= 15.5 mm (initial thickness in specification: 16.0 mm)





■ Investigation results ② Deck piping (17.5 years in service)



External appearance
(17.5 years in service)



Inside surface of cargo oil pipe
(15 years in service)



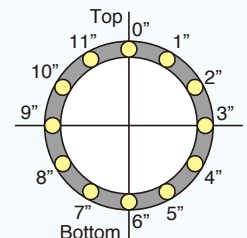
Inside surface of cargo oil pipe
(17.5 years in service)

*In total investigated pipe length of 156 m, only 3 spots with pitting corrosion were detected (depth: 1.0 mm to 2.0 mm; in this case, the level of corrosion did not require repair).

Results of ultrasonic test of pipe wall thickness (average)

Measurement position	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
Remaining thickness (mm)	12.3	12.5	12.4	12.4	12.4	12.4	12.3	12.4	12.4	12.4	12.4	12.3

Average remaining thickness= 12.5 mm (initial thickness in specification: 13.0 mm)



■ Disclaimer

The technical information contained in this catalogue is intended to show the representative properties and performance of the product and does not mean guaranteed values.

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