Helical Bending

The Evaluation of Helical Bending for Steam Generator in Integral Reactor

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555

(Helical

Type)   Helical Bending   ,   /

Bending

Titanium

Helical Bending Mock-up   Bending

Titanium   Helical Bending   .

Abstract

An integral reactor in comparison with loop reactor is that all of major primary components are placed in reactor vessel. It is necessary of helical bending to be manufactured once-through steam generator in the integral reactor, On the other hand dimensions variation and introduced residual stress of the part of helical bend can be serious problem. We have executed the mock-up test of Titanium tube which is being considered integral steam generator for the sake of detecting the dimension variation and residual stress of bending part. In this paper, we present the bending properties of Titanium tube and applicable possibility in integral steam generator.
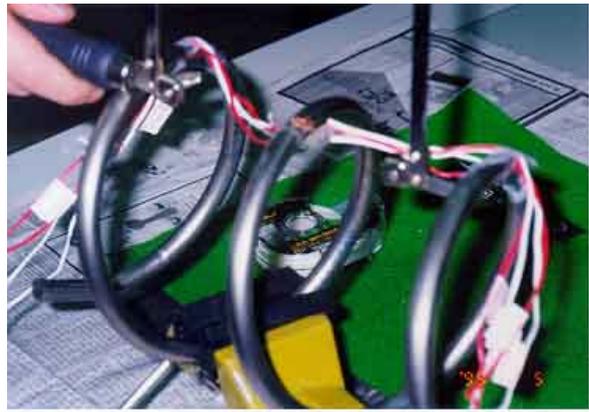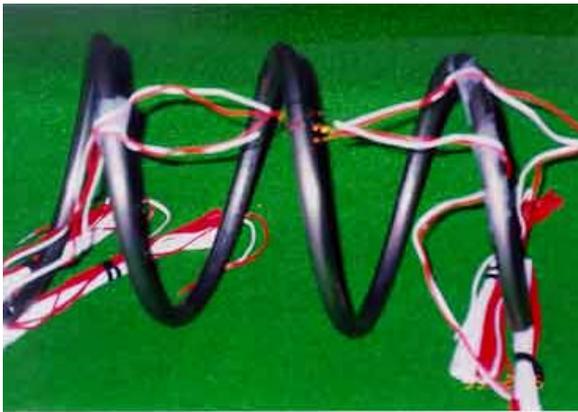
1.

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.

,   330Mw

.   "

"   (Once-through Helical Type)

Helical Bending

Bending

Titanium Helical Bending Mock-up

Bending .

2.

Titanium

(Helical Type) Bending , , /

Bending (Straight) , Bending

Bend Mock-up . , Titanium

Pure Titanium ASTM Grade 2 .
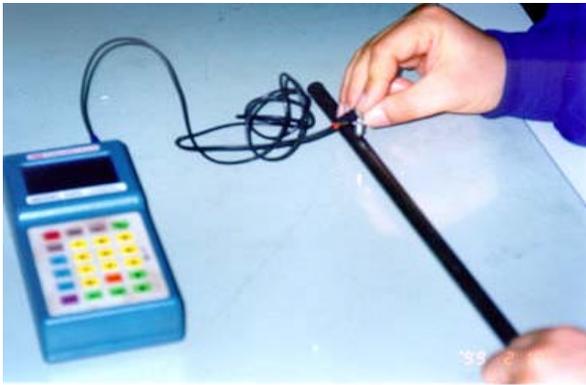
1 UT Thickness Gauge

2 Strain Gauge

3.

3. 1

1 Ti Gr.2 ASTM Spec.

, (O)

.

1							(: wt%)
Ti	Ti	C	Fe	O	N	H	
	Bal.	0.03	0.05	0.09	0.004	0.0027	
ASTM Spec.	Bal.	0.1 Max	0.3 Max	0.25 Max	0.03 Max	0.015	

3. 2

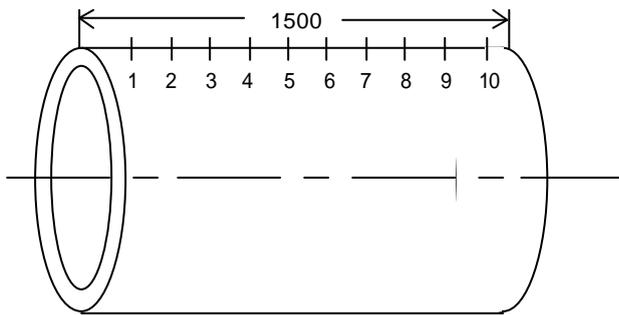2   1   Bending   ,   3

2   Bending Mock-up

3   .

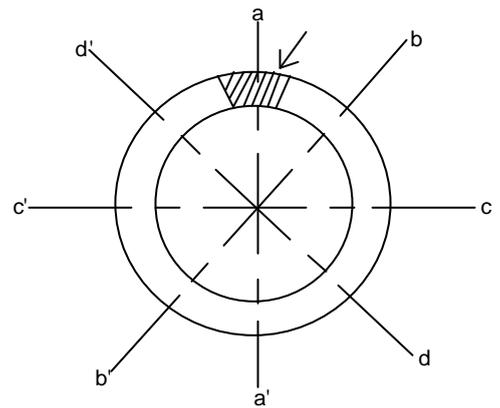2 Bending   (: mm)

Point		1	2	3	4	5	6	7	8	9	10	
	a/a'	12.75	12.72	12.74	12.73	12.75	12.74	12.72	12.74	12.73	12.74	12.73
	b/b'	12.74	12.73	12.73	12.70	12.72	12.71	12.74	12.73	12.74	12.74	12.72
	c/c'	12.72	12.72	12.69	12.67	12.70	12.68	12.68	12.70	12.72	12.71	12.70
	d/d'	12.50	12.52	12.49	12.58	12.55	12.58	12.53	12.48	12.51	12.47	12.52
	a	0.56	0.57	0.57	0.56	0.55	0.56	0.56	0.56	0.58	0.58	0.56
	b	0.52	0.51	0.51	0.52	0.52	0.52	0.53	0.53	0.53	0.51	0.52
	c	0.51	0.50	0.51	0.51	0.51	0.51	0.52	0.52	0.50	0.52	0.51
	d	0.52	0.50	0.52	0.52	0.53	0.51	0.53	0.53	0.52	0.52	0.52

1 Bending
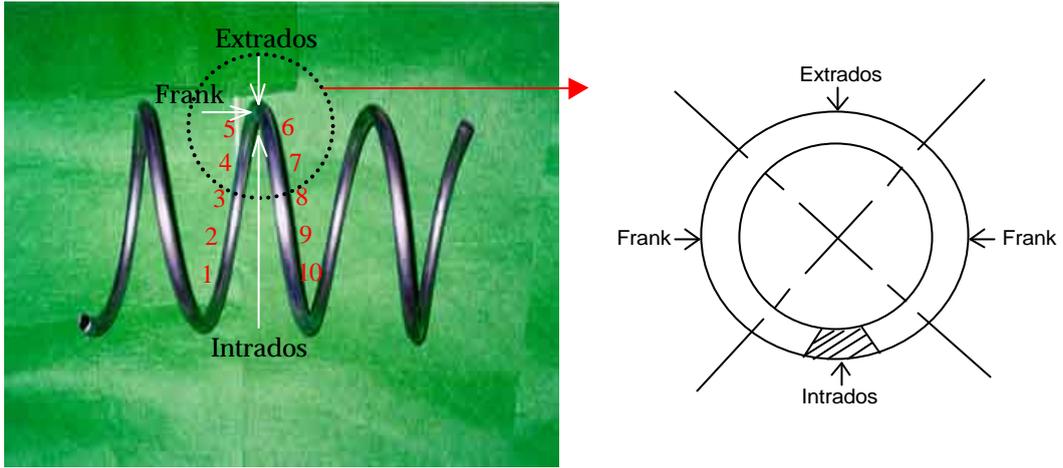
Bending   Bending

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2 Helical Bending Mock-up

3 Helical Bending Mock-up   (: mm)

Point		1	2	3	4	5	6	7	8	9	10	
Extrados ( )		0.51	0.51	0.50	0.52	0.51	0.52	0.50	0.51	0.51	0.51	0.51
Intrados ( )		0.53	0.54	0.54	0.53	0.55	0.55	0.53	0.53	0.54	0.55	0.54
		0.57	0.58	0.58	0.57	0.6	0.57	0.56	0.59	0.59	0.57	0.58
Flank ( )		0.52	0.53	0.53	0.54	0.55	0.54	0.53	0.52	0.53	0.53	0.53
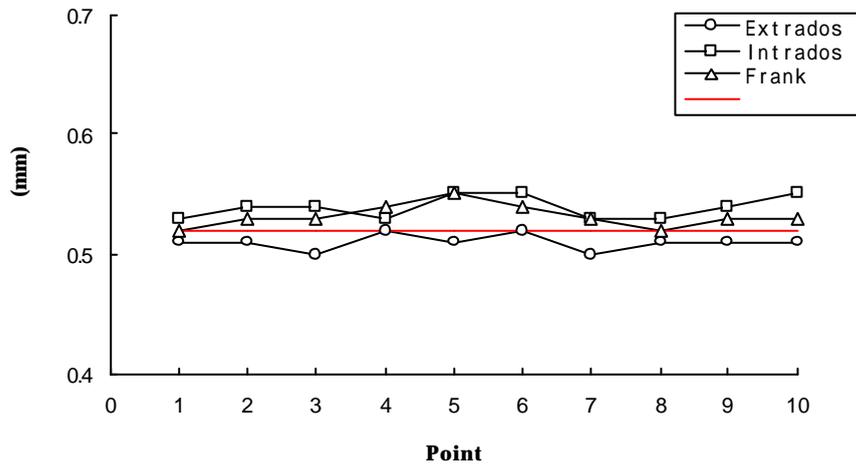
3   Bending

Helical Bend   Intrados(   )   Flank(   )   Bending

, Extrados(   )

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3. 3   /

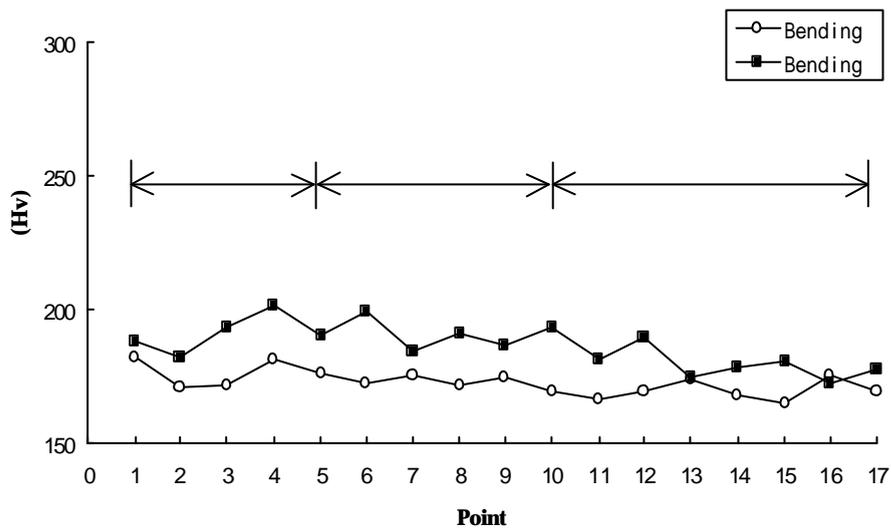　　3　4　Bending　,　　　　　　　　　　　　　　　　　　　Bending
　　　　　　　　　　.　　　　　4　Bending　,　　　　(Microvickers)
　　　　　　　　Helical Bending
　　　　.

3 Bending

4 Helical Bending

4　　　Bending

3. 4

　　5　Helical Bending Mock-up 3　(p, q, r)　　　　　　　　　　　　　　　　　.

Extrados

, Intrados   , Flank

.   Bend   (p, q, r

)   ,

50%   .

5   Bending
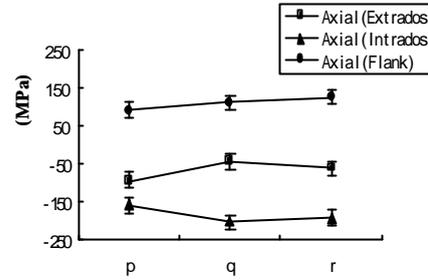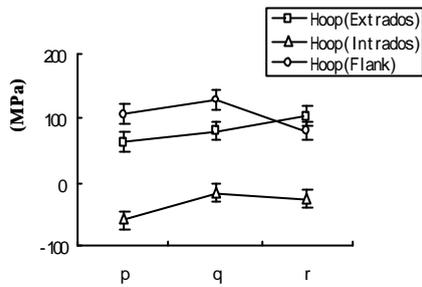
4.

1) Ti Gr.2   Helical Bending   (Wrinkle)   .

2)   Bending   ,   Bending

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3) Bending   ,   ,   (Microvickers)

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4)   Bending   Helical Bend Mock-up   Extrados, Intrados

Flank   , Bend Mock-up

.   Ti Gr.2

50%   .

5.

[1]   , Vol.27, No.2, "   "

[2]   The Boeing Co.   "How to bend titanium tubing"

[3]   Titanium and Titanium Alloys Source Book

[4]   Corrosion-NACE, Vol. 32, No. 9, Sept. 1976, "Residual Stresses in Bent Tubes for Nuclear Steam Generators"

[5]   TMS-AIM Conference Proceeding, 1984, pp. 163-174, "Residual Stress Determination in Inconel-600 Tubes Using Electrochemical Machining"