

यू-ट्यूबों के लिए मानक विनिर्देश

STANDARD SPECIFICATION
FOR
U-TUBES

5	22.09.17	REAFFIRMED AND REISSUED AS STD. SPECN.	SK	KJH	RKT	RN
4.	15.11.11	REVISED AND REISSUED AS STD. SPECN.	KA	RKT	AKM/SC	DM
3	17.02.06	REVISED & REISSUED AS STD. SPECN.	AKM	PK	AKM	VJN
2	01.09.99	REVISED & REISSUED AS STD. SPECN.	AKM	PK	RKA	AS
1	04.05.89	ISSUED AS STANDARD SPECIFICATION	RKA	BSG	VKM	AS
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

Abbreviations:

AI	:	Authorized Inspector
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
EIL	:	Engineers India Limited
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
MD	:	Maximum or minimum outside dimension at bent portion
OD	:	Outside Diameter
TEMA	:	Tubular Exchangers' Manufacturers Association

Static Equipment Standards Committee

Convenor: Mr. R.K. Trivedi

Members: Mr. K.J Hari Narayanan
Mr. P. Bhattacharjee
Mr. Sanjay Mazumdar
Mr. P.P. Pandey
Mr. Nalin Kumar
Mr. K. Anjaneyulu
Mr. Arun Kumar
Mr. Inder Kumar
Mr. Tarun Kumar
Mr. Anish Trehan
Mr. Srikanth Karanam
Mr. M. Azim (Projects)
Mr. S. Ghosal (Process)
Mr. T. Kamalakannan (Inspection)

CONTENTS

1.0	SCOPE.....	4
2.0	CODES.....	4
3.0	MATERIAL.....	4
4.0	MANUFACTURE.....	4
5.0	HEAT TREATMENT.....	5
6.0	INSPECTION & TESTING.....	6

1.0 SCOPE

This specification covers the minimum requirements for materials, manufacture, inspection and testing of U-tubes required for installation in shell and tube heat exchangers.

2.0 CODES AND SPECIFICATION

The following standards/specifications with latest edition shall be used :

ASME Section II Part A & B
ASME Section VIII Division 1
TEMA
IBR, if applicable
EIL Specification No. 6-15-0001

3.0 MATERIAL

3.1 Tubes required for the manufacture of the U-bends shall meet all the requirements of EIL Specification No. 6-15-0001 and the Codes mentioned above.

3.2 Tube thickness specified in the datasheets and/or drawings are minimum before forming.

3.3 Low carbon austenitic stainless steel type 304L, 316L in solution annealed condition or stabilized austenitic stainless steel grades 321, 347, 316 Ti in solution annealed followed by thermal stabilization heat treatment condition shall be used. The use of other austenitic stainless steels type 304, 316, 304H, 316H is not permitted.

4.0 MANUFACTURE

4.1 All U-tubes shall be formed from a continuous length of tubing, free of girth welds.

4.2 The minimum mean radius of U-bends of tubes shall be 2 times the OD of the tube, unless specified otherwise.

4.3 U-tubes shall be manufactured only from seamless tubes. Welded tubes shall not be used.

4.4 All U-bends shall be cold formed.

4.5 Thinning

Thinning of tubes after bending shall be as per TEMA. One tube for each material and size shall be bent to the specified minimum radius and cross sectional thickness measured at 4 points i.e. 0°, 30°, 60° & 90° from tangent line of U-bend.

4.6 Flattening

4.6.1 Flattening after bending shall be within the range given below unless approved otherwise:

Minimum radius of bend	Flattening
Up to 2 x OD	± 10%
Greater than 2 x OD	± 5%

4.6.2 Flattening shall be calculated as below:

$$\% \text{ Flattening} = \frac{MD - OD}{OD} \times 100$$

4.7 Centre to Centre Distance

Centre to centre distance shall be measured at the tangent line of the U bend and shall have the following tolerances:

Bend Radius	Tolerance (mm)
R < 5 x OD	± 1.0
R ≥ 5 x OD	± 1.5

4.8 The bent portion shall be substantially uniform in curvature and shall not exceed ± 1.5 mm of nominal centre line radius.

4.9 Permissible deviation from the plane of bend shall not exceed 1.5 mm as measured from the point of tangency.

5.0 HEAT TREATMENT

5.1 Killed Carbon Steel, Low Temperature Carbon Steel, 3½% Ni, Low Alloy Steel U-tubes up to 5 times tube OD bend radius shall be stress relieved after bending over U-tube plus 300 mm (min) beyond the point of tangency.

5.2 U tubes up to 5 times tube OD bend radius shall be subjected to solution annealing heat treatment after bending over U- tube plus 300 mm (min.) beyond the point of tangency for low carbon austenitic stainless steel types 304L, 316L or stabilized grades austenitic stainless steel type 321, 347, 316Ti. .

5.3 For copper and copper alloys, U-tubes shall be stress-relief annealed after bending over U bend plus 300 mm on each straight length beyond the point of tangency, irrespective of bend radii.

5.4 For nickel and nickel alloys and titanium and titanium alloys, U- tubes shall be heat treated if it is specified in the datasheets/ drawings. The heat treatment procedure for U-tubes shall be agreed with the consultant/owner.

5.5 For duplex stainless steel and super duplex stainless steel tubes heat treatment shall be done only if specified in the data sheets/drawings.

5.6 For ferritic stainless steel and martensitic stainless steel, U-tubes shall be stress relieved only if specified in datasheet/drawings. Stress relieving, if applicable shall be carried out, on the U-bend plus 300 mm (minimum) beyond the point of tangency.

5.7 Tube bending lubricants, oil, grease, etc., shall be removed from U-bends before stress relieving. Internal surfaces of austenitic stainless steel tubes above mentioned shall be checked for cleanliness by blowing close fitting acetone soaked felt plugs. Dry, oil free air or nitrogen shall be used for blowing the plugs. If plugs show more than a light gray discoloration, the tubes shall be recleaned and retested.

5.8 Temperature during heat treatment shall be controlled through the use of optical pyrometers or emission pyrometers or both. Temperature indicating crayons, lacquers or pellets shall not be used.

5.9 Methods for Heat Treatment

5.9.1 Electric Resistance Heat Treatment

- 5.9.1.1 Heat treatment by electric resistance heat treatment is acceptable for most materials except ferritic and martensitic SS and chrome-moly steels, and is always recommended for austenitic stainless steel.
- 5.9.1.2 The close control of tube temperature during heat treatment shall be monitored with the use of thermocouples or calibrated optical pyrometer on the straight tangent near a U- bend. The heat treatment temperatures among the readings shall not be deviated by $\pm 15^{\circ}\text{C}$ as specified in the Code.

5.9.2 Furnace Heat Treatment

- 5.9.2.1 U-Tubes shall be properly supported above the furnace floor.
- 5.9.2.2 Establish a procedure on lines similar to Cl. 5.9.1.2. Proposed procedure shall be submitted to the AI and approval obtained prior to actual heat treatment.

- 5.10 Heat treatment temperatures by furnace and/or electric resistance methods shall be as given in the respective product specification or in the Code, subject to a maximum variation of $\pm 15^{\circ}\text{C}$. The stress relief heat treatment temperature shall be at least 25°C below the minimum tempering temperature used for the original material.

In the case of duplex stainless steel, cooling after the solution annealing shall be carried out by using forced air, inert gas blast or water quenching.

- 5.11 The applicable stainless steels U-tubes as mentioned above in this specification shall be pickled and passivated as per ASTM A380 after heat treatment, employing a previously qualified procedure acceptable to Purchaser/ EIL.

6.0 INSPECTION & TESTING

- 6.1 All U-bends shall be visually inspected to detect any harmful effect.
- 6.2 All U-bends with bend radii less than 5 times the tube OD shall be inspected for thinning, flattening, centre to centre distance, bend curvature and for the deviation from the plane of bend, to ensure conformance to the limits specified. U-bends with bend radii greater than 5 times the tube OD shall be inspected randomly at the discretion of the AI, subject to a minimum 1 tube per one bend radius batch.
- 6.3 For austenitic stainless steels above mentioned, IGC corrosion test shall be carried out as per ASTM A262 practice-E after final heat treatment unless stated otherwise. Specimen after exposure to the IGC environment shall be bent as per A262 practice-E and shall be examined with minimum magnification of 200x. The acceptance criterion is that the bent specimen shall be free of any cracks or grain dropping. The microstructure shall be submitted to Purchaser/EIL or AI for approval.
- 6.4 After heat treatment and final cleaning of U-bend tubes, the same shall be subjected to hydro-testing at a pressure of $70 \text{ kg/cm}^2\text{g}$ or tube side test pressure (whichever is greater) prior to assembling the tube bundle. Minimum holding time shall be 2 minutes. Hydrotest reports shall be submitted to Purchaser/EIL or AI for approval.