



Toase-eh Park Sanati Gohar Ofogh
Petrochemical Co.
**CONCEPTUAL, BASIC and DETAIL DESIGN
ENGINEERING OF STYRENE PARK OFFSITE**



Document Title: Tube Expanding Procedure


Document No.: EI027-DMF-VD-QC-PRO-026

Rev. R0

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Commented.

General comments:

- As per related tube bundle detail dwg, tube to tube sheet joint is strength weld and Expanded with grooved, so please specify the sequence of joint clearly whether ,expand is done before strength weld or after.
- Please add work sequence instruction . The attach file is a sample. 
- The procedure of leak test (e.g. the pressure ..) for tube to tube sheet joint to be added also in this document.
- HINT: Tube to tube sheet joint & related test to be added in NDT map document also.(we put this comment on NDT doc before please implement the comment)

**Document Title:
Tube Expanding Procedure**

R0	06-Oct.-2024	IFA	A.Parsafar	A.Shadmand	M.Heidarzadeh
Rev.	Issued Date	DESCRIPTION	PREPARED	CHECKED	APPROVED



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REVISION RECORD SHEET

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1	X							41							
2	X							42							
3	X							43							
4	X							44							
5	X							45							
6	X							46							
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1.0. PURPOSE

This procedure describes the practical application of the strength expanding operation for tube-to-tube sheet of Air-cooled heat exchangers Project: “Toase-eh Park Sanat Gohar Ofogh Petrochemical Co. CONCEPTUAL, BASIC and DETAIL DESIGN ENGINEERING OF STYRENE PARK OFFSITE”.

2.0. SCOPE

This method is used for the expansion of tubes in a standard air-cooled exchanger when the yield strength of the tube sheet is superior to the yield stress of the tube. Therefore, the plastic deformation of the tube during the expansion process includes BWG 10 to BWG16, which are categorized according to the outer diameter and wall thickness-refer to Appendix Table1. This procedure shall provide essentially uniform expansion throughout the expanded portion of the tube without a sharp transition to the unexpanded portion.

3.0. REFERENCES

API 661: Air-Cooled Heat Exchangers

4.0. DEFINITION

B.W.G: Birmingham wire gauge

d_i = inner diameter of the tube after expansion

d_0 = inner diameter of the tube before expansion






H= diameter of the tube sheet plate hole

D = outer diameter of the tube before expansion

%ER= expansion ratio %

5.0. EQUIPMENT SPECIFICATION

TROUVAY & ARUVIN LE HAVRE FRANCE TYPE:
TCM3

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6.0. TUBE HOLE GROOVING

All tube sheet holes for expanded joints in tube sheets less than 1inch (25mm) thick shall be machined with one groove approximately 1/8 inch (3 millimetres)wide by 1/64 inch (0.4millimeter) deep. A second groove shall be provided for tube sheets 1inch (25millimeters) or greater in thickness.

Grooves shall be located at least 1/8 inch (3mm.) plus corrosion allowance from the process face of the tube sheet and at least ¼ inch (6millimeters) from the airside face of the tube sheet.

Tube-hole grooves shall be square-edged, concentric and free of burrs.

7.0. Expanded tube-to-tube sheet joints

Tubes shall be expanded into the tube sheet for a length at least the smaller of the following:

- a) 50 mm (2 in)
- b) The tube sheet thickness less 3 mm (1/8 in).





In no case shall the expanded portion extend beyond the air-side face of the tube sheet.

The ends of tubes shall extend at least 1.5 mm (1.6 in) and not more than 10mm (3/8 in) beyond the tube sheet.

8.0. CLEANING BEFORE EXPANSION

The tube sheet bores must be cleaned before tubing and must be free from barbs at the level of the expansion grooves.

The inner bore of the tube must be smooth, free from barbs and swellings which would jeopardize the good expansion process.

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9.0. EXPANSION CRITERIA:

To obtain the permissible expansion range in the inner diameter of the tube, we consider the internal expansion of the tube in the plastic range.

so that the tube sheet is still elastic and after removing the expansion force, it is closed by returning to the original state.

This condition is created when the expansion ratio ER % is defined as the following relationship:

$$\% ER = \frac{(d_i - d_o) - (H - D)}{(D - d_o)} \times 100$$

% ER Is situated in the following range: $3\% \leq ER\% \leq 10\%$

for tubes with gauge BWG 12 to 16

10.0. CHECKING OF THE EXPANSION

Due to the application of tube-to-tube sheet weld in the connection of tube and tube sheet: the expansion of tube sheet to tube is done in two stages:





The first step is a small expansion to help escape the welding fumes and fix the tube to the hole in the tube sheet, and there is no need to measure the corresponding amount.

The final expansion rate after full expansion is measured and reported according to **Table 1**.

The expansion operation inside the tube goes back to the first 10 samples.

As a result, the normal value of the expansion force is determined by adjusting the ampere device.

The obtained result is applied to all tubes. Finally, the inner diameter of the pipes after expansion is measured and recorded. This diameter should be within the range of parameter "di" in **Table 1**.

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ITEM No.'s	BWG	Min. Wall THK.	OD	H(mm)	Range Of heavy exp%	d0	Range of di
Air cooler	16	1.651	25.4	25.7	3~10	22.098	22.49~22.79

Range of Expanding L (light), H (Heavy)






Range of di: The limits of "di" values are calculated according to the percentage of permissible expansion from 3% to 10% using the ER% relationship.

The suitable mandrel model is selected according to the thickness of the tube wall and the outer diameter of the tube according to the BWG table.

The expansion on the tubes and the holes of the tube sheet is done according to the ampere and power settings of the device.

The final expansion efficiency is checked during the hydrostatic test, and in case of leakage from the expanded area, by re-expanding up to the maximum allowed range, the sealing of the area is ensured. The results obtained will be reported in the inspection report.

Appendix I: sample inspection report,

 	<h3>Tube Expanding Report</h3>	  
Project Name / Dtt Job No :	Toase-eh Park Sanati Gohar Ofogh Petrochemical Co.	
Reference Document Name / No	Tube Expanding Procedure EI027-DMF-VD-QC-PRO-026	
Item no :	Air Cooler	

Tube Bundle No :						Standard Dimensions		
Front Tube Sheet No:	Rear Tube Sheet No:	Number Of Holes	B.W.G	Expansion Rate %	D	d0	H (mm)	di (rate)

Front Tube Sheet								Rear Tube Sheet							
Item	di (mm)	% ER	Result	Item	di (mm)	%ER	Result	Item	di (mm)	% ER	Result	Item	di (mm)	% ER	Result
1			Ok	11			Ok	1			Ok	11			
2				12				2				12			
3				12				3				12			
4				12				4				12			
5				12				5				12			
6				12				6				12			
7				12				7				12			
8				12				8				12			
9				12				9				12			
10				20				10				20			

<p>D: Tube external diameter before expanding d0: Tube internal diameter before expanding H: Tube sheet hole diameter di: Tube internal diameter after expanding ER: Expansion rate ER</p>	$\% ER = \frac{(d_i - d_0) - (H - D)}{(D - d_0)} \times 100$
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DTT	CONTRACTOR	TPA	CLIENT
Name : Date: Sing:	Name : Date: Sing:	Name : Date: Sing:	Name : Date: Sing:



CHECKING OF THE EXPANSION PROCEDURE

Acceptance ranges for the inner diameter of tube after expansion (di)

Size	BWG	Wall thk(mm)	D	H(mm)	ER%	dO	di	roller		
								Comp. Tool No	Mandrel No	Set of Roller
1"	10	3.403	25.4	25.7	According to customer requirements bet	18.594	The minimum and maximum are calculated by inserting the Exp% in the formula	C1237	CM61	CR15
	11	3.048	25.4	25.7		19.304		C1243	CM62	CR16
	12	2.768	25.4	25.7		19.864		C1245	CM62	CR17
	13	2.413	25.4	25.7		20.574		C1247	CM62	CR18
	14	2.108	25.4	25.7		21.184		C1249	CM63	CR18
	15	1.828	25.4	25.7		21.744		C1251	CM63	CR19
	16	1.651	25.4	25.7		22.098		C1251	CM63	CR19
1 1/4"	10	3.403	31.75	32.11		24.944		C1263	CM65	CR24
	11	3.048	31.75	32.11		25.654		C1267	CM66	CR26
	12	2.768	31.75	32.11		26.214		C1269	CM66	CR27
	13	2.413	31.75	32.11		26.924		C1271	CM67	CR28
	14	2.108	31.75	32.11		27.534		C1273	CM67	CR29
	15	1.828	31.75	32.11		28.094		C1275	CM67	CR30
	16	1.651	31.75	32.11		28.448		C1275	CM67	CR30
1 1/2"	10	3.403	38.1	38.56		31.294		C1287	CM 70	CR 35
	11	3.048	38.1	38.56		32.004		C1291	CM 70	CR 36
	12	2.768	38.1	38.56		32.564		C1293	CM 70	CR 37
	13	2.413	38.1	38.56		33.274		C1295	CM 71	CR 37
	14	2.108	38.1	38.56		33.884		C1295	CM 71	CR 37
	15	1.828	38.1	38.56		34.444		C1297	CM 71	CR 38
	16	1.651	38.1	38.56		34.798		C1297	CM71	CR38

Roler model : TROUVAY & ARUVIN LE HAVRE FRANCE TYPE: TCM3