

TEMA | INTERCAMBIADORES DE CALOR DE C&T

Curso Online: **Lección 8**
Diseño del Haz Tubular

Casos de Estudio Resueltos



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www.arvengtraining.com

S&T Tube Design

BPVC ASME VIII DIV.1



Eqpt: ST-01

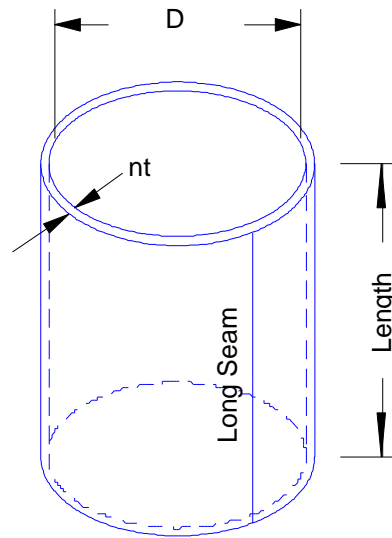
Internal Pressure Calculation

Design Conditions

1	315	T [°C] - Design Temperature
2	1,62	Pi [MPa] - Internal pressure
3	0,000	SG [-] - Specific gravity
4	0	LL [mm] - Liquid level
5	1,62	P [MPa] - Design pressure
6	1	MDMT [°C] - Metal Temperature
7	0,0	CA [mm] - corrosion allowance

Dimensions:

9	14,83	D [mm] - inside diameter
10	19	Do [mm] - outside diameter
11	7	R [mm] - inside radius
12	6100	L [mm] - TL to TL length



Material and Conditions:

13	SA-179	Material
14	90,7	S [MPa] - allowable stress
15	1,00	EI - long seam efficiency (circ stress)
16	1,00	Ec - circ seam efficiency (long stress)

Required Thickness: UG-27(c)(1,2)

19			
20	$ta_{[mm]} = P \cdot R / (S \cdot EI - 0.6 \cdot P)$	long seam	$1,62 \cdot 7,415 / (90,7 \cdot 1 - 0.6 \cdot 1,62) = 0,13$
21	$tb_{[mm]} = P \cdot R / (2 \cdot S \cdot Ec + 0.4 \cdot P)$	circ seam	$1,62 \cdot 7,415 / (2 \cdot 90,7 \cdot 1 + 0.4 \cdot 1,62) = 0,07$
22	$Treq_{[mm]} = \text{Max}(ta, tb) + CA$	required minimum thickness	$\text{Max}(0,13; 0,07) + 0 = 0,13$

Available Thickness

19			
20	$nt_{[mm]} = \text{Select Thk}$	nominal thickness	$nt_{[mm]} = 2,11$
21	$UA_{[mm]} = SA-20$	Mill undertolerance allowance	$UA_{[mm]} = 0,03$
22	$at_{[mm]} = nt - UA$	Available thickness	$2,11 - 0,03 = 2,08$
23	Check $nt = Treq \leq at$		$0,13 \leq 2,08 = \text{Acceptable}$

MAWP: UG-27(c)(1,2)

24			
25	$atc_{[mm]} = (at - CA)$	available thickness corroded	$2,08 - 0 = 2,08$
26	$\text{Pint1}_{[MPa]} = (S \cdot EI \cdot atc) / (R + 0.6 \cdot atc)$		$(91 \cdot 1 \cdot 2,08) / (7 + 0.6 \cdot 2,08) = 21,78$
26	$\text{Pint2}_{[MPa]} = (2 \cdot S \cdot Ec \cdot atc) / (R - 0.4 \cdot atc)$		$(2 \cdot 91 \cdot 1 \cdot 2,08) / (7 - 0.4 \cdot 2,08) = 57,32$
27	$\text{PMax}_{[MPa]} = \text{Min}(\text{Pint1}, \text{Pint2})$	maximum allowable working pressure	$\text{Min}(21,78; 57,32) = 21,78$
28	Check $P = \text{PMax} \geq P$		$21,78 \leq 1,62 = \text{Acceptable}$

Treq provides a worst case required thickness for shell analysis
 This sheet will not calculate thick walled vessels Check → Not a thick walled vessel, calculations are valid
 The UG-16(b) minimum thickness requirement has not been taken into consideration here.
 This sheet cannot be used to check for allowable exterior pressure loads.
 This sheet is for educational use only - use at your own risk.

Tubesheet Calculation

Tema Code



Eqpt: ST-01

Stationary Tubesheet

Design Conditions:

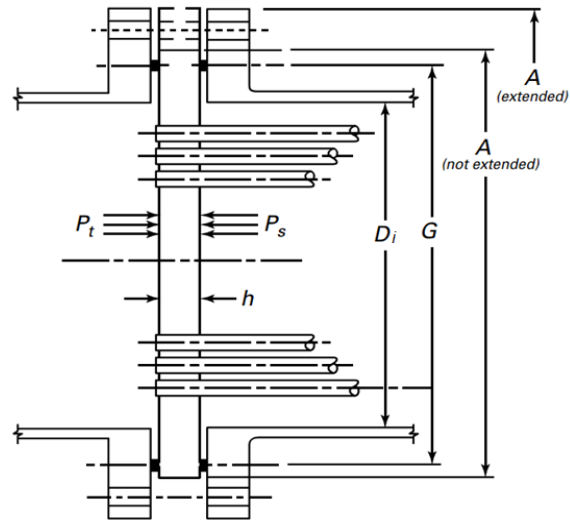
2	420	Td [°C] - Design Temperature
3	9,95	Pi [MPa] - Internal pressure
4	25	Ta [°C] - Ambient Temperature
5	0,000	SG [-] - Specific gravity
6	0	LL [mm] - Liquid level
7	9,95	P [MPa] - Design internal pressure
8	0,0	CAt [mm] - CA tube side
9	0,0	CAs [mm] - CA shell side
10	3,0	Gt [mm] - Channel groove thk

Materials & Allowable Stresses:

12	SA-182 Gr.321	Material Designation
13	117	S [MPa] - allowable stress @ design T°

Tubesheet Design:

15	Non Extended	Tubesheet Design
16	Square	Tube pattern
17	1.060,0	A [mm] - tubesheet diameter
18	19,05	do [mm] - tube outside diameter
19	25,4	Po [mm] - tube layout pitch
20	1,0	F [dless] - tubesheet factor (table A.131)
21	37,0	ts [mm] - shell thickness
22	900,0	Di [mm] - shell inside diameter
23	25,0	Gw [mm] - gasket width - table 2-4 VIII Div.1
23	1.010,0	G [mm] - gasket mean diameter
24	0,558	η [mm] - pattern factor
25	2.545	C [mm] - outside tubes perimeter
26	515.299,74	A [mm²] - area inside the tubes
27	810,00	DL [mm] - equivalent diameter

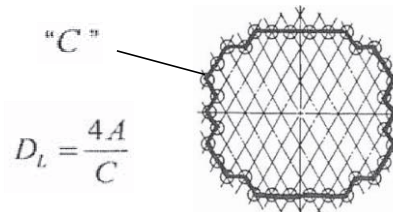


For Tube pattern $\square \diamond$,

$$\eta = 1 - \left[\frac{0.785}{(Pitch/Tube\ OD)^2} \right]$$

For Tube pattern $\triangleright \triangle$,

$$\eta = 1 - \left[\frac{0.907}{(Pitch/Tube\ OD)^2} \right]$$



Required Thickness: TEMA RCB 7.1

Bending Condition:

$$tb_{[mm]} = F \cdot G / 3 \sqrt{P / \eta \cdot S} \quad \text{req'd thickness due to bending} = 131,38$$

Shear Condition:

$$ts_{[mm]} = 0,31 \cdot DL / [1 - do / Po] \cdot [P / S] \quad \text{req'd thickness due to shear} = 85,42$$

Final Thickness:

$$Treq_{[mm]} = \text{Max}(tb; ts) + CAs + CAt + Gt \quad \text{required minimum thickness} = 134,4$$

$$T_{[mm]} = \text{Selected nominal thickness} = 135$$

$$\text{Check } T = Treq \leq T \quad 134,4 \leq 135 = \text{Acceptable}$$

Calculation method used is according to TEMA RCB 7.1.
 The required weld size is not checked on this sheet.
 The UG-16(b) minimum thickness requirement has not been taken into consideration here.
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