

JIS

JAPANESE INDUSTRIAL STANDARD

Construction of Layered Pressure Vessels

JIS B 8248 —1978

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JAPANESE INDUSTRIAL STANDARD

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Construction of Layered Pressure Vessels

B 8248-1978

1. Scope

This Japanese Industrial Standard specifies the layered pressure vessels, hereinafter referred to as the "layered vessels", to be used under the pressure exceeding the atmospheric pressure and at the temperature of -30°C to 350°C incl.

The matters not specified herein shall be in accordance with JIS B 8243.

Remark: In this standard, units and numerical values given in { } are in accordance with the International System of Units (SI) and are given for reference.

2. Definitions

For the purposes of this standard, following definitions apply:

- (1) Internal Layer A part constituting the internal wall of the layered vessel.
- (2) Layered Part A part layered outside the internal layer.
- (3) Dummy A steel sheet to be used, irrespective of the strength, particularly where the protection for the internal layer is required in welding of the first layer of the layer material.

3. Classification

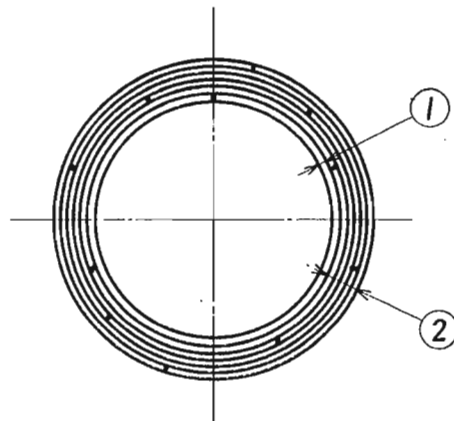
The vessels shall be classified into following three types according to the manufacturing system of the layered shells:

- (1) Concentric System A system in which the shaped steel sheets are piled concentrically on an internal layer made by welding after bending process of sheets or on a tube, and these are joined by longitudinal welding joint; thus the steel sheets are piled on to a required thickness. [See Fig. 1 (1).]

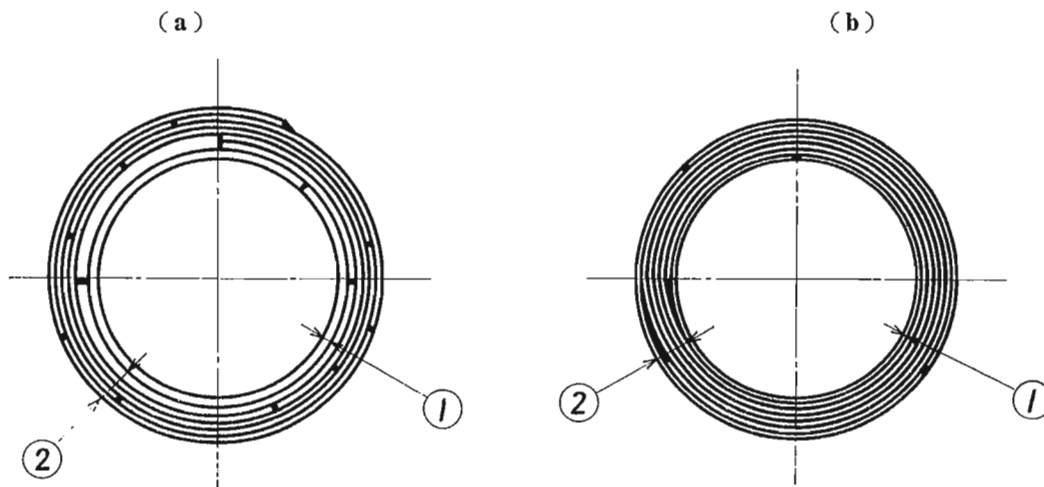
Applicable Standards: See page 26.

Fig. 1. Construction of Layered Shell

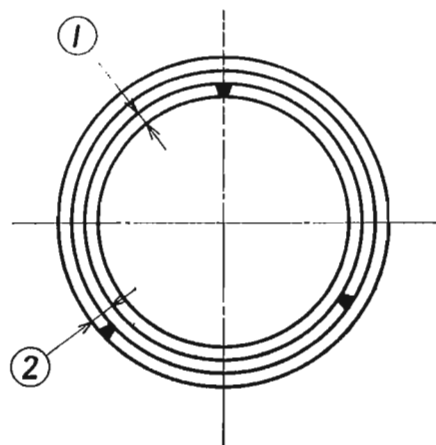
(1) Concentric System



(2) Wrap-Winding System



(3) Shrink-Fitting System



Remark: ① Internal layer
② Layered part

- (2) Wrap-Winding System A system in which the steel coil or steel sheet is wrap-wound spirally, on an internal layer made by welding after bending process of sheets or on a tube, to obtain a required thickness. As the outermost layer, steel sheets may be piled on cylindrically. [See Fig. 1 (2) (a) and (b).]
- (3) Shrink-Fitting System A system in which the cylinders made by welding after bending process of comparatively thick sheets are shrink-fitted each other to a required thickness. [See Fig. 1 (3).]

4. Materials

4.1 Materials for Internal Layer The materials used for the internal layer shall be in compliance with the following standards, or shall be those which are equivalent or superior to these in mechanical properties.

JIS G 3103	JIS G 3106: Class 1, B and C; Class 2, B and C; Class 3, B; Class 4, B and C and Class 5		
JIS G 3115	JIS G 3118	JIS G 3119	JIS G 3120
JIS G 3126	JIS G 3455	JIS G 3456	JIS G 3458
JIS G 3459	JIS G 3460	JIS G 4109	JIS G 4304
JIS G 4305			

The high tension strength steel sheets and strips for layered pressure vessels specified in Appendix 1

JIS H 3100; C 1100 P, C 1100 R and C 1020 P
JIS H 4000 JIS H 4600

4.2 Materials for Layered Part The materials used for the layered part shall be in compliance with the following standards, or shall be those which are equivalent or superior to these in mechanical properties.

JIS G 3103	JIS G 3106: Class 1, B and C; Class 2, B and C; Class 3, B; Class 4, B and C and Class 5		
JIS G 3115	JIS G 3118	JIS G 3119	JIS G 3120
JIS G 3126	JIS G 4109		

The high tension strength steel sheets and strips for layered pressure vessels specified in Appendix 1

4.3 Materials for Dummy The materials used for the dummy shall be the materials specified in JIS B 8243.

4.4 Welding Materials The welding materials shall be in compliance with the following standards or shall be those which are equivalent or superior to these in mechanical properties when used. However, where it is impossible to comply with these standards according to the kind of base metal, the welding material adequate to the base metal shall be used.

JIS Z 3202	JIS Z 3211	JIS Z 3212	JIS Z 3221
JIS Z 3223	JIS Z 3224	JIS Z 3231	JIS Z 3232
JIS Z 3241	JIS Z 3311	JIS Z 3312	JIS Z 3321
JIS Z 3322			

5. Strength Calculation

5.1 Shell The maximum permissible pressure for the shell of layered vessel under internal pressure shall be given from the following equation:

(1) Where Materials of Internal-Layer Material and Layer Material Are Identical

$$P_A = \frac{200}{\sqrt{3}} \alpha x \eta \sigma_v \left(2 - \frac{\sigma_v}{\sigma_B} \right) \ln K$$

$$\left\{ P_A = \frac{2}{\sqrt{3}} \alpha x \eta \sigma_v \left(2 - \frac{\sigma_v}{\sigma_B} \right) \ln K \right\}$$

The calculated thickness of shell where the above calculating equation is used shall be as follows:

$$t = \frac{D_i}{2} \left[\exp \frac{\sqrt{3} P}{200 \alpha x \eta \sigma_v \left(2 - \frac{\sigma_v}{\sigma_B} \right)} - 1 \right]$$

$$\left\{ t = \frac{D_i}{2} \left[\exp \frac{\sqrt{3} P}{2 \alpha x \eta \sigma_v \left(2 - \frac{\sigma_v}{\sigma_B} \right)} - 1 \right] \right\}$$

where P_A : maximum permissible pressure (kgf/cm²) { MPa }

α : correction factor corresponding to designed temperature given in Table 1

x : reciprocal of safety factor taken as 1/3

η : efficiency of welded joint given from the following equation:

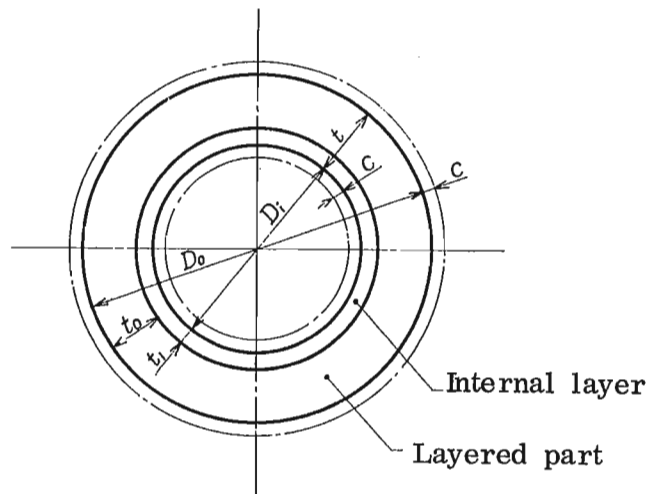
$$\eta = \frac{t_i \eta_i + t_0 \left[1 - \frac{(1 - \eta_e)m}{n} \right]}{t_0 + t_i}$$

- where t_i : thickness of internal layer excluding corrosion allowance (see Fig. 2) (mm)
- η_i : efficiency for longitudinal welded joint of internal layer, referring to Table 12.2 of JIS B 8243
- t_o : thickness of layered part excluding corrosion allowance (see Fig. 2) (mm)
- η_e : efficiency for longitudinal welded joint of layer material, referring to Table 12.2 of JIS B 8243
- m : the largest number of longitudinal welded joints included throughout total layers of the layered part, within the larger of the central angle of 6 degrees distributed 3 degrees each in both sides or circumferential length of 80 mm distributed 40 mm each in both sides, taking an arbitrary longitudinal welded joint as centre whichever is larger
- n : number of layers of layered part
- σ_y : specified minimum yield point or 0.2 % proof stress of material (kgf/mm²) {N/mm²}
- σ_b : specified minimum tensile strength of material (kgf/mm²) {N/mm²}
- K : $\frac{D_o}{D_i}$
- D_o : outside diameter (see Fig. 2) (mm)
- D_i : inside diameter (see Fig. 2) (mm)
- t : calculated thickness of shell (see Fig. 2) (mm)
- P : designed pressure (kgf/cm²) {MPa}

Table 1. Correction Factors Corresponding to Designed Temperatures

Designed temperature θ ($^{\circ}\text{C}$)	Correction factor d
$-30 \leq \theta \leq 50$	1
$50 < \theta \leq 150$	$1 - \frac{\theta - 50}{1000}$
$150 < \theta \leq 350$	0.9

Fig. 2. Dimension of Layered Shell



(2) Where Materials of Internal-Layer Material and Layer Material Are Different

$$P_A = \frac{200}{\sqrt{3}} \alpha x \eta \frac{\sigma_{yi} t_i + \sigma_{y0} t_0}{t_i + t_0} \left(2 - \frac{\sigma_{y0}}{\sigma_{B0}} \right) \ln K$$

$$\left\{ P_A = \frac{2}{\sqrt{3}} \alpha x \eta \frac{\sigma_{yi} t_i + \sigma_{y0} t_0}{t_i + t_0} \left(2 - \frac{\sigma_{y0}}{\sigma_{B0}} \right) \ln K \right\}$$

The calculated thickness of shell where the above calculating equations are used shall be as follows:

$$t = \frac{D_i}{2} \left[\exp \frac{\sqrt{3} P}{200 \alpha x \eta \frac{\sigma_{yi} t_i + \sigma_{y0} t_0}{t_i + t_0} \left(2 - \frac{\sigma_{y0}}{\sigma_{B0}} \right)} - 1 \right]$$

$$\left\{ t = \frac{D_i}{2} \left[\exp \frac{\sqrt{3} P}{2 \alpha x \eta \frac{\sigma_{yi} t_i + \sigma_{y0} t_0}{t_i + t_0} \left(2 - \frac{\sigma_{y0}}{\sigma_{B0}} \right)} - 1 \right] \right\}$$

where σ_{vi} : specified minimum yield point or 0.2 % proof stress of internal-layer material (kgf/mm²) { N/mm² }

σ_{vo} : specified minimum yield point or 0.2 % proof stress of layer material (kgf/mm²) { N/mm² }

σ_{B0} : specified minimum tensile strength of layer material (kgf/mm²) { N/mm² }

P_A , P , t , D_i , α , x , η , t_i , t_o and K shall be the same as those in 5.1 (1).

Where the elongation of an internal-layer material is remarkably small compared with that of a layer material, the strength of the internal-layer material shall not be calculated in the strength of the shell.

5.2 Hole to Be Installed on Layered Shell

- (1) Limits on Size of Hole The size of hole to be installed on the layered shell shall be as follows:
 - (a) It shall be not more than 1/2 of inside diameter and be not more than 500 mm, in the case where inside diameter of shell is not more than 1500 mm.
 - (b) It shall be not more than 1/3 of inside diameter and be not more than 1000 mm, in the case where inside diameter of shell exceeds 1500 mm.
- (2) Reinforcement of Hole The hole to be installed on the layered shell shall be reinforced as the following. However, no reinforcement is required for the hole for attachment of tube of nominal diameter 50 A or under or for fittings of outside diameter 61 mm or under.

$$A = dtk$$

where A : required minimum sectional area of reinforcing material (mm²)

d : hole diameter (mm)

t : calculated thickness of shell (mm)

k : coefficient corresponding to strength of reinforcing material and layer material

$$k = 1 \text{ for } \sigma_R \geq \sigma$$

$$k = \frac{\sigma}{\sigma_R} \text{ for } \sigma_R < \sigma$$