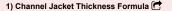
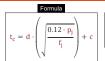
# Important Jacketed Reaction Vessel Formulas PDF



# List of 21

Important Jacketed Reaction Vessel Formulas





Example with Units 
$$\Theta_{mm} \,=\, 72.3\,\text{mm} \,\cdot \left(\sqrt{\frac{0.12\cdot0.105\,\text{N/mm}^2}{120\,\text{N/mm}^2}}\right) +\, 10.5\,\text{mm}$$

# 2) Combined Moment of Inertia of Shell and Stiffener per Unit Length Formula 🗂



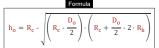
$$1.2E + 14 \, \text{mm}^4 / \text{mm} \ = \ \frac{550 \, \text{mm}^{-2} \cdot 330 \, \text{mm} \cdot \left(15 \, \text{mm}^{-1} + \frac{1640 \, \text{mm}^4}{330 \, \text{mm}^{-1}}\right) \cdot 120 \, \text{N/mm}^2}{12 \cdot 170000 \, \text{N/mm}^2}$$

# 3) Cross Sectional Area of Stiffening Ring Formula



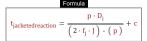
Example with Units  $1640\,{\rm mm^2}\,=\,40\,{\rm mm}\,\cdot\,41\,{\rm mm}$ 

### 4) Depth of Torisperical Head Formula (7)



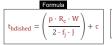


### 5) Design of Shell Thickness Subjected to Internal Pressure Formula (



$$t_{jacketed reaction} = \frac{p \cdot D_{i}}{\left(2 \cdot f_{j} \cdot J\right) \cdot \left(p\right)} + c \\ \begin{bmatrix} 14.3333 \, \text{mm} & \frac{\text{Example with Units}}{\left(2 \cdot 120 \, \text{N/mm}^{2} \cdot 0.85\right) \cdot \left(0.52 \, \text{N/mm}^{2}}\right) + 10.5 \, \text{mm} \\ \end{bmatrix}$$

### 6) Dished Head Thickness Formula C



$$t_{hdished} = \left(\frac{p \cdot R_c \cdot W}{2 \cdot f_j \cdot J}\right) + c = \begin{bmatrix} 81.9235 \text{ mm} & = \left(\frac{0.52 \text{ N/mm}^2 \cdot 1401 \text{ mm} \cdot 20}{2 \cdot 120 \text{ N/mm}^2 \cdot 0.85}\right) + 10.5 \text{ mm} \end{bmatrix}$$

### 7) Jacket Width Formula



Example with Units 
$$50_{mm} = \frac{1100_{mm} - 1000_{mm}}{2}$$

### 8) Length of Shell for Jacket Formula (7)



$$520.3333 \,\text{mm} = 497 \,\text{mm} + \frac{1}{3} \cdot 70 \,\text{mm}$$

Evaluate Formula [

Evaluate Formula

# 9) Length of Shell under Combined Moment of Inertia Formula 🗂



$$89.3644_{\text{mm}} = 1.1 \cdot \sqrt{550_{\text{mm}} \cdot 12_{\text{m}}}$$

# 10) Maximum Axial Stress in Coil at Junction with Shell Formula

$$p_j \cdot d_i$$

Evaluate Formula

Evaluate Formula

Evaluate Formula @

Evaluate Formula [

$$f_{ac} = \frac{p_{j} \cdot d_{i}}{\left(4 \cdot t_{coil} \cdot J_{coil}\right) + \left(2.5 \cdot t \cdot J\right)}$$

 $f_{ac} = \frac{p_j \cdot d_i}{\left(4 \cdot t_{coil} \cdot J_{coil}\right) + \left(2.5 \cdot t \cdot J\right)} \; \middle| \; \middle| \; 0.0125 \, \text{N/mm}^2 \; = \frac{0.105 \, \text{N/mm}^2 \cdot 54 \, \text{mm}}{\left(4 \cdot 11.2 \, \text{mm} \cdot 0.6\right) + \left(2.5 \cdot 200 \, \text{mm} \cdot 0.85\right)}$ 

### 11) Maximum Equivalent Stress at Junction with Shell Formula [

$$f_{e} = \left(\sqrt{\left(\left.f_{as}\right)^{2} + \left(\left.f_{cs}\right)^{2} + \left(\left.f_{cc}\right)^{2} \cdot \left(\left.\left(\left.f_{as} \cdot f_{cs}\right) + \left(\left.f_{as} \cdot f_{cc}\right) + \left(\left.f_{cc} \cdot f_{cs}\right)\right)\right.\right)}\right)$$

 $2.0057_{\text{N/mm}^2} = \left(\sqrt{\left(1.20_{\text{N/mm}^2}\right)^2 + \left(2.70_{\text{N/mm}^2}\right)^2 + \left(0.421875_{\text{N/mm}^2}\right)^2 - \left(\left(1.20_{\text{N/mm}^2} \cdot 2.70_{\text{N/mm}^2}\right) + \left(1.20_{\text{N/mm}^2} \cdot 0.421875_{\text{N/mm}^2}\right) + \left(0.421875_{\text{N/mm}^2} \cdot 2.70_{\text{N/m}^2}\right)^2 + \left(0.421875_{\text{N/mm}^2} \cdot 0.421875_{\text{N/mm}^2}\right)^2 + \left(0.421875_{\text{N/mm}^2} \cdot 0.421875_{\text{N/mm}^2}}\right)^2 + \left(0.421875_{\text{N/mm}^2}} \cdot 0.421875_{\text{N/mm}^2}\right)^2 + \left(0.421875_{\text{N/mm}^2}} \cdot 0.421875_{\text{N/mm}^2}\right)^2 + \left(0.421875_{\text{N/mm}^2} \cdot 0.421875_{\text{N/mm}^2}}\right)^2 + \left(0.421875_{\text{N/m$ 

# 12) Maximum Hoop Stress in Coil at Junction with Shell Formula

$$f_{cc} = \frac{p_j \cdot d_i}{2 \cdot t_{coil} \cdot J_{coil}}$$

 $f_{cc} = \frac{p_j \cdot d_i}{2 \cdot t_{coil} \cdot J_{coil}} \quad \boxed{ 0.4219 \text{\tiny N/mm}^2 = \frac{0.105 \, \text{\tiny N/mm}^2 \cdot 54 \text{\tiny mm}}{2 \cdot 11.2 \text{\tiny mm} \cdot 0.6} }$ 

# 13) Required Plate Thickness for Dimple Jacket Formula 🕝

$$t_{j \text{ (minimum)}} = Maximum_{Pitch} \cdot \sqrt{\frac{p_{j}}{3 \cdot f_{j}}}$$

# 14) Required Thickness for Jacket Closer Member with Jacket Width Formula 🗂

$$t_{rc} = 0.886 \cdot w_j \cdot \sqrt{\frac{p_j}{f_j}}$$

 $t_{rc} = 0.886 \cdot w_j \cdot \begin{bmatrix} p_j \\ f_j \end{bmatrix} \quad 1.3104 \, \text{mm} \, = 0.886 \cdot 50 \, \text{mm} \cdot \sqrt{\frac{0.105 \, \text{N/mm}^2}{120 \, \text{N/mm}^2}}$ 

### 15) Shell Thickness for Critical External Pressure Formula (

$$p_{c} = \frac{2.42 \cdot E}{\left(1 \cdot \left(u\right)^{2}\right)^{\frac{3}{4}}} \cdot \left(\frac{\left(\frac{t_{vessel}}{D_{o}}\right)^{\frac{5}{2}}}{\left(\frac{L}{D_{o}}\right) \cdot 0.45 \cdot \left(\frac{t_{vessel}}{D_{o}}\right)^{\frac{1}{2}}}\right)$$

### 16) Thickness of Bottom Head subjected to Pressure Formula 🕝

$$t_{h} = 4.4 \cdot R_{c} \cdot \left(3 \cdot \left(1 - \left(u\right)^{2}\right)\right)^{\frac{1}{4}} \cdot \sqrt{\frac{p}{2 \cdot E}}$$

Example with Units  $t_{h} = 4.4 \cdot R_{c} \cdot \left(3 \cdot \left(1 \cdot \left(u\right)^{2}\right)\right)^{\frac{1}{4}} \cdot \sqrt{\frac{p}{2 \cdot E}} \\ 9.7993_{mm} = 4.4 \cdot 1401_{mm} \cdot \left(3 \cdot \left(1 \cdot \left(0.3\right)^{2}\right)\right)^{\frac{1}{4}} \cdot \sqrt{\frac{0.52_{N/mm^{2}}}{2 \cdot 170000_{N/mm^{2}}}} \\ \frac{1}{2} \cdot \frac{170000_{N/mm^{2}}}{170000_{N/mm^{2}}} \cdot \frac{1}{2} \cdot \frac{1}{2$ 

### 17) Thickness of Half Coil Jacket Formula 🕝

$$t_{coil} = \frac{p_j \cdot d_i}{\left(2 \cdot f_j \cdot J\right)} + c$$

 $t_{coll} = \frac{p_j \cdot d_i}{\left(2 \cdot f_i \cdot J\right)} + c \left[ 10.5278 \, \text{mm} = \frac{0.105 \, \text{N/mm}^2 \cdot 54 \, \text{mm}}{\left(2 \cdot 120 \, \text{N/mm}^2 \cdot 0.85\right)} + 10.5 \, \text{mm} \right]$ 

# 18) Thickness of Jacket Shell for Internal Pressure Formula 🕝

# 19) Total Axial Stress in Vessel Shell Formula

ormula

$$\mathbf{a}_{as} = \left(\frac{\mathbf{p} \cdot \mathbf{D}_{i}}{4 \cdot \mathbf{t} \cdot \mathbf{J}}\right) + \left(\frac{\mathbf{p}_{j} \cdot \mathbf{d}_{i}}{2 \cdot \mathbf{t} \cdot \mathbf{J}}\right) + \frac{2 \cdot \Delta \mathbf{p} \cdot \left(d_{o}\right)^{2}}{3 \cdot \mathbf{t}^{2}}$$

- . .....

$$1.1885 \, \text{N/mm}^2 = \left(\frac{0.52 \, \text{N/mm}^2 \cdot 1500 \, \text{mm}}{4 \cdot 200 \, \text{nm} \cdot 0.85}\right) + \left(\frac{0.105 \, \text{N/mm}^2 \cdot 54 \, \text{mm}}{2 \cdot 200 \, \text{nm} \cdot 0.85}\right) + \frac{2 \cdot 0.4 \, \text{N/mm}^2 \cdot \left(61 \, \text{nm}\right)^2}{3 \cdot 200 \, \text{nm}^2}$$

### 20) Total Hoop Stress in Shell Formula [

Formula

$$p_{j} \cdot d_{i}$$

$$2.7037 \, _{N/mm^2} = \frac{0.61 \, _{N/mm^2} \cdot 1500 \, _{mm}}{2 \cdot 200 \, _{mm} \cdot 0.85} + \frac{0.105 \, _{N/mm^2} \cdot 54 \, _{mm}}{\left(4 \cdot 11.2 \, _{mm} \cdot 0.6\right) + \left(2.5 \cdot 200 \, _{mm} \cdot 0.85\right)}$$

Evaluate Formula

# 21) Vessel Wall Thickness for Channel Type Jacket Formula 🗂

Formula

$$t_{vessel} = d \cdot \sqrt{\frac{0.167 \cdot p_j}{f_j}} + c$$

Example with Units

$$11.374\, _{mm} \, = \, 72.3\, _{mm} \, \cdot \, \sqrt{\frac{0.167 \cdot 0.105\, _{N/mm^2}}{120\, _{N/mm^2}}} \, + \, 10.5\, _{mm}$$

# Variables used in list of Jacketed Reaction Vessel Formulas above

- A<sub>s</sub> Cross Sectional Area of Stiffening Ring (Square Millimeter)
- C Corrosion Allowance (Millimeter)
- **d** Design Length of Channel Section (Millimeter)
- d<sub>i</sub> Internal Diameter of Half Coil (Millimeter)
- D<sub>i</sub> Internal Diameter of Shell (Millimeter)
- D<sub>ii</sub> Inside Diameter of Jacket (Millimeter)
- d<sub>o</sub> Outer Diameter of Half Coil (Millimeter)
- D<sub>o</sub> Vessel Shell Outer Diameter (Millimeter)
- E Modulus of Elasticity Jacketed Reaction Vessel (Newton per Square Millimeter)
- fac Maximum Axial Stress in Coil at Junction (Newton per Square Millimeter)
- fas Total Axial Stress (Newton per Square Millimeter)
- f<sub>CC</sub> Maximum Hoop Stress in Coil at Junction with Shell (Newton per Square Millimeter)
- · fcs Total Hoop Stress (Newton per Square Millimeter)
- f<sub>e</sub> Maximum Equivalent Stress at Junction with Shell (Newton per Square Millimeter)
- fi Allowable Stress for Jacket Material (Newton per Square Millimeter)
- ho Depth of Head (Millimeter)
- I<sub>required</sub> Combined Moment of Inertia of Shell and Stiffener (Millimeter<sup>4</sup> per Millimeter)
- J Joint Efficiency for Shell
- J<sub>coil</sub> Weld Joint Efficiency Factor for Coil
- L Length of Shell (Millimeter)
- Leff Effective Length Between Stiffeners (Millimeter)
- Liacket Length of Shell for Jacket (Millimeter)
- Ls Length of Straight Side Jacket (Millimeter)
- Maximum<sub>Pitch</sub> Maximum Pitch between Steam Weld Centre Lines
- OD<sub>Vessel</sub> Outer Diameter of Vessel (Millimeter)
- p Internal Pressure in Vessel (Newton per Square Millimeter)
- p<sub>c</sub> Critical External Pressure (Newton per Square Millimeter)
- p<sub>j</sub> Design Jacket Pressure (Newton per Square Millimeter)
- p<sub>shell</sub> Design Pressure Shell (Newton per Square Millimeter)
- R<sub>c</sub> Crown Radius for Jacketed Reaction Vessel (Millimeter)
- R<sub>k</sub> Knuckle Radius (Millimeter)
- t Shell Thickness (Millimeter)
- t<sub>c</sub> Channel Wall Thickness (Millimeter)
- t<sub>coil</sub> Thickness of Half Coil Jacket (Millimeter)
- t<sub>h</sub> Head Thickness (Millimeter)
- thdished Dished Head Thickness (Millimeter)
- t<sub>i</sub> (minimum) Required Thickness of Dimple Jacket (Millimeter)
- tiacketedreaction Shell Thickness for Jackted Reaction Vessel (Millimeter)
- t<sub>rc</sub> Required Thickness for Jacket Closer Member (Millimeter)
- tri Required Thickness of Jacket (Millimeter)
- T<sub>s</sub> Thickness of Stiffener (Millimeter)
- t<sub>vessel</sub> Vessel Thickness (Millimeter)
- vessel vessel mickies
- u Poisson Ratio
- W Stress Intensification Factor
- W<sub>i</sub> Jacket Width (Millimeter)

### Constants, Functions, Measurements used in list of Jacketed Reaction Vessel Formulas above

• Functions: sqrt, sqrt(Number)

A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.

Measurement: Length in Millimeter (mm)

Length Unit Conversion 🗂

Measurement: Area in Square Millimeter (mm²)

Area Unit Conversion

Measurement: Pressure in Newton per Square Millimeter (N/mm²)
 Pressure Unit Conversion (

 Measurement: Moment of Inertia per Unit Length in Millimeter<sup>4</sup> per Millimeter (mm<sup>4</sup>/mm)

Moment of Inertia per Unit Length Unit Conversion

Measurement: Stress in Newton per Square Millimeter (N/mm²)
 Stress Unit Conversion

- W<sub>S</sub> Width of Stiffener (Millimeter)
- Ap Maximum difference between Coil and Shell Pressure (Newton per Square Millimeter)

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