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Jacketed Reaction Vessel Formulas

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List of 21 Jacketed Reaction Vessel Formulas

Jacketed Reaction Vessel

1) Channel Jacket Thickness

Open Calculator

fx $$t_c = d \cdot \left(\sqrt{\frac{0.12 \cdot p_j}{f_j}} \right) + c$$

ex $$11.24085\text{mm} = 72.3\text{mm} \cdot \left(\sqrt{\frac{0.12 \cdot 0.105\text{N/mm}^2}{120\text{N/mm}^2}} \right) + 10.5\text{mm}$$

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

Open Calculator

fx $$I_{required} = \frac{D_o^2 \cdot L_{eff} \cdot \left(t_{jacketedreaction} + \frac{A_s}{L_{eff}} \right) \cdot f_j}{12 \cdot E}$$

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

3) Cross Sectional Area of Stiffening Ring

Open Calculator

fx $$A_s = W_s \cdot T_s$$

ex $$1640\text{mm}^2 = 40\text{mm} \cdot 41\text{mm}$$

4) Depth of Torisperical Head

Open Calculator

fx $$h_o = R_c - \sqrt{\left(R_c - \frac{D_o}{2} \right) \cdot \left(R_c + \frac{D_o}{2} - 2 \cdot R_k \right)}$$

ex $$73.10091\text{mm} = 1401\text{mm} - \sqrt{\left(1401\text{mm} - \frac{550\text{mm}}{2} \right) \cdot \left(1401\text{mm} + \frac{550\text{mm}}{2} - 2 \cdot 55\text{mm} \right)}$$

5) Design of Shell Thickness Subjected to Internal Pressure

Open Calculator

fx $$t_{jacketedreaction} = \frac{p \cdot D_i}{(2 \cdot f_j \cdot J) - (p)} + c$$

ex $$14.3333\text{mm} = \frac{0.52\text{N/mm}^2 \cdot 1500\text{mm}}{(2 \cdot 120\text{N/mm}^2 \cdot 0.85) - (0.52\text{N/mm}^2)} + 10.5\text{mm}$$

6) Dished Head Thickness

Open Calculator

fx $$t_{hdished} = \left(\frac{p \cdot R_c \cdot W}{2 \cdot f_j \cdot J}\right) + c$$

ex $$81.92353mm = \left(\frac{0.52N/mm^2 \cdot 1401mm \cdot 20}{2 \cdot 120N/mm^2 \cdot 0.85}\right) + 10.5mm$$

7) Jacket Width

Open Calculator

fx $$w_j = \frac{D_{ij} - OD_{Vessel}}{2}$$

ex $$50mm = \frac{1100mm - 1000mm}{2}$$

8) Length of Shell for Jacket

Open Calculator

fx $$L_{jacket} = L_s + \frac{1}{3} \cdot h_o$$

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

9) Length of Shell under Combined Moment of Inertia

Open Calculator

fx $$L = 1.1 \cdot \sqrt{D_o \cdot t_{vessel}}$$

ex $$89.36442mm = 1.1 \cdot \sqrt{550mm \cdot 12mm}$$

10) Maximum Axial Stress in Coil at Junction with Shell

Open Calculator

fx $$f_{ac} = \frac{p_j \cdot d_i}{(4 \cdot t_{coil} \cdot J_{coil}) + (2.5 \cdot t \cdot J)}$$

ex $$0.012548N/mm^2 = \frac{0.105N/mm^2 \cdot 54mm}{(4 \cdot 11.2mm \cdot 0.6) + (2.5 \cdot 200mm \cdot 0.85)}$$

11) Maximum Equivalent Stress at Junction with Shell

Open Calculator

fx $$f_e = \left(\sqrt{(f_{as})^2 + (f_{cs})^2 + (f_{cc})^2 - ((f_{as} \cdot f_{cs}) + (f_{as} \cdot f_{cc}) + (f_{cc} \cdot f_{cs}))}\right)$$

ex $$2.005658N/mm^2 = \left(\sqrt{(1.20N/mm^2)^2 + (2.70N/mm^2)^2 + (0.421875N/mm^2)^2 - ((1.20N/mm^2 \cdot 2.70N/mm^2)}\right.$$

12) Maximum Hoop Stress in Coil at Junction with Shell

Open Calculator

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

$$0.421875\text{N/mm}^2 = \frac{0.105\text{N/mm}^2 \cdot 54\text{mm}}{2 \cdot 11.2\text{mm} \cdot 0.6}$$

13) Required Plate Thickness for Dimple Jacket

Open Calculator

$$t_{j\ (minimum)} = \text{Maximum}_{Pitch} \cdot \sqrt{\frac{p_j}{3 \cdot f_j}}$$

$$0.153704\text{mm} = 9\text{mm} \cdot \sqrt{\frac{0.105\text{N/mm}^2}{3 \cdot 120\text{N/mm}^2}}$$

14) Required Thickness for Jacket Closer Member with Jacket Width

Open Calculator

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

$$1.310412\text{mm} = 0.886 \cdot 50\text{mm} \cdot \sqrt{\frac{0.105\text{N/mm}^2}{120\text{N/mm}^2}}$$

15) Shell Thickness for Critical External Pressure

Open Calculator

$$p_c = \frac{2.42 \cdot E}{\left(1 - (u)^2\right)^{\frac{3}{4}}} \cdot \left(\frac{\left(\frac{t_{vessel}}{D_o}\right)^{\frac{5}{2}}}{\left(\frac{L}{D_o}\right) - 0.45 \cdot \left(\frac{t_{vessel}}{D_o}\right)^{\frac{1}{2}}} \right)$$

$$319.5295\text{N/mm}^2 = \frac{2.42 \cdot 170000\text{N/mm}^2}{\left(1 - (0.3)^2\right)^{\frac{3}{4}}} \cdot \left(\frac{\left(\frac{12\text{mm}}{550\text{mm}}\right)^{\frac{5}{2}}}{\left(\frac{90\text{mm}}{550\text{mm}}\right) - 0.45 \cdot \left(\frac{12\text{mm}}{550\text{mm}}\right)^{\frac{1}{2}}} \right)$$

16) Thickness of Bottom Head subjected to Pressure

Open Calculator

$$t_h = 4.4 \cdot R_c \cdot \left(3 \cdot \left(1 - (u)^2\right)\right)^{\frac{1}{4}} \cdot \sqrt{\frac{p}{2 \cdot E}}$$

$$9.799269\text{mm} = 4.4 \cdot 1401\text{mm} \cdot \left(3 \cdot \left(1 - (0.3)^2\right)\right)^{\frac{1}{4}} \cdot \sqrt{\frac{0.52\text{N/mm}^2}{2 \cdot 170000\text{N/mm}^2}}$$

17) Thickness of Half Coil Jacket

Open Calculator

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

$$10.52779\text{mm} = \frac{0.105\text{N/mm}^2 \cdot 54\text{mm}}{(2 \cdot 120\text{N/mm}^2 \cdot 0.85)} + 10.5\text{mm}$$

18) Thickness of Jacket Shell for Internal Pressure

Open Calculator

$$t_{rj} = \frac{p_j \cdot D_i}{(2 \cdot f_j \cdot J) - p_j}$$

$$0.772456\text{mm} = \frac{0.105\text{N/mm}^2 \cdot 1500\text{mm}}{(2 \cdot 120\text{N/mm}^2 \cdot 0.85) - 0.105\text{N/mm}^2}$$

19) Total Axial Stress in Vessel Shell

Open Calculator

$$f_{as} = \left(\frac{p \cdot D_i}{4 \cdot t \cdot J}\right) + \left(\frac{p_j \cdot d_i}{2 \cdot t \cdot J}\right) + \frac{2 \cdot \Delta p \cdot (d_o)^2}{3 \cdot t^2}$$

$$1.188542\text{N/mm}^2 = \left(\frac{0.52\text{N/mm}^2 \cdot 1500\text{mm}}{4 \cdot 200\text{mm} \cdot 0.85}\right) + \left(\frac{0.105\text{N/mm}^2 \cdot 54\text{mm}}{2 \cdot 200\text{mm} \cdot 0.85}\right) + \frac{2 \cdot 0.4\text{N/mm}^2 \cdot (61\text{mm})^2}{3 \cdot (200\text{mm})^2}$$

20) Total Hoop Stress in Shell

Open Calculator

$$f_{cs} = \frac{p_{shell} \cdot D_i}{2 \cdot t \cdot J} + \frac{p_j \cdot d_i}{(4 \cdot t_{coil} \cdot J_{coil}) + (2.5 \cdot t \cdot J)}$$

$$2.703724\text{N/mm}^2 = \frac{0.61\text{N/mm}^2 \cdot 1500\text{mm}}{2 \cdot 200\text{mm} \cdot 0.85} + \frac{0.105\text{N/mm}^2 \cdot 54\text{mm}}{(4 \cdot 11.2\text{mm} \cdot 0.6) + (2.5 \cdot 200\text{mm} \cdot 0.85)}$$

21) Vessel Wall Thickness for Channel Type Jacket

Open Calculator

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

$$11.37398\text{mm} = 72.3\text{mm} \cdot \sqrt{\frac{0.167 \cdot 0.105\text{N/mm}^2}{120\text{N/mm}^2}} + 10.5\text{mm}$$

Variables Used

- A_s Cross Sectional Area of Stiffening Ring *(Square Millimeter)*
- **c** Corrosion Allowance *(Millimeter)*
- **d** Design Length of Channel Section *(Millimeter)*
- d_i Internal Diameter of Half Coil *(Millimeter)*
- D_i Internal Diameter of Shell *(Millimeter)*
- D_{ij} Inside Diameter of Jacket *(Millimeter)*
- d_o Outer Diameter of Half Coil *(Millimeter)*
- D_o Vessel Shell Outer Diameter *(Millimeter)*
- **E** Modulus of Elasticity Jacketed Reaction Vessel *(Newton per Square Millimeter)*
- f_{ac} Maximum Axial Stress in Coil at Junction *(Newton per Square Millimeter)*
- f_{as} Total Axial Stress *(Newton per Square Millimeter)*
- f_{cc} Maximum Hoop Stress in Coil at Junction with Shell *(Newton per Square Millimeter)*
- f_{cs} Total Hoop Stress *(Newton per Square Millimeter)*
- f_e Maximum Equivalent Stress at Junction with Shell *(Newton per Square Millimeter)*
- f_j Allowable Stress for Jacket Material *(Newton per Square Millimeter)*
- h_o Depth of Head *(Millimeter)*
- $I_{required}$ Combined Moment of Inertia of Shell and Stiffener *(Millimeter⁴ per Millimeter)*
- **J** Joint Efficiency for Shell
- J_{coil} Weld Joint Efficiency Factor for Coil
- **L** Length of Shell *(Millimeter)*
- L_{eff} Effective Length Between Stiffeners *(Millimeter)*
- L_{jacket} Length of Shell for Jacket *(Millimeter)*
- L_s Length of Straight Side Jacket *(Millimeter)*
- $Maximum_{Pitch}$ Maximum Pitch between Steam Weld Centre Lines *(Millimeter)*
- OD_{Vessel} Outer Diameter of Vessel *(Millimeter)*
- **p** Internal Pressure in Vessel *(Newton per Square Millimeter)*
- p_c Critical External Pressure *(Newton per Square Millimeter)*
- p_j Design Jacket Pressure *(Newton per Square Millimeter)*
- p_{shell} Design Pressure Shell *(Newton per Square Millimeter)*
- R_c Crown Radius for Jacketed Reaction Vessel *(Millimeter)*
- R_k Knuckle Radius *(Millimeter)*
- **t** Shell Thickness *(Millimeter)*
- t_c Channel Wall Thickness *(Millimeter)*

- t_{coil} Thickness of Half Coil Jacket *(Millimeter)*
- t_h Head Thickness *(Millimeter)*
- $t_{hdished}$ Dished Head Thickness *(Millimeter)*
- $t_{j\ (minimum)}$ Required Thickness of Dimple Jacket *(Millimeter)*
- $t_{jacketedreaction}$ Shell Thickness for Jackted Reaction Vessel *(Millimeter)*
- t_{rc} Required Thickness for Jacket Closer Member *(Millimeter)*
- t_{rj} Required Thickness of Jacket *(Millimeter)*
- T_s Thickness of Stiffener *(Millimeter)*
- t_{vessel} Vessel Thickness *(Millimeter)*
- **u** Poisson Ratio
- **W** Stress Intensification Factor
- w_j Jacket Width *(Millimeter)*
- W_s Width of Stiffener *(Millimeter)*
- **Δp** Maximum difference between Coil and Shell Pressure *(Newton per Square Millimeter)*

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  Square root function
- 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 Millimeter⁴ per Millimeter (mm⁴/mm)
  Moment of Inertia per Unit Length Unit Conversion
- Measurement: **Stress** in Newton per Square Millimeter (N/mm²)
  Stress Unit Conversion

Check other formula lists

- **Jacketed Reaction Vessel Formulas**

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