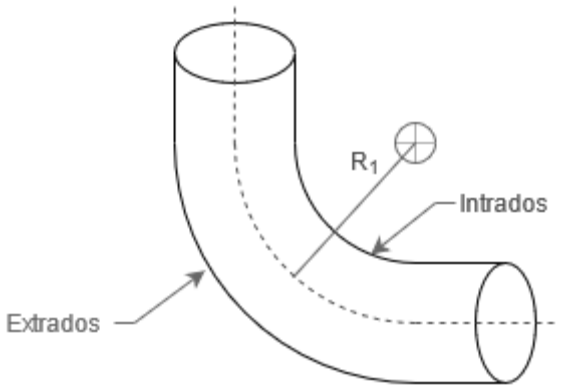
ASME B31.3 Processing Piping - Required Pressure Design Wall Thickness for Bends

This application calculates the required thickness for a pipe bend according to ASME B31.1 - 2020 Power piping paragraph 102.4.5 & 104.1.2(a)



Parameters

Weld joint quality factor ASME B31.3 Table 302.3.4	$E_j := 1.00$
Coefficient Y ASME B31.3 Table 304.1.1	$Y := 0.4$
Design temperature (C)	$temp := 537$
Bend radius, measured to pipe centerline	$R_1 := 762\ mm$
Material allowable stress (MPa) ASME B31.3 Table A-1M	$S := 95\ MPa$

Pipe outside diameter from pipe charts

$Dia := 273.05\,mm$

Nominal thickness

$T_{nom} := 2.6416\,mm$

Manufacturing tolerance (%)

$mil := 12.5$

Corrosion allowance

$C := 0\,mm$

Depth of threading, grooving or machining

$D_{tgm} := 0.063\,mm$

$A := C + D_{tgm} = 0.063\,mm$

Internal gauge pressure

$P := 1000\,kPa$

Weld joint strength reduction factor ASME B31.3 Cl. 302.3.5

$$W := \begin{cases} 1 & temp < 510.1 \\ 1 - \dfrac{temp - 510}{610} & otherwise \end{cases}$$

$W = 0.956$

Pressure Design Thickness of Connecting Straight Pipe

Pressure design thickness of connecting straight pipe

$$t_m := \frac{P \cdot Dia}{2 \cdot (S \cdot E_j + P \cdot Y)} + A = 1.494\,mm$$

Suggested thickness of pipe before bending

$t_m \cdot 1.25 = 1.868\,mm$

Minimum or measured thickness of pipe

$$T := T_{nom} \cdot \frac{(100 - mil)}{100} = 2.311\,mm$$

$$\begin{cases} \text{"Nominal thickness is ok"} & T \geq t_m \\ \text{"Increase nominal thickness"} & otherwise \end{cases} = \text{"Nominal thickness is ok"}$$

Required maximum inside nominal diameter of connecting pipe

$$d := Dia - 2 \cdot t_m = 270.062\ mm$$

Pressure Design Thickness of Bended Pipe

I at the intrados

$$I_{intrados} := \frac{4 \cdot R_1/Dia - 1}{4 \cdot R_1/Dia - 2} = 1.109$$

I at the extrados

$$I_{extrados} := \frac{4 \cdot R_1/Dia + 1}{4 \cdot R_1/Dia + 2} = 0.924$$

I at the sidewall on the bend centerline

$$I_s := 1.0$$

Pressure design thickness at intrados

$$t_{intrados} := \frac{P \cdot Dia}{2 \cdot \left(\frac{S \cdot E_j \cdot W}{I_{intrados}} + P \cdot Y \right)} + A = 1.723\ mm$$

$$\begin{cases} \text{"Nominal thickness is ok"} & T \geq t_{intrados} \\ \text{"Increase nominal thickness"} & \text{otherwise} \end{cases} = \text{"Nominal thickness is ok"}$$

Pressure design thickness at intrados

$$t_{extrados} := \frac{P \cdot Dia}{2 \cdot \left(\frac{S \cdot E_j \cdot W}{I_{extrados}} + P \cdot Y \right)} + A = 1.447\ mm$$

$$\begin{cases} \text{"Nominal thickness is ok"} & T \geq t_{extrados} \\ \text{"Increase nominal thickness"} & \text{otherwise} \end{cases} = \text{"Nominal thickness is ok"}$$

Minimum required thickness at side wall

$$t_s := \frac{P \cdot Dia}{2 \cdot \left(\frac{S \cdot E_j \cdot W}{I_s} + P \cdot Y \right)} + A = 1.560\ mm$$

$$\begin{cases} \text{"Nominal thickness is ok"} & T \geq t_s \\ \text{"Increase nominal thickness"} & \text{otherwise} \end{cases} = \text{"Nominal thickness is ok"}$$

Minimum thickness of bend at any point $\max(t_{intrados}, t_{extrados}, t_s) = 1.723\ \text{mm}$