Engineering Calculation Report: Pressure Design of a Straight Pipe Under Internal Pressure

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Description

Calculate the minimum wall thickness of a straight pipe under internal pressure according to ASME B31.3.

1 Known Variables

Symbol	Name	Value	Unit
D	Outside Diameter	0.84	in
E	Quality Factor	0.8	
P	Design Pressure	90	psi
S	Allowable Stress	20000	psi
$\overline{T}$	Nominal Wall Thickness	0.147	in
U_m	Mill Undertolerance	0.125	
W	Weld Joint Strength Reduction Factor	1	
Y	Y Coefficient	0.4	
c	Mechanical Allowances	0	in

2 Unknown Variables (To Calculate)

Symbol	Name	Unit
P_{max}	Maximum Pressure	psi
T	Wall Thickness	in
d	Inside Diameter	in
t	Pressure Design Thickness	in
t_m	Minimum Required Thickness	in

3 Equations Used

1. $T = \overline{T} \cdot (1 - U_m)$
2. $t = \frac{P \cdot D}{2 \cdot (S \cdot E \cdot W + P \cdot Y)}$
3. $d = D - 2 \cdot T$
4. $P_{max} = \frac{2 \cdot (T - c) \cdot S \cdot E \cdot W}{D - 2 \cdot (T - c) \cdot Y}$
5. $t_m = t + c$

4 Step-by-Step Solution

Step 1: Solve for T

Equation:

$$T = \overline{T} \cdot (1 - U_m)$$

Substitution:

$$T = 0.147\,\text{in} \cdot (1 - 0.125)$$

Result:

$$T = 0.128625\,in$$

Step 2: Solve for t

Equation:

$$t = \frac{P \cdot D}{2 \cdot (S \cdot E \cdot W + P \cdot Y)}$$

Substitution:

$$t = \frac{90\,\text{psi} \cdot 0.84\,\text{in}}{2 \cdot (20000\,\text{psi} \cdot 0.8 \cdot 1 + 90\,\text{psi} \cdot 0.4)}$$

Result:

$$t = 0.0023572\,in$$

Step 3: Solve for d

Equation:

$$d = D - 2 \cdot T$$

Substitution:

$$d = 0.84\,\text{in} - 2 \cdot 0.128625\,\text{in}$$

Result:

$$d = 0.58275\,in$$

Step 4: Solve for P_{max}

Equation:

$$P_{max} = \frac{2 \cdot (T - c) \cdot S \cdot E \cdot W}{D - 2 \cdot (T - c) \cdot Y}$$

Substitution:

$$P_{max} = \frac{2 \cdot (0.128625\,\text{in} - 0\,\text{in}) \cdot 20000\,\text{psi} \cdot 0.8 \cdot 1}{0.84\,\text{in} - 2 \cdot (0.128625\,\text{in} - 0\,\text{in}) \cdot 0.4}$$

Result:

$$P_{max} = 5584.05\,psi$$

Step 5: Solve for t_m

Equation:

$$t_m = t + c$$

Substitution:

$$t_m = 0.0023572\,\text{in} + 0\,\text{in}$$

Result:

$$t_m = 0.0023572\,in$$

5 Summary of Results

Variable	Name	Final Value	Unit
P_{max}	Maximum Pressure	5584.05	psi
T	Wall Thickness	0.128625	in
d	Inside Diameter	0.58275	in
t	Pressure Design Thickness	0.0023572	in
t_m	Minimum Required Thickness	0.0023572	in