Pipe or Tubing Support Span Calculations

Client:	Description:	Prepared By:	Approval:	Date:	Rev.:
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Customer No.:	Item No.:				1
					2
Owner No.:	Dwg. No.:				3
					4

The user is responsible for verifying that method and results are correct.

Service:	new process	SG =	1.00		**Measurement Units:**	Imperial		
Design Temperature:	(•) F ( ) C		100	Deg. F	**Corrosion, erosion, mech. allow:**	C =	0.0000	inch
Factor of Safety:		FS =	4.0		**Ice Thickness (external):**	T_{ice} =	0	inch

Pipe or Tubing Material:				**Pipe or Tube Dimensions:**			
ASTM A 53-B Type S Carbon Steel Pipe				Nom. Size:	NPS 8 (DN 200)		
Hot modulus of elasticity	E =	2.934E+07	psi	Nom. Thk.:	Sch 40 per ASME B36.10M		
Hot allowable stress	S_h =	20,000	psi	Actual OD:	D_o =	8.625	inch
Design stress, Sh / FS	S_a =	5,000	psi	Nominal thickness:	T_{nom} =	0.322	inch
Material density	P_{den} =	2.833E-01	lb/in^3	Thickness tolerance: Mill = 12.5%	and, h =	0.000	inch
Relative weight factor (vs. carbon steel)	Mat =	1.000					

Insulation:	Semi-rigid Fiberglass			**Liner on ID:**	none		
Density, I_{ns} =	7.0 lb/ft^3	I_{den} =	4.051E-03 lb/in^3	Density:	L_{den} =	0.000E+00	lb/in^3
Thk, T_i =	2 inch			Thickness:	T_r =	0.000	inch

Comments: x
x
x

Weight of concentrated load assumed at center of span (valves + flanges + animal, etc.): W_c = 0 lbs

Minimum pipe thickness, $t = T_{nom} - (T_{nom} * \text{Mill} \% / 100) - c - h$	t =	0.3216	inch
Outside radius of pipe, $R = D_o / 2$	R =	4.313	inch
Pipe moment of inertia (based on t), $I = \pi / 64 [D_o^4 - (D_o - 2t)^4]$	I =	7.241E+01	in^4
Pipe inside diameter, $d = D_o - 2 T_{nom}$	d =	7.981	inch
Pipe section modulus, $Z = \pi / 32 (D_o^4 - d^4) / D_o$	Z =	1.681E+01	in^3
Metal area of pipe cross-section, $A_m = (D_o^2 - d^2) * \pi / 4$	A_m =	8.40	in^2
Conversion factor, water density, dw = 62.4 lb / cu ft	d_w =	62.40	lb/ft^3
Conversion factor: n = 1 ft / 12 in	n =	8.3333E-02	ft / in
Pipe weight per unit length, $W_p = P_{den} * A_m / n$	W_p =	28.55	lb / ft
Pipe or liner or refractory inside diameter, $d_L = d - 2 T_r$	d_L =	7.981	inch
Liner area cross-section, $A_r = (d^2 - d_L^2) * \pi / 4$	A_r =	0.00	in^2
Liner weight per unit length, $W_r = L_{den} * A_r / n$	W_r =	0.00	lb / ft
Flow area, $A_f = d * L^2 * \pi / 4$	A_f =	5.003E+01	in^2
Fluid weight per unit length, $W_f = SG * A_f * n^2 * d_w$	W_f =	21.68	lb / ft
Insulation outside diameter, $D_{io} = D_o + 2 T_i$	D_{io} =	12.63	inch
Insulation area cross-section, $A_i = (D_{io}^2 - D_o^2) * \pi / 4$	A_i =	66.76	in^2
Insulation weight per unit length (w/ factor 1.12 for lagging), $W_i = 1.12 * A_i * n^2 * I_{ns}$	W_i =	3.63	lb / ft
Ice area cross-section, $A_{ice} = [(Dio + (2 * T_{ice}))^2 - D_{io}^2] * \pi / 4$	A_{ice} =	0.00	in^2
Ice weight (external w/ S.G. = 0.9) per unit length, $W_{ice} = 0.9 * A_{ice} * n^2 * d_w$	W_{ice} =	0.00	lb / ft
Total weight per unit length, $W = W_p + W_r + W_f + W_i + W_{ice}$ (excluding W_c)	**W =**	**53.87**	**lb / ft**

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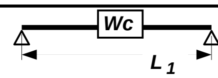
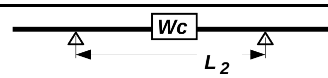
Method (A) -- Reference book *Design Of Piping Systems, pp. 239 - 240 & 356 - 358, by M. W. Kellogg, Second Edition, 1956*

Type of support span: Single span, free ends			
Length of support span	L =	32.00	feet
Factor for modifying stress value obtained by the basic formula for S	fs =	1.250	
Maximum calculated bending stress due to loads, $S = fs (1.2 W L^2 / Z) (2 W_c / W L)$	S =	4,922.3	psi
The calculated bending stress is within limits.			
Factor for modifying deflection value obtained by the basic formula for y	fy =	1.316	
Deflection, $y = fy (17.1 (W L^4 / E * I))$	y =	0.598	inch
Natural frequency estimate, $fn = 3.13 / y^{0.5}$	fn =	4.046	Hz
OK. Natural frequency above 4 Hz is recommended for most spans. Consider 8 Hz or more for pulsating line.			
Slope of pipe between supports for drainage, $h = (12 * L)^2 * y / (0.25 (12 * L)^2 - y^2)$	h =	2.393	inch

Method (B) -- Reference Book: *Piping Handbook, pg 22-47, by Crocker and King, Fifth Edition, 1967, McGraw-Hill*



Length of support span (Single Span w/ Free Ends)	L_1 =	32.00	feet
Maximum bending stress, $Sw_1 = (0.75 W * (L_1)^2 + 1.5 W_c * L_1) * D_o / I$	Sw_1 =	4,927.8	psi
Deflection, $y_1 = (22.5 W * (L_1)^4 + 36 W_c * (L_1)^3) / (E * I)$	y_1 =	0.598	inch
The calculated bending stress is within limits.	Deflection is within recommended limits.		
Natural frequency estimate, $fn_1 = 3.13 / (y_1)^{0.5}$	fn_1 =	4.047	Hz
OK. Natural frequency above 4 Hz is recommended for most spans. Consider 8 Hz or more for pulsating line.			
Slope between supports for drainage, $h_1 = (12 * L_1)^2 * y_1 / (0.25 (12 * L_1)^2 - (y_1)^2)$	h_1 =	2.393	inch



Length of support span (Continuous Straight Run)	L_2 =	39.00	feet
Maximum bending stress, $Sw_2 = (0.5 W * L_2^2 + 0.75 W_c * L_2) * D_o / I$	Sw_2 =	4,879.7	psi
Deflection, $y_2 = (4.5 W * (L_2)^4 + 9 W_c * (L_2)^3) / (E * I)$	y_2 =	0.264	inch
The calculated bending stress is within limits.	Deflection is within recommended limits.		
Natural frequency estimate, $fn_2 = 3.13 / (y_2)^{0.5}$	fn_2 =	6.092	Hz
OK. Natural frequency above 4 Hz is recommended for most spans. Consider 8 Hz or more for pulsating line.			
Slope between supports for drainage, $h_2 = (12 * L_2)^2 * y_2 / (0.25 (12 * L_2)^2 - (y_2)^2)$	h_2 =	1.056	inch