Green Thread® Product Data

Applications

- Dilute Acids
- Caustics
- Produced Water
- Industrial Waste
- Hot Water
- Condensate Return

Materials and Construction

All pipe manufactured by filament winding process using amine-cured epoxy thermosetting resin to impregnate strands of continuous glass filaments with a resin-rich corrosion barrier.

Pipe is available in **1" through 16"** diameters with pressure ratings up to 450 psig static at a maximum operating temperature of 225°F. Pipe diameters of **1" through 6"** are available in 20' random lengths and the **8" through 16"** diameters are in 10' or 39' random lengths.

Green Thread pipe in larger diameter (18" - 42") and higher pressure are available upon request.

Fittings

Fittings are manufactured with the same **chemical/temperature** capabilities as the pipe. Depending on the particular part and size, fittings will be compression molded, contact molded, hand fabricated or filament wound.

Joining Systems

Bell & Spigot
Matched-taper joint secured with epoxy adhesive. Self-locking feature resists movement, facilitating joining runs of pipe without awaiting adhesive cure.

Flanged
Available for all piping systems and diameters; factory assembled or shipped loose for assembly in the field.

Nominal Dimensional Data

Pipe Size	I.D.		O.D.		Wall Thickness		Liner Thickness		Weight		Capacity	
(In)	(In)	(mm)	(In)	(mm)	(In)	(mm)	(In)	(mm)	(Lbs/Ft)	(kg/m)	(Gal/Ft)	(Ft^3/Ft)
1	1.193	30	1.370	35	0.090	2.29	0.015	0.38	0.3	0.45	0.06	0.008
1½	1.760	45	1.960	50	0.100	2.54	0.015	0.38	0.5	0.74	0.13	0.017
2	2.152	55	2.390	61	0.119	3.02	0.025	0.64	0.7	1.04	0.19	0.025
3	3.279	83	3.516	89	0.119	3.05	0.025	0.64	1.0	1.49	0.44	0.059
4	4.281	109	4.521	115	0.120	3.05	0.030	0.76	1.3	1.93	0.75	0.100
6	6.351	161	6.645	169	0.147	3.73	0.030	0.76	2.4	3.57	1.65	0.220
8	8.361	212	8.717	221	0.178	4.52	0.030	0.76	3.9	5.80	2.85	0.382
10	10.363	263	10.795	274	0.216	5.49	0.030	0.76	5.9	8.78	4.38	0.586
12	12.286	312	12.758	324	0.236	5.99	0.030	0.76	7.7	11.50	6.16	0.823
14	14.038	357	14.548	370	0.255	6.48	0.030	0.76	9.5	14.10	8.04	1.075
16	16.040	407	16.610	422	0.285	7.24	0.030	0.76	12.2	18.20	10.50	1.403

Tolerances or maximum/minimum limits can be obtained from NOV Fiber Glass Systems.

Properties of Pipe Sections Based on Minimum Reinforced Walls

Size (In)	Reinforcement End Area(In^2)	Reinforcement Moment of Inertia (In^4)	Reinforcement Section Modulus (In^3)	Nominal Wall End Area (In^2)
1	0.23	0.06	0.07	0.36
1½	0.37	0.16	0.16	0.58
2	0.57	0.37	0.31	0.85
3	0.85	1.24	0.70	1.27
4	1.06	2.59	1.15	1.66
6	2.20	11.71	3.52	3.00
8	3.66	33.50	7.69	4.78
10	5.70	79.90	14.80	7.18
12	7.46	146.60	22.98	9.28
14	9.30	238.00	32.72	11.45
16	12.04	402.00	48.40	14.62

Average Physical Properties

Property			75°F psi	24°C MPa	225°F psi	107°C MPa
Axial Tensile - ASTM D2105						
Ultimate Stress			10,550	71	7,160	49.4
Modulus of Elasticity			1.75×10^6	12,100	1.03×10^6	7,102
Poisson's Ratio $V_{a/h}$ ($V_{h/a}$)				0.35 (0.72)		
Axial Compression - ASTM D695						
Ultimate Stress			33,300	230	17,800	122.7
Modulus of Elasticity			1.26×10^6	8,687	0.54×10^6	3,723
Beam Bending - ASTM D2925						
Ultimate Stress			23,000	158.6	16,000	110
Modulus of Elasticity (Long Term)			2.18×10^6	15,031	1.11×10^6	7,653
Hydrostatic Burst - ASTM D1599						
Ultimate Hoop Tensile Stress			46,300	319.2	49,540	342
Ring Tensile - ASTM D2290		Sizes				
Minimum Hoop Tensile Stress		1"- 1½"	9,018	62.4	-	-
		2"-16"	27,280	188	-	-
Hydrostatic Design - ASTM D2992,						
Procedure B - Hoop Tensile Stress	LTHS		27,715	191.1	16,945*	116.8*
Static 20 Year Life (* 200°F/93.3°C data)	LCL		22,400	154.4	14,654*	101.0*

Thermal Expansion Coefficient - ASTM D696	1.26×10^{-5} in/in/°F	2.27×10^{-5} mm/mm/°C
Thermal Conductivity	0.23 BTU/hr-ft-°F	0.4 W/m-°C
Specific Gravity - ASTM D792	1.8	
Hazen-Williams Coefficient	150	
Absolute Surface Roughness	0.00021 Inch	0.0053 mm
Manning's Roughness Coefficient, N	0.009	

Water Hammer:

Care should be taken when designing an FRP piping system to eliminate sudden surges. Soft start pumps and slow actuating valves should be considered.

Pipe Lengths Available	
Size (In)	**Random Length (Ft)**
1-6	20
8-16	19 or 39

Pressure Ratings[1]

Size (In)	Maximum Internal Static Pressure (psig) 225°F	Maximum External Pressure (psig)[1] 75°F	225°F
1	450	360	292
1½	450	187	150
2	450	289	241
3	450	123	69
4	225	77	56
6	225	33	21
8	225	18	15
10	225	18	15
12	225	18	15
14	225	15	10
16	225	15	10

[1]Vacuum Service: A full vacuum within the pipe is equivalent to 14.7 psig external pressure at sea level. External pressure ratings are based on test data obtained using ASTM D2924. Contact NOV Fiber Glass Systems if higher external pressure designs are required.

ASTM D2996 Designation Codes	
1"-1½"	RTRP-11FY1-3111
2"-8"	RTRP-11FY1-3112
10"	RTRP-11FY1-3114
12"-16"	RTRP-11FY1-3116

Recommended Operating Ratings

Size (In)	Axial Tensile Loads Max. (Lbs) Temperature 75°F	225°F	Axial Compressive Loads Max. (Lbs)[1] Temperature 75°F	225°F	Bending Radius Min. (Ft) Entire Temp. Range	Torque Max. (Ft Lbs) Entire Temp. Range	Parallel Plate Loading[2] ASTM D2412 Stiffness Factor (In^3/ Lbs/In^2)	Pipe Stiffness (psi)	Hoop Modulus x10^6 (psi)
1	580	410	1,880	1,010	40	25	40	1,170	1.26
1½	960	660	3,090	1,650	60	60	70	640	1.50
2	1,480	1,030	4,770	2,550	80	180	200	910	1.58
3	2,190	1,520	7,090	3,790	110	230	240	330	1.89
4	2,740	1,900	8,840	4,730	140	380	230	140	1.81
6	5,680	3,950	18,350	9,810	210	1,070	540	100	2.13
8	9,430	6,550	30,470	16,290	270	2,490	730	60	2.24
10	14,690	10,200	47,450	25,370	340	4,510	1,620	70	2.95
12	19,210	13,350	62,110	33,200	400	7,000	2,800	80	3.27
14	23,950	16,650	77,420	41,390	460	9,970	3,600	60	2.46
16	31,000	21,550	100,230	53,580	530	14,700	6,500	60	3.20

[1]Compressive loads are for short columns only.

Testing:

Hydrostatic testing should be performed to evaluate the structural integrity of a new piping system installation. Test pressures of 1.5 times the design pressure but not exceeding 1.2 times the static pressure rating of the lowerst rated fiberglass component in the piping system are recommended. Contact the factory if test pressures exceed 450 psig before testing. The hydro test pressure should be repeated up to ten times to provide a high degree of confidence in the piping system. The final pressurization cycle should be allowed to stabilize for 15-30 minutes, then inspected for leaks. Do not attempt to repair leaks while system is pressurized. The hydro test should be repeated after any re-work is performed.

When hydro testing, open vents to prevent entrapment of air in the lines as the system is slowly filled with water. Then close the vents and slowly pressurize to the test pressure. Upon completion of hydro test, relieve the pressure on the system slowly, open vents and any drains to allow for complete drainage of the system.

Piping systems with design temperatures above 160°F should be tested at 1.2 times the static pressure rating of the lowest rated fiberglass component in the system.

Supports

Proper pipe support spacing depends on the temperature and weight of the fluid in the pipe. The support spacing table is based on unrestrained continuous beam theory using the pipe bending modulus derived from long-term beam bending tests. The maximum spans lengths were developed to ensure a design that limits mid-span deflection to 1/2 inch and dead weight bending to 1/8 of the ultimate bending stress. Any additional loads on the piping system such as insulation, wind, seismic, etc. requires further consideration. Restrained (anchored) piping systems operating at elevated temperatures may result in guide spacing requirements that are shorter than unrestrained piping systems. In this case, the maximum guide spacing governs the support span requirements for the system. Pipe spans near elbows require special attention. Both supported and unsupported elbows are considered in the following tables and must be followed to properly design the piping system.

There are seven basic rules to follow when designing piping system supports:

1. Do not exceed the recommended support span.
2. Support heavy valves and in-line equipment independently.
3. Protect pipe from external abrasion at supports.
4. Avoid point contact loads.
5. Avoid excessive bending. This applies to handling, transporting, initial layout, and final installed position.
6. Avoid excessive vertical loading to minimize bending stresses on pipe and fittings.
7. Provide adequate axial and lateral restraint to ensure line stability during rapid changes in flow.

Maximum Support Spacing for Uninsulated Pipe[1]

Pipe Size (In.)	Continuous Spans of Pipe (Ft.)[2]			
	75°F	150°F	225°F	Gas 75°F
1	10.9	10.2	9.2	13.9
1½	12.6	11.8	10.7	16.9
2	14.1	13.2	11.9	19.0
3	15.9	14.8	13.4	23.2
4	17.0	15.8	14.3	26.2
6	20.5	19.1	17.3	32.8
8	23.3	21.7	19.7	38.0
10	26.0	24.2	22.0	42.6
12	27.9	26.0	23.5	46.3
14	29.5	27.5	24.9	49.6
16	31.4	29.3	26.6	53.1

[1]Consult factory for insulated pipe support spacing.
[2]Max. mid span deflection 1/2" with specific gravity 1.0.

Support Spacing vs. Specific Gravity

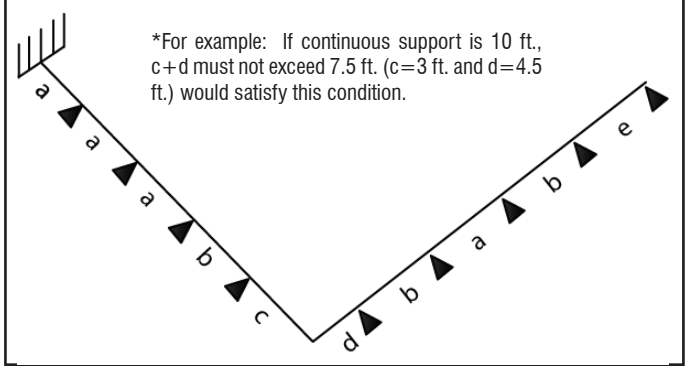
Specific Gravity	2.00	1.50	1.25	1.00	0.75
Multiplier	0.86	0.92	0.96	1.00	1.07

Example: 6" pipe @ 150°F with 1.5 specific gravity fluid, maximum support spacing = 19.1 x 0.92 = 17.6 ft.

Adjustment Factors for Various Spans With Unsupported Fitting at Change in Direction

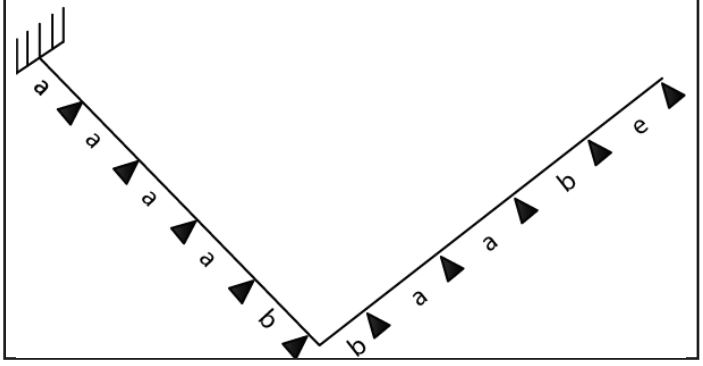
	Span Type	Factor
a	Continuous interior or fixed end spans	1.00
b	Second span from supported end or unsupported fitting	0.80
c+d	Sum of unsupported spans at fitting	≤0.75*
e	Simple supported end span	0.67

*For example: If continuous support is 10 ft., c+d must not exceed 7.5 ft. (c=3 ft. and d=4.5 ft.) would satisfy this condition.



Adjustment Factors for Various Spans With Supported Fitting at Change in Direction

	Span Type	Factor
a	Continuous interior or fixed end spans	1.00
b	Second span from simple supported end or unsupported fitting	0.80
e	Simple supported end span	0.67



Thermal Expanson

The effects of thermal gradients on piping systems may be significant and should be considered in every piping system stress analysis. Pipe line movements due to thermal expansion or contraction may cause high stresses or even buckle a pipe line if improperly restrained. Several piping system designs are used to manage thermal expansion and contraction in above ground piping systems. They are listed below according to economic preference:

1. Use of inherent flexibility in directional changes
2. Restraining axial movements and guiding to prevent buckling
3. Use expansion loops to absorb thermal movements
4. Use mechanical expansion joints to absorb thermal movements

To perform a thermal analysis the following information is required:

1. Isometric layout of piping system
2. Physical and material properties of pipe
3. Design temperatures
4. Installation temperature (Final tie in temperature)
5. Terminal equipment load limits
6. Support movements

A comprehensive review of temperature effects on fiberglass pipe may be found in NOV Fiber Glass Systems' **"Engineering and Piping Design Guide", Manual No. E5000, Section 3.**

Change in Temperature °F	Pipe Change in Length (In/100 Ft)
25	0.4
50	0.8
75	1.1
100	1.5
125	1.9
150	2.3

Restrained Thermal End Loads and Guide Spacing

Size (In)	Operating Temperature °F (Based on installation temperature of 75°F)									
	125		150		175		200		225	
	Guide Spacing (Ft)	Thermal End Load (Lbs)	Guide Spacing (Ft)	Thermal End Load (Lbs)	Guide Spacing (Ft)	Thermal End Load (Lbs)	Guide Spacing (Ft)	Thermal End Load (Lbs)	Guide Spacing (Ft)	Thermal End Loads (Lbs)
1	6.3	145	5.2	190	4.6	220	4.2	235	3.9	230
1½	9.2	240	7.6	315	6.6	365	6.1	385	5.7	380
2	11.3	370	9.3	490	8.2	565	7.4	595	7.0	585
3	16.8	550	13.9	720	12.2	835	11.1	885	10.4	870
4	21.8	680	18.0	908	15.8	1,040	14.4	1,100	13.5	1,080
6	32.1	1,420	26.5	1,870	23.3	2,170	21.2	2,190	19.9	2,250
8	42.2	2,350	34.8	3,110	30.6	3,600	27.9	3,800	26.1	3,740
10	52.2	3,660	43.1	4,850	37.9	5,600	34.5	5,930	32.3	5,820
12	61.8	4,790	51.0	6,340	44.8	7,330	40.9	7,750	38.3	7,610
14	70.5	5,980	58.2	7,910	51.2	9,140	46.6	9,670	43.7	9,490
16	80.6	7,740	66.5	10,240	58.4	11,830	53.3	12,520	49.9	12,290

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