Z-Core® Product Data

Applications

- Sulfuric Acid
- Hydrochloric Acid
- Solvents
- Caustics
- Process Drains

Materials and Construction

Z-Core pipe is a centrifugally cast fiberglass pipe with a 100 mil resin-rich liner and is available in 1" through 8" diameters. The pipe is rated for temperatures to 275°F and for pressures to 150 psig (higher pressures available on request).

Z-Core has a resin-rich 10 mil reinforced corrosion barrier on the outside surface which provides superior resistance to exterior corrosion. The resin-rich exterior also offers protection against "fiber blooming" caused by ultraviolet radiation. Pipe and fittings are warranted against reduction of physical and corrosion ratings due to ultraviolet exposure for a period of 15 years.

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

Socket Joint
Adhesive bonded straight socket joint with positive stops.
This is the standard for Centricast piping systems.

Nominal Dimensional Data

Pipe Size (In)	I.D.		O.D.		Wall Thickness		Reinforcement Thickness		Weight		Capacity	
	(In)	(mm)	(In)	(mm)	(In)	(mm)	(In)	(mm)	(Lbs/Ft)	(kg/m)	(Gal/Ft)	(Ft^3/Ft)
1	0.92	23.2	1.315	33.4	0.20	5.1	0.09	2.3	0.67	0.99	0.03	0.005
1½	1.40	35.6	1.900	48.3	0.25	6.4	0.14	3.6	1.24	1.84	0.08	0.011
2	1.88	47.6	2.375	60.3	0.25	6.4	0.14	3.6	1.59	2.36	0.14	0.019
3	3.00	76.2	3.500	88.9	0.25	6.4	0.14	3.6	2.43	3.62	0.37	0.049
4	3.94	100.1	4.500	114.3	0.28	7.1	0.17	4.3	3.54	5.26	0.63	0.085
6	5.88	149.2	6.625	168.3	0.38	9.5	0.27	6.7	7.02	10.43	1.41	0.189
8	7.79	197.7	8.625	219.1	0.42	10.7	0.31	7.9	10.32	15.34	2.48	0.331

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	0.35	0.07	0.10	0.70
1½	0.77	0.30	0.32	1.30
2	0.98	0.62	0.52	1.67
3	1.48	2.09	1.19	2.55
4	2.31	5.43	2.41	3.71
6	5.39	27.26	8.23	7.46
8	8.10	70.08	16.25	10.83

Average Physical Properties

Property	75°F/24°C				250°F/121°C				275°F/135°C			
	1"		1½"-8"		1"		1½"-8"		1"		1½"-8"	
	psi	MPa	psi	MPa	psi	MPa	psi	MPa	psi	MPa	psi	MPa
Axial Tensile - ASTM D2105												
Ultimate Stress	23,000	159	29,000	200	15,000	100	19,000	131	13,500	93	17,500	121
Modulus of Elasticity	-	-	1.9×10^6	13,100	-	-	1.6×10^6	11,000	-	-	1.5×10^6	10,300
Poisson's Ratio ν	0.15				0.15				0.15			
Axial Compression - ASTM D695												
Ultimate Stress	20,000	138	26,000	179	21,000	145	22,000	152	20,000	138	21,000	145
Modulus of Elasticity	4.7×10^6	32,400	6.4×10^6	44,126	1.4×10^6	9,653	1.8×10^6	12,411	1.0×10^6	6,895	1.1×10^6	7.860
Beam Bending - ASTM D2925												
Ultimate Stress	50,000	345	42,000	290	32,000	221	27,000	186	29,000	200	25,000	172
Modulus of Elasticity (Long Term)	6.0×10^5	4,137	4.0×10^6	27,579	1.8×10^5	1,241	1.2×10^6	8,274	1.2×10^5	827	8.0×10^5	5,516
Hydrostatic Burst - ASTM D1599												
Ultimate Hoop Tensile Stress	28,000	193	11,000	76	NA				NA			
Hoop Tensile Modulus of Elasticity	-	-	2.1×10^6	14,686								

Thermal Expansion Coefficient - ASTM D696	Non-Insulated Pipe: 9.2×10^{-6} in/in/°F Insulated Pipe: 1.04×10^{-5} in/in/°F	1.7×10^{-5} mm/mm°C 1.9×10^{-5} mm/mm/°C
Thermal Conductivity	0.09 BTU / ft-hr-°F	0.16 W/m-°C
Specific Gravity - ASTM D792	2.20	
Hazen-Williams Coefficient	150	
Absolute Surface Roughness	0.00021 in	0.0053 mm
Manning's Roughness Coefficient, n	0.009	

Testing:

See ***Pipe Installation Handbook for Hydrostatic Testing and System Startup.***

When possible, NOV Fiber Glass Systems piping systems should be hydrostatically tested prior to being put into service. Care should be taken when testing, as in actual service, to avoid water hammer. **All anchors, guides and supports must be in place prior to testing the line.**

Test pressure should not be more than 1½ times the working pressure of the piping system and never exceed 1½ times the rated pressure of the lowest rated component in the system.

Steam Cleaning:

Z-CORE piping systems can be steam cleaned under the following conditions:

1. The piping must be open-ended to prevent pressure buildup.
2. A maximum steam pressure of 45 psig must not be exceeded. (Temperature not to exceed 275°F.)
3. To prevent pipe sagging at the steam cleaning temperature, support spacing must be adjusted for 275°F service.

Pressure Ratings[1]

Pipe Size In	Max Internal Pressure @ 275°F (psig)			Maximum External Pressure (psig)[5]		
	Socket Pressure Fittings [2]	Flg'd Pressure Fittings [3]	Other Pressure Fittings [4]	75°F	200°F	275°F
1	275	275	NA	2,125	1,700	1,381
1½	275	275	125	2,065	1,652	1,342
2	275	275	125	1,170	931	763
3	175	150	100	335	267	219
4	150	150	100	225	179	147
6	150	150	100	62	49	40
8	150	150	100	45	36	29

[1] Specially fabricated higher pressure fittings are available on request. Consult the factory for compressible gases. Heat cured joints are recommended for all piping systems carrying fluids at temperatures above 120°F.

[2] Socket elbows, tees reducers, couplings, flanges and nipples joined with **WELDFAST ZC-275** adhesive.

[3] Flanged elbows, tees, reducers, couplings and nipples assembled at factory.

[4] Laterals and crosses.

[5] Ratings shown are 50% of ultimate; 14.7 psi external pressure is equal to full vacuum.

NA = Not available at time of printing.

ASTM D2997 Designation Codes:

1"	RTRP-21CO-3406
1½" - 6"	RTRP-21CO-1446
8"	RTRP-21CO-1445

Recommended Operating Ratings

Size In	Axial Tensile Loads Max. (Lbs) Temperature 75°F	275°F	Axial Compressive Loads Max. (Lbs)[1] Temperature 75°F	275°F	Bending Radius Min. (Ft) Entire Temp. Range	Torque Max. (Ft Lbs) Entire Temp. Range	Parallel Plate Loading ASTM D2412 Stiffness Factor $In^3/ Lbs/In^2$	Pipe Stiffness (psi)	Hoop Modulus $x10^6$ (psi)
1	1,990	1,200	1,730	1,700	50	41	170	4,968	2.8
1½	5,610	3,400	5,030	4,100	60	132	869	8,558	3.8
2	7,130	4,300	6,390	5,200	75	216	2,287	10,997	10.0
3	10,710	6,500	9,610	7,800	111	497	2,515	3,560	11.0
4	16,770	10,100	15,030	12,100	143	1,005	4,094	2,708	10.0
6	39,080	23,580	35,040	28,300	210	3,373	10,080	2,104	6.5
8	58,710	35,400	52,640	42,500	274	6,771	10,179	951	4.1

[1]Compressive loads are for short columns only.

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)
1-8	20

*Pipe is offered in random lengths from 18.0 to 20.4 feet long.

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]

	Continuous Spans of Pipe (Ft.) [2]			
(In.)	75°F	250°F	275°F	Gas 75°F
1	8.2	6.1	5.5	9.0
1½	16.3	12.1	10.9	18.2
2	17.7	13.1	11.9	20.4
3	20.3	15.0	13.6	24.9
4	22.9	16.9	15.3	28.8
6	28.4	21.0	19.0	36.2
8	31.7	23.5	21.2	41.8

[1] Consult factory for insulated pipe support spacing.
[2] Maximum mid-span deflection ½" with a specific gravity of 1.0

Support Spacing vs. Specific Gravity

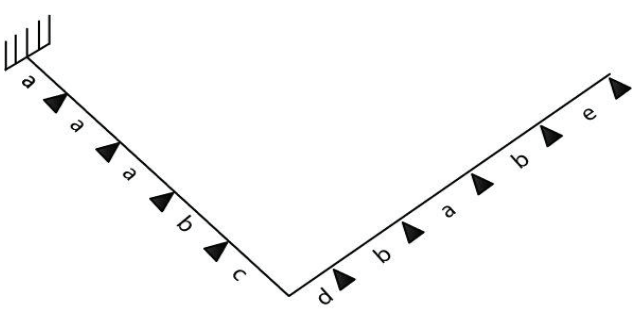
Specific Gravity	2.00	1.50	1.25	1.00	0.75
Multiplier	0.80	0.93	0.96	1.00	1.04

Example: 6" pipe @ 250°F with 1.5 specific gravity fluid, maximum support spacing = 21 x 0.93 = 19.5 ft.

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

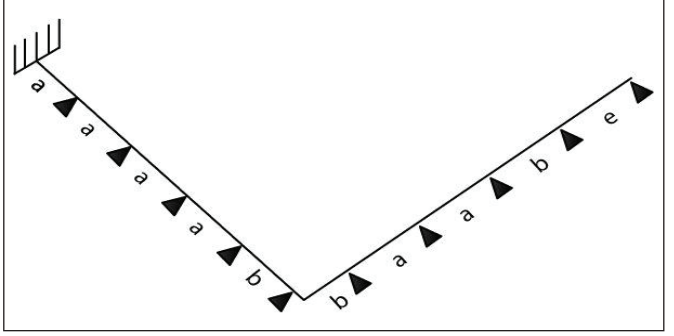
	Span Type	Factor
a	Continuous interior or fixed end spans	1.00
b	Second span from supported end or unsupported fitting	0.80
c+d	Sum of unsupported spans at fitting	≤0.75*
e	Simple supported end span	0.67

*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 Expansion

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.**

Unrestrained Thermal Expansion Uninsulated Pipe [1]	
Change in Temperature °F	**Pipe Change in Length (In/100 Ft)**
25	0.28
50	0.55
75	0.83
100	1.10
125	1.38
150	1.66
175	1.93
200	2.21
225	2.48
250	2.76
275	3.04

[1] Consult the factory for thermal expansion and compressive end loads of insulated pipe.

Restrained Thermal End Loads and Guide Spacing

Size (In)	Operating Temperature °F (Based on installation temperature of 75°F)									
	100		150		200		250		275	
	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 Load (Lbs)
1	2.7	335	1.5	767	1.2	904	1.0	781	0.9	637
1½	8.5	1,026	4.9	2,388	3.8	2,813	3.2	2,243	3.0	1,567
2	10.8	1,302	6.2	3,032	4.8	3,572	4.1	2,849	3.8	1,990
3	16.2	1,958	9.4	4,558	7.3	5,370	6.1	4,283	5.7	2,991
4	20.9	3,064	12.1	7,133	9.4	8,404	7.9	6,702	7.4	4,681
6	30.7	7,141	17.7	16,626	13.7	19,589	11.6	15,622	10.9	10,910
8	40.1	10,728	23.2	24,976	18.0	29,428	15.2	23,468	14.2	16,390

Allowable Bending Moment 90° Elbow	
Pipe Size (In)	**Allowable Moment (Ft /Lbs)**
1	100
1½	150
2	225
3	475
4	650
6	1,650
8	2,850

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