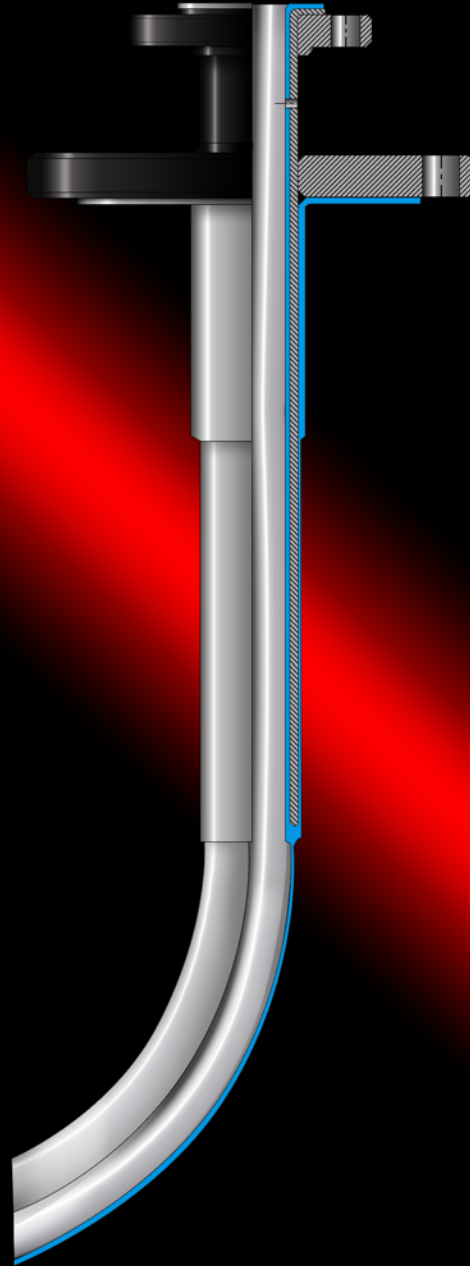


ETHYLARMOR®

Dip Pipes and Spargers



ETHYLARMOR® Dip Pipe

High Temperature Corrosion Resistance

Ethylene Ethylarmor Dip Pipes and Spargers combine the high temperature and near-universal corrosion resistance of PTFE with the mechanical strength of an encapsulated Schedule 80 carbon steel pipe for tough applications such as agitated reactors.

Durability

Ethylarmor Dip Pipes and Spargers pass both the ASTM F423 steam-cold water cycle test and a 10,000-volt electrostatic spark test, the industry's most rigorous testing program. This virtually eliminates the possibility of heat-seal failure and resultant damage to the reactor's fragile glass lining.

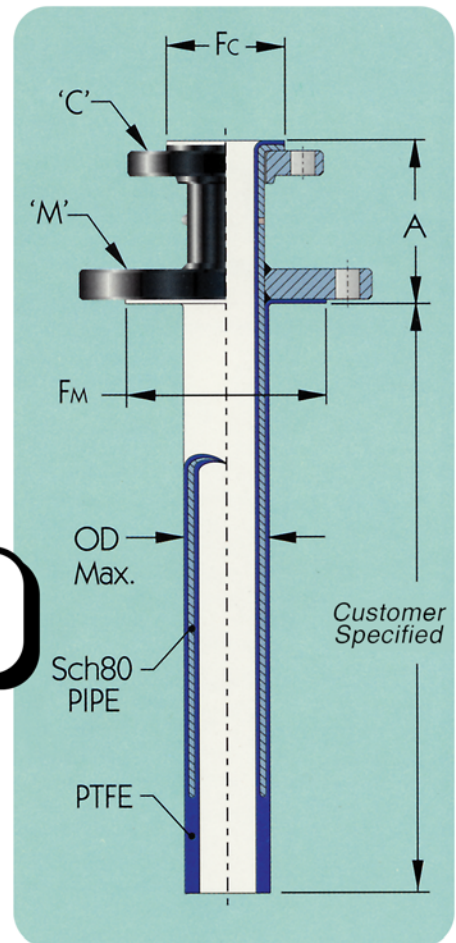
Design

A broad range of optional features are available to meet your process requirements. These include Diverters (to direct liquid/gas flow away or towards vessel walls), Extended Flares (to eliminate additional reducing flanges), Sparger, Anti-Siphon Holes, ect.

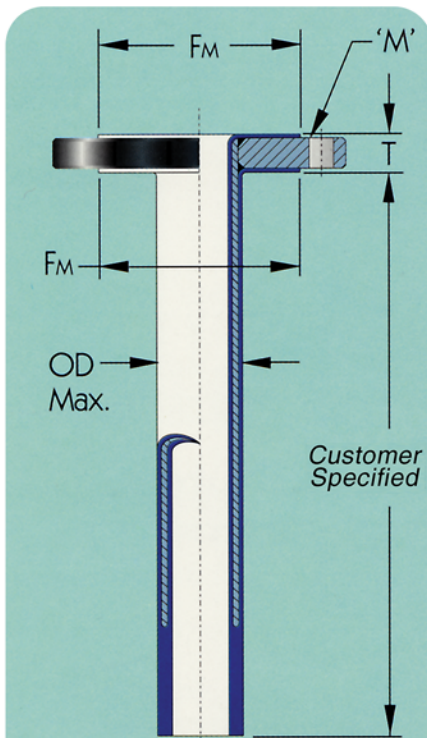
**ETHYLENE Dip Pipes and Spargers Withstand
The Heat, Corrosion and Stress of Your Most
Demanding Processes**

ETHYLARMOR® DF and SF Dip Pipes

These standard dip pipes can be supplied in a variety of diameters and length configurations. Maximum recommended unsupported length for agitated service is shown in Table 1 (a general guide only). Ethylene will review your specific service conditions (please see pages 6 and 7 of this bulletin: Bending Moment Calculations) and advise a suitable dip pipe construction. See Table 1 and Table 2 for available sizes and lengths.



Ethylarmor® DF Dip Pipe



Available in 2" through 8" sizes

Ethylarmor® SF Dip Pipe

Table 1: Ethylarmor SF and DF Dip Pipe Data

Nominal Size	PTFE Wall	Connecting Flange	Mounting Flange	PTFE Flare		A	T	Max.
		'C'	'M'	F _c	F _m			OD
3/4	.090	3/4	1 1/2	1 11/16	2 7/8	5	-	1 3/8
1	.090	1	2*	2	3 5/8	5	-	1 5/8
1 1/2	.125	1 1/2	2*	2 7/8	5	5	-	2 1/4
			3/4		6 3/16			2 1/4
			6		8 1/2			2 9/16
			8		10 5/8			2 9/16
2	.125	2	3*	3 5/8	5	5	1	2 13/16
			4		6 3/16			3
			6		8 1/2			3
3	.125	3	4*	5	6 3/16	5	1 3/16	3 15/16
			6		8 1/2			4 1/8
			8		10 5/8			4 1/8
4	.150	4	6*	6 3/16	8 1/2	6	1 1/4	4 15/16
			8		10 5/8			5 1/4
6	.150	6	8*	8 1/2	10 5/8	6	1 3/8	7 1/16
			10*		12 3/4			9 3/16

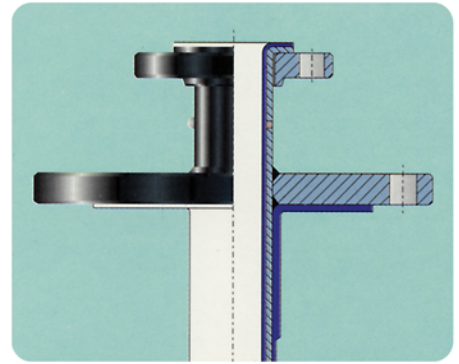
All dimensions in inches. Now available to 16" CL 150 vessel mounting flanges.

* Denotes size of Mounting Flanges available on SF type dip pipes.

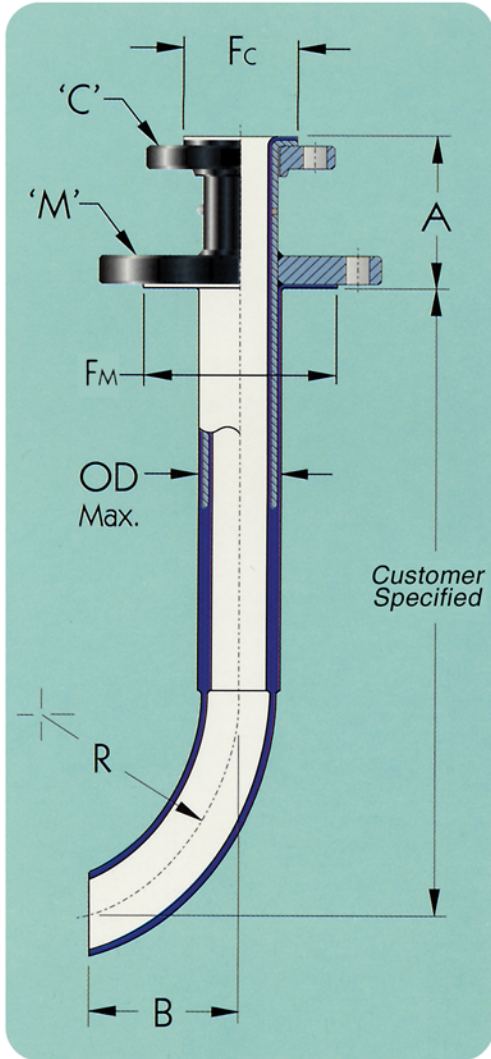
Extended Flare Technology

Ethylene's Extended Flare Face technology eliminates costly reducing flanges by allowing oversized mounting flanges to be integrated into dip pipe fabrication. This is also an important factor in the reduction of fugitive emissions; fewer connections mean fewer leak points. The extended flare is subjected to the same rigorous steam-cold water and 10,000-volt electrostatic spark tests as other Ethylarmor products.

Table 1 gives the mounting and connecting flange combinations available on DF Dip Pipes.



DF Dip Pipe with Extended Flare



Ethylarmor® Diverter Pipe

ETHYLARMOR® Diverter Pipe

A unique tight radius bend capability is ideal when a diverter is required to deflect liquid or gas either toward or away from a vessel wall. The curvature at the bottom of the pipe simplifies the installation of the dip pipe in reactors with limited overhead space. Variations of the standard diverter's geometry can be accommodated in most cases. Please consult Ethylene for assistance.

Table 2 below gives standard bend radii and offsets available.

Table 2: Diverter Data

Nominal Size	B (Nom.)	R (Nom.)	A (Nom.)	Max. OD
1	4	6	5	1 ⁵ / ₈
1½	5	8	5	2¼
2	6	10	5	2 ¹³ / ₁₆
3	6	16	5	3 ¹⁵ / ₁₆
4	8	20	6	4 ¹⁵ / ₁₆

All dimensions in inches.

See Table 1 for Connection and Mounting Flange Data.

Color Legend



Special Orders

Ethylene prides itself on its ability to respond to customer needs. Please consult the factory for information on items not shown in this catalog.

ETHYLARMOR® AGI Dip Pipe

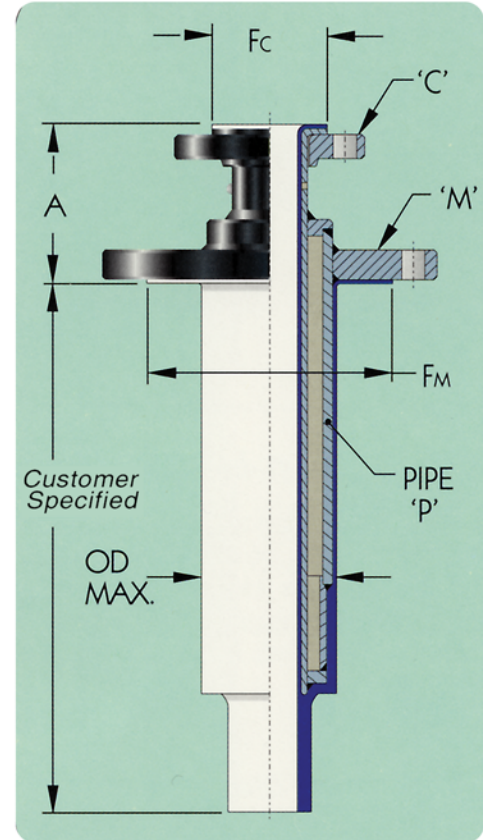
for Severe Agitation Service.

The AGI Dip Pipe is intended for use in services where the combination of length and loading prohibit the use of standard Ethylarmor DF Dip Pipes. The larger outer diameter reinforcing pipe significantly increases the ability of the dip tube to withstand external loading. Severe agitation applications of smaller diameter Ethylarmor dip pipes may require additional reinforcement of the dip pipe. Ethylene can offer Schedule 120 or even Schedule 160 reinforcing pipe for special applications.

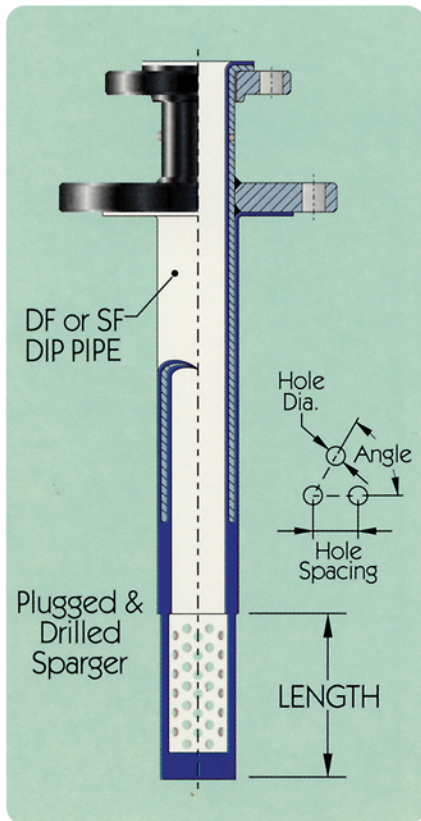
Table 3: Ethylarmor AGI Dip Pipe Data

Nominal Size	Connecting Flange	Mounting Flange	Reinforcing Pipe	PTFE Flare		A	Max. OD
	'C'	'M'		FC	FC		OD
1	1	4 6 8	3	2	6 ³ / ₁₆ 8 ¹ / ₂ 10 ¹ / ₂	5	3 ¹⁵ / ₁₆ 4 ¹ / ₄ 4 ¹ / ₄
1 ¹ / ₂	1 ¹ / ₂	4 6 8	3	2 ⁷ / ₈	6 ³ / ₁₆ 8 ¹ / ₂ 10 ¹ / ₂	5	3 ¹⁵ / ₁₆ 4 ¹ / ₄ 4 ¹ / ₄
1 ¹ / ₂	1 ¹ / ₂	6 8	4	2 ⁷ / ₈	8 ¹ / ₂ 10 ¹ / ₂	6	4 ¹⁵ / ₁₆ 5 ³ / ₈
2	2	6 8	4	3 ⁵ / ₈	8 ¹ / ₂ 10 ¹ / ₂	6	4 ¹⁵ / ₁₆ 5 ⁵ / ₈

All dimensions in inches.



Ethylarmor® AGI Dip Pipe



Ethylarmor® DF Sparger

ETHYLARMOR® Spargers

Ethylarmor Spargers are ideal for steam entrainment or other applications where diffusion of the process fluid is desired. The bottom section of the sparger is an integral part of the encapsulating PTFE liner. It is designed to provide a radial spray that can be tailored to your exact requirements. Spargers can be drilled to your specifications: number and diameter of holes, distance from the end of the pipe and length of drilled section can all be specified.

If not otherwise specified, the drilling shown in Table 4 below is provided.

Table 4: Spargers Dimensions

Nominal Size	Length	Hole Number	Hole Diameter	Hole Spacing	Angle
1	2	16	1/4	1.02	60°
1 ¹ / ₂	6	16	3/8	1.47	60°
2	6	32	3/8	1.25	60°
3	8	40	1/2	1.38	60°
4	10	64	1/2	1.77	60°

All dimensions in inches.

Solid PTFE Dip Tubes and Spargers

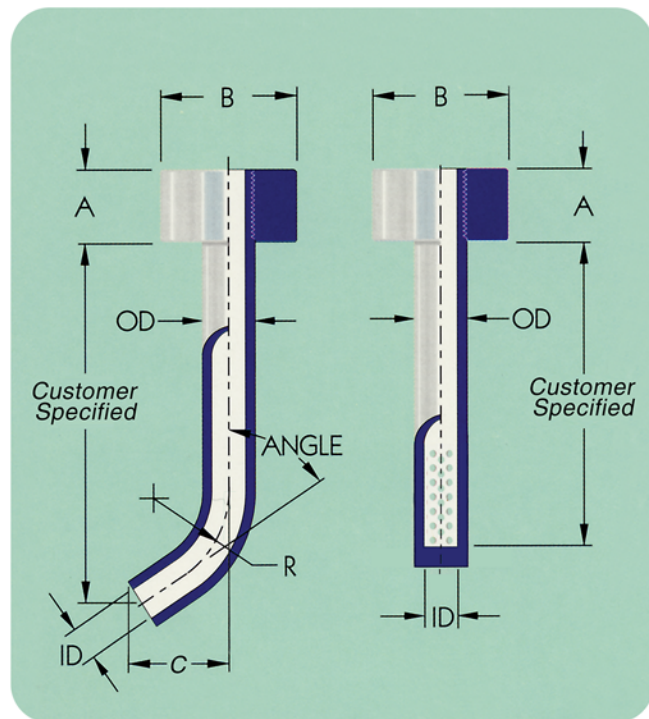
Ethylene solid PTFE Dip Tubes and Spargers are fabricated from heavy-walled virgin PTFE tubes. All flanges are threaded onto the tube and pinned in place. Spargers are drilled to your specifications; number and diameter of holes, distance from the end of the tube and length of drilled section.

Consult Ethylene for applications involving non-standard sizes or multiple bend configurations. Table 5 below gives dimensions.

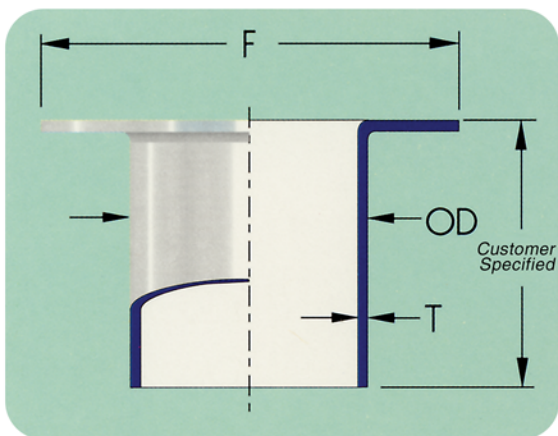
Table 5: Solid Dip Tube Dimensions

Minimum Dia.	Nozzle Size	OD	ID	A	B	C	R
1/2	1	1	1/2	1	2	5	4
1	1 1/2	1 3/8	7/8	1 1/2	2 7/8	5	6
1 1/2	2	1 7/8	1 1/8	1 3/4	3 5/8	5	8
2	3	2 3/4	2	2	5	5	10
3	4	3 1/2	2 1/2	2 3/4	6 3/16	5	16
4	6	4	3	3	8 1/2	6	20

All dimensions in inches.



Solid Dip Tubes, Diverters and Spargers.



Nozzle Liners

Used in glass lined steel reactors and vessels, Ethylene nozzle liners eliminate damage to fragile nozzles during the insertion and operation of the dip pipes, spargers and instrumentation. Nozzle liners also reduce erosion of the glass or alloy vessel nozzle by steam or abrasive materials, preventing process contamination and expensive repairs. Solid build-up is also reduced. They are provided in lengths to meet your exact requirements.

Table 6: Nozzle Liner Dimensions

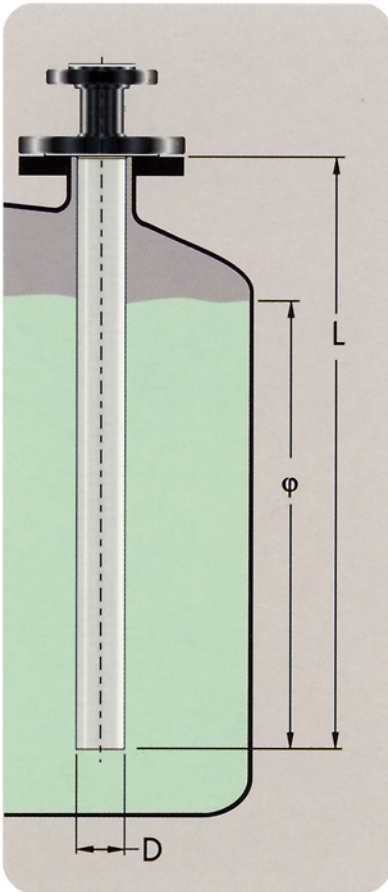
Nozzle Size	OD	Flare F	Wall T	Nozzle Size	OD	Flare F	Wall T
1/2	1/2	1 3/8	1/16	4	3 13/16	6 3/16	1/8
3/4	3/4	1 11/16	1/16	6	5 3/4	8 1/2	1/8
1	1 5/16	2	1/16	8	7 3/4	10 5/8	1/8
1 1/2	1 7/16	2 7/8	1/16	10	9 3/4	12 3/4	5/32
2	1 15/16	3 3/8	1/16	12	11 3/4	15	5/32
3	2 15/16	5	1/8	14	13 3/4	16 1/4	5/32

Diameters through 36" are available.

Please consult the factory for diameters over 14".

Note: Nominal dimensions shown. All dimensions in inches.

Dip Pipe Calculation



Dip Pipes and spargers used in agitated service are subject to loads which under certain conditions can be so great that bending or complete failure of the unit can occur. Therefore, it is important that these loads be considered when designing or specifying a dip pipe or sparger for use in highly agitated service or service with highly viscous materials.

To determine these loads, the following must be known:

- V** - Velocity of the process fluid past the tip of the dip pipe (ft/sec)
- D** - Outside diameter of the dip pipe(ft) See Table 7
- L** - Entry Length of the dip pipe (ft)
- φ** - Length of the dip pipe immersed in the fluid (ft)
- μ** - Dynamic viscosity of the process fluid (lbs sec/ft²)
- ρ** - Mass density of the process fluid (slugs/ft³) [(1slug/ft³=32.17lb/ft³)]

The total force exerted on the pipe, F_T can be determined from the above information. F_T is the resultant of the drag and lift forces acting on the tube, F_D and F_L respectively. F_T is given by Equation 1.

$$F_T = \sqrt{F_D^2 + F_L^2} \tag{Equation 1}$$

The viscous drag force, F_D , is defined by Equation 2.

$$\text{when: } A = \phi D \quad F_D = \frac{C_D V^2 \rho A}{2} \tag{Equation 2}$$

The lift force, F_L , created by alternative vortex shedding on the back surface of the immersed pipe is given by Equation 3.

$$F_L = \frac{C_L \rho V^2 A}{2} \tag{Equation 3}$$

The coefficients for lift and drag, C_D and C_L , are based on the Reynolds number which can be calculated using Equation 4.

$$\text{Reynolds Number} \quad R = \rho \frac{DV}{\mu} \tag{Equation 4}$$

NOTE:

These equations are provided as a guide only and do not constitute a warranty, expressed or implied, for the fitness of an Etyharmor® Dip Pipe in specific service.

C_D can be calculated from Figure 1 shown below.

C_L is as follows:

when:

- $C_L = 0.8$ ($R < 10^5$)
- $C_L = 2.4 - 0.4 \log_{10} R$ ($10^5 \leq R \leq 10^6$)
- $C_L = 0.4$ ($R > 10^6$)

Figure 1: Factor C_D

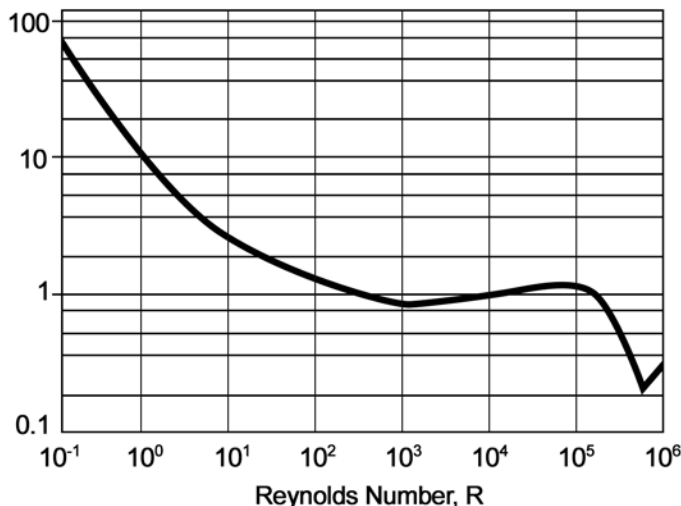


Table 7: Factors W_D , H and D

Nominal Size	W_D	H	D
3/4	1,877	11.75	0.101
1	3,533	18.79	0.123
1 1/2	9,064	41.62	0.179
2	16,080	66.79	0.219
3	48,970	147.02	0.312
4	93,940	247.88	0.401
6	187,000	573.19	0.583
8	369,820	981.23	0.760

Equation 1 can be rewritten as:

$$F_T = \frac{\rho V^2 A \sqrt{C_D^2 + C_L^2}}{2} \quad \text{Equation 5}$$

The value obtained by Equation 5 must be less than or equal to the maximum allowable load recommended by Ethylene for the selected unit. The maximum load, S_m , for a dip pipe or sparger is given by Equation 6:

$$S_m = \frac{W_D}{12(L - 0.5\phi)} \quad \text{Equation 6}$$

Where W_D is the factor given in table 7.

If $F_T \leq S_m$, the unit is sufficiently strong for the intended service. However, a check for resonance should be made. If the natural frequency of the dip pipe is too close to the wake frequency, resonance can occur in the dip pipe causing stresses much greater than expected. The natural and wake frequency must be calculated and the ratio of these frequencies must be greater than $\sqrt{2}$ or less than 0.5. The natural frequency of the dip pipe can be calculated using Equation 7 where the value of factor H is taken from Table 7.

$$W_n = 135 \sqrt{H/L^4} \quad \text{Equation 7}$$

The wake frequency, W , is calculated using Equation 8.

$$W = 0.22 \frac{V}{D} \quad \text{Equation 8}$$

The ratio W/W_n should be less than 0.5 or greater than $\sqrt{2}$

Example 1: Dip Pipe is Adequate

V , fluid velocity = 15(ft/sec)
 D , dip tube size = 3" or 0.312(ft) from Table 7
 L , entry length = 80" or 6.67(ft)
 ϕ , immersed length = 65" or 5.52(ft)
 μ , dynamic viscosity = 1.10 centipoise or
 = 2.298x10⁻⁵ lbs sec/ft²
 ρ , fluid mass density = 2.10 slugs/ft³

Step 1:

Determine Reynolds number
 $R = (2.10 \cdot 0.312 \cdot 15) / 2.298 \times 10^{-5} = 4.277 \times 10^5$

Step 2:

Determine C_D and C_L
 $C_D = 0.90$ (Fig. 1), $C_L = 2.4 - 0.4 \log_{10}(4.277 \times 10^5) = 0.148$

Step 3:

Calculate Force F_T using Equation 5,
 $F_T = 0.5 \cdot 2.10 \cdot 15^2 \cdot (.312 \cdot 5.42) \times \sqrt{0.9^2 + 0.148^2}$
 = 364 lbs

Step 4:

Calculate allowable force, S_m using Equation 6,
 $S_m = 48,970 / (12 \cdot (6.67 - 0.5 \cdot 5.41))$
 = 1,030 lbs

Since 364 < 1,030 a 3" dip pipe would be adequate for this application.

Step 5:

Determine the natural frequency, W_n , of the dip pipe from Equation 7.

$$W_n = 135 \sqrt{147.024 / 6.67^4} = 36.8 \text{ Hz}$$

Step 6:

Determine wake frequency, W , using Equation 8.

$$W = 0.22 \cdot 15 / 0.312 = 10.6 \text{ Hz}$$

Step 7:

Test ratio of $W/W_n = 10.6 / 36.8 = 0.29$

Since 0.29 < 0.5, the dip pipe passes the test

Example 2: Dip Pipe is Inadequate

V , fluid velocity = 15(ft/sec)
 D , Dip tube size = 1.5" or 0.179(ft) from Table 7
 L , entry length = 80" or 6.67(ft)
 ϕ , immersed length = 65" or 5.42(ft)
 μ , dynamic viscosity = 1.10 centipoise or
 2.298x10⁻⁵ sec/ft²
 ρ , fluid mass density = 2.10 slugs/ft³

Step 1:

Determine Reynolds number,
 $R = (2.10 \cdot 0.179 \cdot 15) / 2.298 \times 10^{-5} = 2.454 \times 10^5$

Step 2:

Determine C_D and C_L
 $C_D = 0.90$ (Fig. 1), $C_L = 2.4 - \log_{10}(2.454 \times 10^5) = 0.244$

Step 3:

Calculate force F_T using Equation 5.
 $F_T = 0.5 \cdot 2.10 \cdot 15^2 \cdot (.179 \cdot 5.42) \times \sqrt{0.9^2 + 0.244^2}$
 = 214 lbs

Step 4:

Calculate allowable force, S_m using Equation 6,
 $S_m = 9064 / (12 \cdot (6.67 - 0.5 \cdot 5.41))$
 = 191 lbs

Since 214 > 191 a 1.5" dip tube would NOT be suitable for this application.

Step 5:

Determine the natural frequency, W_n , of the dip tube from Equation 7.

$$W_n = 135 \sqrt{41.62 / 6.67^4} = 24.8 \text{ Hz}$$

Step 6:

Determine wake frequency, W , using Equation 8.

$$W = 0.22 \cdot 15 / 0.179 = 15.1 \text{ Hz}$$

Step 7:

Test ratio of $W/W_n = 15.1 / 24.8 = 0.61$

Since 0.5 < 0.61 < $\sqrt{2}$, the dip pipe fails the test.