TECHNICAL RESOURCES

+1 800 426 0191
+1 360 679 2528
www.idex-hs.com

How to Order

Direct from IDEX Health & Science

For North America orders:

Tel: +1 800 426 0191 / +1 360 679 2528
Fax: +1 800 359 3460 / +1 360 679 3830
E-mail: CustomerService.hs@idexcorp.com

For Europe orders:

Tel: +49 (0) 1801 808 800
Fax: +49 (0) 9377 1388
E-mail: CustomerService.hsEurope@idexcorp.com

For Asia orders:

E-mail: CustomerService.hsAsia@idexcorp.com

NORTH ASIA

Tel: +86 10 6566 9090 / +86 21 5241 5599
Fax: +86 10 6567 5152 / +86 21 5241 8338

SOUTHEAST ASIA AND OCEANIA

Tel: +65 6684 7307
Fax: +65 6795 8070

SOUTH ASIA

Tel: +91 22 66 78 55 50
Fax: +91 22 66 78 00 55

JAPAN

Tel: +81 48 240 5750
Fax: +81 48 259 0715

For Online orders:

Web: www.idex-hs.com

Please include the following information with your order: Purchase Order Number, Contact Name, Shipping and Billing Address, Telephone Number, Product Number(s) and Quantity(ies). If you are a Purchasing Agent, please include the name of the person for whom the products are ordered.

For your information, our U.S. Federal Taxpayer Identification number is 01-0736657; European Taxpayer Identification number is DE 146581180.

Order Processing/Shipping

Orders process within one business day and ship within two business days. Requests for earlier shipments can be made — please contact IDEX Health & Science for more details.

All shipments are FCA unless otherwise noted. Shipping charges will be prepaid and added to the invoice. Or, if requested, we will charge your carrier account number.

Terms

Terms of payment are net 30 days. **Credit cards are accepted for orders placed directly with our U.S. site. No international credit card payment is possible.** Customers are responsible for C.O.D. charges if they elect this payment method. Terms and prices are subject to change without notice. Visit www.idex-hs.com for complete Terms & Conditions.

Return of Materials

Returns must be authorized in advance. Please contact us within 30 days of purchase for your Returns Material Authorization (RMA) Number. A restocking fee may apply.

Customer Number:

Direct from our Global Distribution Network

The IDEX Health & Science brands represented in this catalog (Ismatec®, Isolation Technologies™, Rheodyne®, Systec®, and Upchurch Scientific®) have established relationships with a large, global network of Distributors, many of whom can offer the product support and assistance that we cannot, including:

- Carrying local inventory of commonly-ordered items
- Understanding YOUR working environment and requirements
- Providing technical application assistance
- Answering questions regarding new and existing products
- Complete availability during your time zone business hours
- Personal visits as required
- Access to complementary product lines to provide a "one-stop shopping" experience

We have come to rely on our authorized Distributors to provide value-added service to end-users of our products. So, while we are happy to take your order directly, we encourage you to contact your local Distributor — we feel confident it will be a positive experience!

How to Find A Local Distributor

For a complete distributor listing please visit www.idex-hs.com/distributors or email:

US: CustomerService.hs@idexcorp.com
Europe: CustomerService.hsEurope@idexcorp.com
Asia: CustomerService.hsAsia@idexcorp.com

Our customer service team will help you contact a distributor in your area.

Return of Materials

Product purchased through a Distributor must be returned directly to that Distributor. Please contact them for Return Material Authorization procedures.

The products in this catalog are intended for use with analytical, biotechnology and diagnostic equipment and accessories. THE MANUFACTURERS OF THE PRODUCTS IN THIS CATALOG SHALL HAVE NO LIABILITY WHATSOEVER DUE TO ANY MISUSE OF THEIR PRODUCTS. Of course, the safe use of our products depends on our customers, since it is you who select and control the protective gear and safety procedures used, as well as the pressures, temperatures, solvents, samples, ventilation, and other variables. Product and material performance ratings are provided as guides only. Individual field tests should be performed by customers to determine safe operating parameters given your particular procedures and use.

IDEX Health & Science facilities are certified ISO 9001. Some facilities are also certified ISO 13485:2003.

Visit us online!
www.idex-hs.com

Technical Resources available at www.idex-hs.com

Help is only a click away at www.idex-hs.com! To access a wealth of product and application support information, including:

Fittings Primer

Learn how to:

- Describe the fittings needed for your application
- Classify your fitting needs

Visit **www.idex-hs.com/fittings_primer**

Conversion Tools

- Calculator to help determine volumes and tubing sizes to achieve specific volume requirements
- Conversion calculators for pressure, temperature and length

Visit **www.idex-hs.com/conversions**

Materials Guide

- Material Properties Guide
- Chemical Compatibility
- Polymer Information Summary

Visit **www.idex-hs.com/materials**

Standard Port Drawings

- 6-40 flat-bottom
- 6-32 coned
- 10-32 coned and flat-bottom
- 1/4-28 coned and flat-bottom
- 5/16-24 flat-bottom
- 1/2-20 flat-bottom
- M6 flat-bottom

Visit **www.idex-hs.com/standard_ports**

Please Note: For more information regarding the properties of the polymers listed below, please refer to www.idex-hs.com/materials. Find refractive index data on pages 62 and 70; gas permeability data on pages 75–76.

Delrin® (acetal). Delrin exhibits excellent chemical resistance to most organic solvents as well as to most neutral-pH aqueous solvents. However, it is not suitable for use with acids, bases or oxidizing agents. This polymer's high tensile strength yields superior, highly wear-resistant threads and excellent thread strength.

FEP (fluorinated ethylene-propylene) and **PFA** (perfluoroalkoxy alkane). Both of these polymers are in the same family as PTFE, and as such are inert to virtually all chemicals used in HPLC. However, because of their relative softness and low durability, these polymers are generally used for low pressure applications. Choose PFA for high purity applications, or choose FEP as a general, all-purpose material. Both FEP and PFA have good thread strength.

Halar® ECTFE (ethylene-chlorotrifluoroethylene). Halar is a member of the fluoropolymer family. It offers excellent chemical resistance coupled with a mechanical strength superior to many other fluoropolymers. Halar also outperforms PTFE and similar fluoropolymers in ability to withstand radiation, making it an attractive alternative for medical applications. Its exceptionally smooth surface enhances optical clarity while also helping prevent the shedding of microparticles into the fluid stream.

PCTFE (polychloro-trifluoroethylene). PCTFE has excellent chemical resistance. In general, only THF and a few halogenated solvents will react with it. This resilient fluoropolymer is ideal for fittings and sealing surfaces and also has good thread strength.

PEEK (polyetheretherketone). PEEK polymer is the flagship member of the poly(aryl)ether ketone family of polymers. It has excellent chemical resistance to virtually all commonly used solvents. However, the following solvents are usually not recommended for use with PEEK: nitric acid; sulfuric acid; halogenated acids, such as hydrofluoric acid and hydrobromic acid (hydrochloric acid is approved for use in most applications); and pure halogenated gases. Additionally, due to a swelling effect, be cautious in using the following solvents with PEEK tubing: methylene chloride, THF, and DMSO in any concentration and acetonitrile in higher concentrations. Excellent thread strength.

PK A proprietary polymer blend comprised mainly of polyetheretherketone (PEEK). PK demonstrates all of the superior chemical resistance of PEEK (see PEEK above). The proprietary blend however, will allow a fitting to attain a higher pressure while reducing the cold flow properties of pure PEEK. CAUTION: some fittings molded of PK are known to be conductive. Use caution when employing PK fittings in high voltage applications.

Polypropylene Polypropylene is a relatively soft polymer commonly used in low pressure applications, and is especially prevalent in IVD and similar equipment. Polypropylene is excellent for aqueous solutions; however, it should not be used with chlorinated, aromatic, and some organic solvents. Fair thread strength.

PPS (polyphenylene sulfide). PPS is a resilient polymer known for its high tensile strength and excellent chemical resistance. PPS may be safely used at room temperature with most organic solvents and neutral-to-high pH aqueous solvents. However, it is not recommended for use with chlorinated solvents, inorganic acids, or any solvent at elevated temperatures.

Radel® (polyphenylsulphone). Radel is an amorphous thermopolymer that is mechanically strong and offers good chemical resistance. This polymer withstands repeated autoclave sterilization cycles without suffering thermal breakdown. This property, coupled with its optical clarity, makes Radel tubing an excellent choice for medical and other applications where visual monitoring is essential. Radel is also a readily wetted material, minimizing air bubble accumulation on the inner walls of tubing manufactured with this polymer.

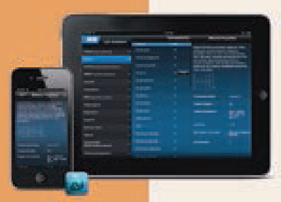
ETFE (ethylene-tetrafluoroethylene). As a member of the fluoropolymer family, ETFE has excellent solvent resistance. Its physical properties make it ideal for demanding sealing applications. While most commonly used solvents do not interact with ETFE, take caution when using some chlorinated chemicals. ETFE has good thread strength.

UHMWPE (ultra-high molecular weight polyethylene). UHMWPE is a well-known and durable manufacturing polymer. Its physical properties make it ideal for general, aqueous-based environments. Take caution when using this polymer in heavily organic-based applications. Good thread strength.

Ultem® PEI (polyetherimide). An amorphous thermoplastic offering high heat resistance, high strength, and broad chemical resistance. Tubing made from Ultem offers a high degree of transparency. This polymer withstands various sterilization methods, such as repeated autoclaving as well as gamma radiation, ethylene oxide gas, and dry heat. Ultem meets the criteria for ISO10993, FDA, and USP Class VI certification.

Vespel® (polyimide). Vespel thermoplastic offers high heat resistance, high mechanical strength, and broad chemical resistance in most common liquid chromatography applications. However, it is particularly susceptible to attack by high pH chemical environments. Vespel can be autoclaved and sterilized using gamma radiation. Vespel offers inherent lubricity, making it ideal as a chemically resistant bearing surface.

RoHS Compliance Search for RoHS at www.idex-hs.com. For items not included in the catalog, please contact IDEX Health & Science directly.



+1 800 426 0191
+1 360 679 2528
www.idex-hs.com

The fluid transfer community uses both the International System of Units (Metric System) and the U.S. Customary System. To access automatic conversion calculation tools, please go to **www.idex-hs.com/conversions**.

Dimensions — Inches to Metric

Decimal Inches	Fractional Inches	Metric
0.031″	1/32″	0.79 mm
0.062″	1/16″	1.57 mm
0.125″	1/8″	3.18 mm
0.188″	3/16″	4.78 mm
0.250″	1/4″	6.35 mm
0.313″	5/16″	7.95 mm
0.375″	3/8″	9.53 mm
0.438″	7/16″	11.13 mm
0.500″	1/2″	12.70 mm
0.563″	9/16″	14.30 mm
0.625″	5/8″	15.88 mm
0.688″	11/16″	17.48 mm
0.750″	3/4″	19.05 mm
0.813″	13/16″	20.65 mm
0.875″	7/8″	22.23 mm
0.938″	15/16″	23.83 mm
1″	1″	2.54 cm
2″	2″	5.08 cm
3″	3″	7.62 cm
4″	4″	10.16 cm
5″	5″	12.70 cm
6″	6″	15.24 cm
7″	7″	17.78 cm
10″	10″	25.40 cm

Dimensions — Metric to Inches

Metric	Decimal Inches
1.0 mm	0.039″
1.8 mm	0.071″
2.0 mm	0.079″
3.0 mm	0.118″
3.2 mm	0.126″
4.0 mm	0.157″
4.3 mm	0.169″
4.6 mm	0.181″
5.0 mm	0.197″
6.0 mm	0.236″
7.0 mm	0.276″
8.0 mm	0.315″
9.0 mm	0.354″
1.0 cm	0.394″
2.0 cm	0.787″
3.0 cm	1.181″
4.0 cm	1.575″
5.0 cm	1.969″
6.0 cm	2.362″
7.0 cm	2.756″
8.0 cm	3.150″
9.0 cm	3.543″
10.0 cm	3.937″

Conversion Factors

Conversion Desired	Formula
Inches to millimeters	Inches x 25.4 mm/in.
Inches to centimeters	Inches x 2.54 cm/in.
Inches to microns	Inches x 25.4 mm/in. x 1,000 µm/mm
Diameter in inches to linear volume (µL/inch)*	12870.4 (d2)
Diameter in µm to linear volume (µL/cm)*	7.85 x 10-6 (d2)
Celsius to Fahrenheit	(Celsius x 9/5) + 32
Fahrenheit to Celsius	(Fahrenheit - 32) x 5/9
psi to bar	psi x 0.06894757
psi to MPa	psi x 0.00689476
psi to torr	psi x 51.7150733
psi to ATM	psi x 0.06804596
**d = internal diameter*	

Temperature

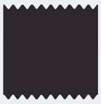
Celsius (°C)	Fahrenheit (°F)
0	32
1	34
5	41
10	50
15	59
20	68
25	77
30	86
35	95
40	104
45	113
50	122
55	131
60	140
65	149
70	158
75	167
80	176
85	185
90	194
95	203
100	212
105	221
110	230
115	239
120	248
125	257
130	266
135	275
140	284
145	293
150	302
155	311
160	320
165	329
170	338
175	347
180	356
185	365
190	374
195	383
200	392
205	401
210	410
215	419

+1 800 426 0191
+1 360 679 2528
www.idex-hs.com

What Threads Do I Have?

Hold your fitting over the thread silhouettes below to identify the threads.

U.S. Customary Threads

6-40	
6-32	
10-32	
1/4-28	
5/16-24	
1/2-20	

Metric Threads

M4 x 0.7	
M6 x 1	

Refer to page 223 for an explanation of thread nomenclature.

Pressure Conversion

psi	bar	MPa	ATM
100	6.9	0.7	6.8
500	34.5	3.4	34.0
1,000	68.9	6.9	68.0
1,500	103.4	10.3	102.1
2,000	137.9	13.8	136.1
2,500	172.4	17.2	170.1
3,000	206.8	20.7	204.1
3,500	241.3	24.1	238.2
4,000	275.8	27.6	272.2
4,500	310.3	31.0	306.2
5,000	344.7	34.5	340.2
5,500	379.2	37.9	374.3
6,000	413.7	41.4	408.3
6,500	448.2	44.8	442.3
7,000	482.6	48.3	476.3
7,500	517.1	51.7	510.3
8,000	551.6	55.2	544.4
8,500	586.1	58.6	578.4
9,000	620.5	62.1	612.4
10,000	689.5	68.9	680.5

+1 800 426 0191
+1 360 679 2528
www.idex-hs.com

Fittings Primer

Fittings

Fittings — typically comprised of a nut and ferrule — are designed to connect and seal tubing. While simple in function, fittings can be complex in description and use. General descriptive terms include: the geometry of the receiving port (coned or flat-bottom); the tubing size for which the fitting is designed; and a description of the threads on the nut, e.g., 10-32, 1/4-28, etc. Fittings may also be classified by dimensions and by the type of material from which they are manufactured. Additional information — such as tubing and port material, solvent(s) to be used, and expected system pressure — is required to determine which fittings are best suited for a particular application.

Threads

Several thread sizes are commonly used in analytical fluid transfer. The most common sizes are 1/4-28, 10-32, and M6. The first two are U.S. Customary System measurements. The third, M6, is measured in the Metric System.

U.S. Customary System Two numbers are used to describe a thread size. The first number indicates the diameter of the threaded portion of the nut. Thread diameter numbers range from gauge 1 (0.073") to gauge 12 (0.216"). Beyond 0.216" the thread diameter is given as the actual diameter in fractions of an inch. The second number indicates the threads-per-inch count. Thus, a 1/4-28 nut (Figure 1) has a 1/4" (0.250") diameter thread barrel and 28 threads-per-inch. A 10-32 male nut (Figure 2) has a gauge 10 (0.190") thread barrel with 32 threads-per-inch.

Metric System The Metric System also uses a two number system to describe the threads. The first number, preceded by the letter M (for metric), indicates the diameter of the threads in millimeters. The second number indicates how many millimeters between each thread. When the spacing between threads is 1 mm, the callout for the thread often excludes that second number. Thus, an M6x1 thread is often denoted by a simple M6 (Figure 3).

Please see the previous page for a visual comparison of common threads.

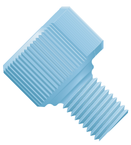


Figure 1
1/4-28 Nut

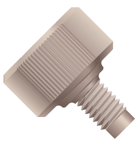


Figure 2
10-32 Nut

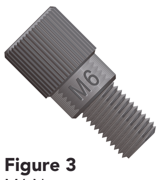


Figure 3
M6 Nut

MATERIAL STRUCTURAL COMPATIBILITY

Fitting	Tubing	Port	Recommended?
Plastic	Plastic	Plastic	Yes
Plastic	Steel	Plastic	Yes
Plastic	Steel	Steel	Yes
Plastic	Plastic	Steel	Yes
Steel	Steel	Steel	Yes
Steel	Plastic	Steel	Sometimes
Steel	Plastic	Plastic	No
Steel	Steel	Plastic	No

Stainless Steel Fittings

Although restrictive in use and application (see the Fittings Applications table, bottom left), stainless steel fittings remain popular for many analytical applications due to their chemical inertness and high pressure-holding capabilities.

The dimensions and shapes of stainless steel fittings vary and can be manufacturer specific (Figures 4 and 5). Even so, the most commonly-used stainless steel fittings for chromatography employ 10-32 threads, allowing many stainless steel fittings to be paired with a variety of receiving ports prior to being swaged onto a tube.

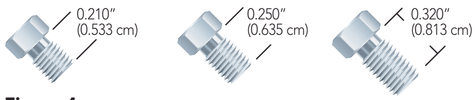


Figure 4

Figure 5

To be used properly stainless steel fittings must be swaged (permanently attached) to the tubing they are connecting. To do this correctly, IDEX Health & Science recommends the following procedure:

Place the nut and ferrule, in that order, on the tubing. Place this loose assembly into a mating port and tighten the nut finger tight, while ensuring the tubing is bottomed out inside the port. Now wrench tighten the nut an additional 3/4 turn. ***Please Note:*** *The ferrule is now permanently attached to the tubing and should only be used in the port into which it was swaged. Attempting to use a pre-swaged ferrule in a receiving port that is different from the one into which it was initially swaged may result in dead volume or leaks (see the Interchangeability section, next page).*

To properly tighten a pre-swaged stainless steel fitting, IDEX Health & Science recommends wrench tightening only an additional 1/4 to 1/2 turn past finger tight. Should any leaking occur, continue tightening the fitting a little at a time until the leak stops. If the fitting requires more than one complete revolution past finger tight, we recommend it be replaced, as excessive tightening typically indicates a damaged product.

Polymer-Based Fittings

Unlike their stainless steel counterparts, polymer fittings are nearly universal in application (see the Fittings Applications table) and are comparatively easy to use. Polymer fittings do not permanently attach to tubing, and they usually do not require any tool (besides your fingers!) to properly tighten. Additionally, these fittings come in a variety of polymers, providing several cost, pressure and chemical-resistance options.

Fittings Primer

Interchangeability

Because swaged stainless steel ferrules are permanently attached to the tubing, interchangeability is almost impossible with stainless steel fittings. The key factor that limits interchangeability of stainless steel fittings is "Dimension X"—the length of tubing that extends past a swaged ferrule (Figure 6; see page 184 for details on swaging a ferrule into place).

Dimension X varies among manufacturers (Figure 7). Dimension X can also vary for the same manufacturer due to production tolerances. Because of these differences, if you are using all stainless steel fittings we recommend you only use swaged fittings in the port where they were initially swaged (Figure 8a). Interchanging fitting assemblies and receiving ports can introduce leaks and/or dead-volume chambers to the flow path (Figure 8b). Therefore, for stainless steel fittings, we generally recommend new fittings, new ferrules, and new connections each time receiving ports are changed.

Even though interchangeability is a problem with stainless steel fittings, it is generally not a problem with polymer fittings. Because polymer ferrules don't permanently attach to the tubing wall, Dimension X can be adjusted each time the fitting assembly is connected to a receiving port. This helps ensure a good connection with minimal dead volume.

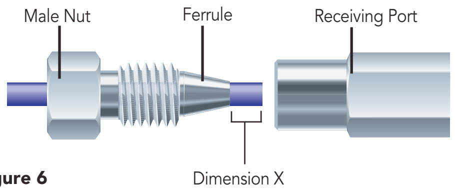
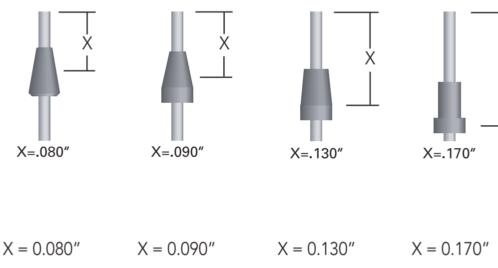


Figure 6



Dimension X can range from 0.080" to 0.170" among various manufacturers.

Figure 7

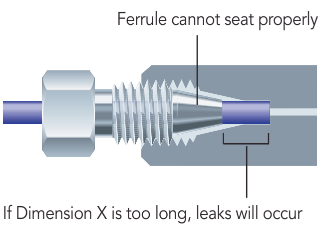


Figure 8a

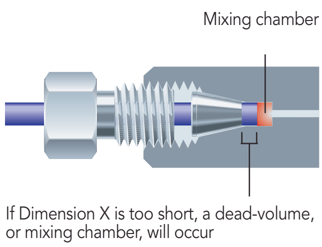


Figure 8b

If Your Fittings Leak

1. Check to make sure your tubing is seated properly. When using universal Fingertight fittings, the tubing must bottom out in the receiving port before the nut and ferrule are tightened. If a gentle tug disengages your tubing after the fittings have been tightened, loosen the nut and ferrule and try again.

2. The fitting may not be tightened enough. Stainless steel nuts and ferrules require a wrench to tighten them, even after repeated use. Fingertight fittings also require a good turn; however, using tools may lead to over-tightening and damage to the fitting, and as such, tools should be used with caution on Fingertight fittings.

3. You may be using incompatible fittings. Make sure you are using a nut and ferrule that are compatible with each other and with the components of your system. To avoid this problem and ensure compatibility, use IDEX Health & Science universal Fingertight fittings. Because the ferrule does not permanently swage onto your tubing, a Fingertight can be used repeatedly for several cycles in most systems.

4. Check the condition of the sealing area. After repeated use, a fitting's "sealing area" (at the tip of the fitting or ferrule), will gradually become deformed to the point of being incapable of creating a seal. As such, it is a good idea to keep an extra supply of the fittings you are using so you can replace them quickly and avoid unnecessary downtime.

5. Check the receiving port for damage. Sometimes a leaking connection has nothing at all to do with the nut and ferrule, but with the receiving port. Ports that have had stainless steel fittings swaged into them are especially susceptible to damage. Check the receiving port for visible burrs or scratches and replace if necessary.

6. Evaluate chemical compatibility. Using fittings made of material incompatible with your mobile phase is a sure way of creating leaks. Please visit the IDEX Health & Science website, www.idex-hs.com, for more information about chemical compatibility.

TELLTALE SIGNS OF SYSTEM LEAKS

Before you see the first drip of mobile phase, your system can warn you that a problem exists. The most common signs of system leaks are:

1. No flow or pressure
2. Pump pressures up, but there is no flow
3. Noisy baseline
4. Baseline drift

While all of these symptoms could also indicate problems unrelated to leaking connections, it is always easiest to start there. Not only are leaking connections usually easy to repair, they are also typically the least expensive option.

Adapters & Unions

With all the different tubing sizes and threaded port configurations, scientists frequently use adapters to make connections. However, adapters are not always the only choice, or even the best choice, when making connections between dissimilar components.

Adapters have two different thread configurations, such as 1/4-28 flat-bottom to 10-32 coned, or 1/4-28 male flat-bottom to luer. Unions have the same thread on both sides, such as 10-32 coned to 10-32 coned. Please refer to Figure 9 for examples of adapters and unions.

Unions are typically less expensive than adapters while performing equally as well. Thus, it is often advantageous to use a union wherever possible. To determine whether a union or an adapter is appropriate for a particular connection, first determine if the connection is designed for low pressure or high pressure. This is not always obvious, but you can make some assumptions.

(For example, when connecting 1/16” OD PEEK tubing to 1/8” OD FEP or PFA tubing, you likely have a low pressure connection since the connection pressure is limited by the amount of pressure the fluoropolymer tubing can withstand.)

Once you know the pressure classification for your connection, determine what connectors are available for that classification. For the low pressure example given, there are a number of unions available with 1/4-28 internal flat-bottom geometry on both sides (see pages 40 – 41). Other options with matching M6 and 5/16-24 internal threads are also available (pages 40 and 50, respectively).

After you identify the connector needed, the focus turns to finding fittings that work with your tubing sizes to mate with each side of the selected union. In our example, the connection is between 1/16” OD and 1/8” OD tubing, and there are several 1/4-28 flat-bottom fittings for both 1/16” and 1/8” OD tubing, such as those on pages 22 – 28.

Of course, a number of cases remain where only an adapter will do. For recommendations on making typical threaded connections, please see the “Connections Reference” on page 35.

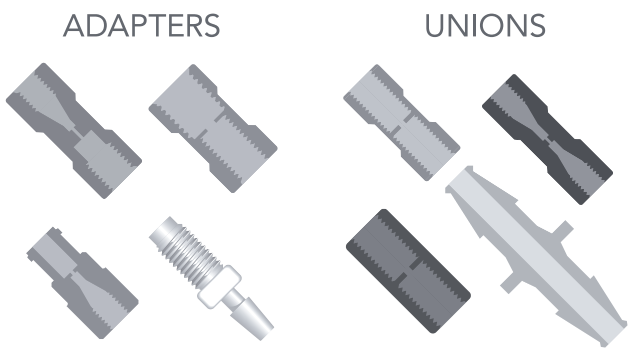


Figure 9 — Adapters and Unions

Connectors

Void, Dead, and Swept Volume

When making connections, in most instances, what is of primary importance is how much internal volume exists within a connection and how that internal volume will impact chromatographic results.

Three terms describe the internal volume of a product: void volume, dead volume, and swept volume. Void volume is simply another way of describing the total internal space within a connection into which fluid can flow. Dead volume is that portion of the void volume that is out of the intended flow path, while swept volume is that portion of the void volume which is in the intended flow path (see Figure 10). Therefore, Void Volume = Dead Volume + Swept Volume.

Dead volume, particularly in capillary connections, can cause undesirable chromatographic effects, including:

- Analysis delays
- Broadened peaks
- Poor resolution
- Sample carry-over
- Split peaks
- Gas collection

Because of the negative impact of dead volume in a connection, all dead volume should be removed from the connection if possible.

To keep most of the void volume truly swept volume, match the tubing ID as closely as possible with the diameter of the holes in your equipment. This ensures the fluid runs completely through the entire passageway. Matching internal diameters also helps reduce turbulence as the fluid passes through the connection.

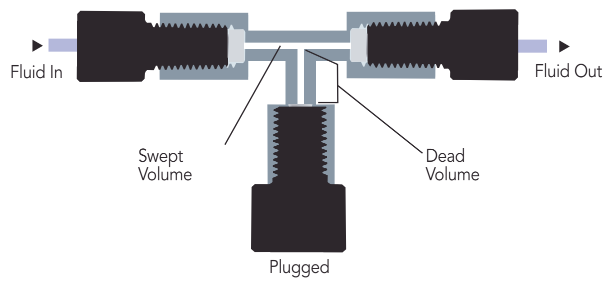


Figure 10 — Internal Volume Defined

Differential Pressure Per 5–Foot Length

Which ID is best for your application? Refer to flow rates (using water as the solvent) and tubing IDs below and the corresponding differential pressure per 5-foot length.

These theoretical data are presented in psi with the bar equivalent in parentheses, and were calculated using the formula presented to the right.

	Tubing ID						
Flow Rate	**0.0025″**	**0.005″**	**0.007″**	**0.010″**	**0.020″**	**0.030″**	**0.062″**
0.1 mL/min	923	58	15	4	0	0	0
	(64)	(4.0)	(1.0)	(0.3)	(0)	(0)	(0)
1.0 mL/min	NR*	577	150	36	2	0	0
		(40)	(10)	(2.5)	(0.1)	(0)	(0)
2.0 mL/min	NR*	1,154	300	72	5	1	0
		(80)	(21)	(5.0)	(0.3)	(0.1)	(0)
10.0 mL/min	NR*	5,770	1,502	361	23	5	0
		(398)	(103)	(25)	(1.6)	(0.3)	(0)
25.0 mL/min	NR*	NR*	3,755	902	56	11	0
			(259)	(62)	(3.9)	(0.8)	(0)

**Not Recommended — Exceeds the pressure rating of the tubing.*

Theoretical Pressure Drop Along a Length of Tubing

$$\Delta P = \left(9.86 \times 10^{-8}\right)\left(\frac{F\,L\,V}{d^4}\right)$$

Where: ΔP = pressure drop in psi; F = flow rate in mL/min; L = tubing length in cm; V = viscoscity in centipoise (cp); d = tubing inside diameter in cm

(See table above for data calculated using this formula.)

Tubing Internal Diameters & Volumes

Tubing Internal Diameter (d) in inches to Linear Volume (µL/inch): 12870.4 (d2)

Tubing Internal Diameter (d) in µm to Linear Volume (µL/cm): 7.85 x 10-6 (d2)

Internal Diameters				Linear Volumes	
Inches	**Wire Gauge***	**Millimeters**	**Microns**	**µL/in**	**µL/cm**
0.0008	—	0.020	20	0.008	0.003
0.001	—	0.025	25	0.013	0.005
0.002	—	0.051	51	0.051	0.020
0.0025	—	0.064	64	0.081	0.032
0.003	—	0.076	76	0.116	0.046
0.004	36	0.102	102	0.206	0.081
0.005	35	0.127	127	0.322	0.127
0.006	—	0.152	152	0.463	0.182
0.007	34	0.178	178	0.631	0.248
0.008	33	0.203	203	0.824	0.324
0.009	32	0.229	229	1.042	0.410
0.010	31	0.254	254	1.287	0.507
0.012	30	0.305	305	1.853	0.730
0.014	28	0.356	356	2.523	0.993
0.015	—	0.381	381	2.896	1.140
0.018	26	0.457	457	4.170	1.642
0.020	25	0.508	508	5.148	2.027
0.028	22	0.711	711	10.090	3.973
0.030	—	0.762	762	11.583	4.560
0.032	21	0.813	813	13.179	5.189
0.040	—	1.016	1016	20.593	8.107
0.042	19	1.067	1067	22.703	8.938
0.046	—	1.168	1168	27.234	10.722
0.055	—	1.397	1397	38.933	15.328
0.062	—	1.575	1575	49.474	19.478
0.080	14	2.032	2032	82.370	32.429
0.093	—	2.362	2362	111.316	43.825
0.120	9	3.048	3048	185.333	72.966
0.125	—	3.175	3175	201.099	79.173

** Wire Gauge numbers are referencing Birmingham or Stub's Iron Wire Gauge values, which are commonly used by most stainless steel syringe manufacturers.*

+1 800 426 0191
+1 360 679 2528
www.idex-hs.com

Rating Comparison

All information has been supplied to IDEX Health & Science by the tubing manufacturers. It is for your guidance only. We recommend that you test the tubing before use.

Rating: + meets the stated property
± meets the stated property to limited extent
– does not meet the stated property

1 not recommended
10 excellent

Properties		Tygon® LMT-55	Tygon E-LFL	Pharmed®	Tygon 2001	Tygon MHLL
FDA		+	+	+	+	+
US Pharmacopoeia Class VI		–	+	+	–	+
Transparency		+	+	–	+	–
Long Life		1	7	10	3	10
Gas Permeability	**CO_2**	7	8	5	5	5
	O_2	9	9	8	9	8
	N_2	9	10	8	6	8
Temperature, above 0 °C		2	2	7	1	7
Temperature, below 0 °C		4	3	8	7	8
Pressure		5	9	1	1	1
Absorption / Adsorption		6	6	9	10	9
Chemical Resistance						
Acids (H2SO4)	**10%**	10	10	10	10	10
	30%	10	7	10	10	10
	95–98%	1	1	1	7	1
Bases (NaOH)	**10–15%**	10	10	10	10	10
	30–40%	4	2	10	10	10
Hydrocarbons (aliphatic)		1	1	1	1	1
Mineral Salts		10	10	10	10	10
Alcohols		1	1	10	10	10
Ketones (Acetone)		1	1	1	7	1

Maximum recommended operating pressure

Wall Thickness	Inner Diameter	bar (psi)	bar (psi)	bar (psi)	bar (psi)	bar (psi)
1.6 mm	0.8 mm	8.7 (126)	8.7 (126)	3.7 (54)	N/A	N/A
1.6 mm	1.6 mm	4.8 (70)	4.8 (70)	2.1 (30)	3.1 (45)	N/A
1.6 mm	2.4 mm	3.8 (55)	3.8 (55)	1.6 (23)	N/A	N/A
1.6 mm	3.2 mm	3.0 (44)	3.0 (44)	1.3 (19)	2.0 (29)	N/A
1.6 mm	4.8 mm	2.2 (32)	2.2 (32)	0.9 (13)	1.5 (22)	N/A
1.6 mm	6.4 mm	1.8 (26)	1.8 (26)	0.8 (12)	1.1 (16)	N/A
1.6 mm	8.0 mm	1.5 (22)	1.5 (22)	0.6 (9)	0.9 (13)	N/A
1.6 mm	9.5 mm	1.3 (19)	1.3 (19)	0.5 (7)	0.8 (12)	N/A
1.6 mm	11.1 mm	1.2 (17)	1.2 (17)	0.5 (7)	N/A	N/A
1.6 mm	12.7 mm	1.1 (16)	1.1 (16)	0.5 (7)	N/A	N/A
1.6 mm	15.9 mm	1.0 (15)	1.0 (15)	0.4 (6)	N/A	N/A
2.4 mm	4.8 mm	3.0 (44)	3.0 (44)	1.3 (19)	N/A	N/A
2.4 mm	6.4 mm	2.4 (35)	2.4 (35)	1.0 (15)	N/A	N/A
2.4 mm	8.0 mm	2.0 (29)	2.0 (29)	0.8 (12)	N/A	N/A
2.4 mm	9.5 mm	1.8 (26)	1.8 (26)	0.8 (12)	N/A	N/A
2.4 mm	11.1 mm	1.5 (22)	1.5 (22)	0.6 (9)	N/A	N/A
2.4 mm	12.7 mm	1.3 (19)	1.3 (19)	0.6 (9)	N/A	N/A
2.4 mm	15.9 mm	1.2 (17)	1.2 (17)	0.5 (7)	N/A	N/A
3.2 mm	6.4 mm	3.0 (44)	3.0 (44)	1.3 (19)	N/A	N/A
3.2 mm	9.6 mm	2.2 (32)	2.2 (32)	0.9 (13)	N/A	N/A
3.2 mm	12.7 mm	1.8 (26)	1.8 (26)	0.8 (12)	1.1 (16)	N/A
3.2 mm	15.9 mm	1.5 (22)	1.5 (22)	0.6 (9)	0.9 (13)	N/A

N/A = Not applicable

Rating Comparison

All information has been supplied to IDEX Health & Science by the tubing manufacturers. It is for your guidance only.
We recommend that you test the tubing before use.

Rating:
+ meets the stated property
± meets the stated property to limited extent
– does not meet the stated property

1 not recommended
10 excellent

Properties		Tygon® HC F-4040-A	Tygon 3350	Silicone Peroxide	Norprene® A-60-G	Fluran® F-5500-A
FDA		–	+	+	–	–
US Pharmacopoeia Class VI		–	+	+	–	–
Transparency		±	±	±	–	–
Long Life		2	4	4	10	3
Gas Permeability	**CO_2**	9	1	1	5	10
	O_2	10	1	1	8	10
	N_2	10	1	1	8	10
Temperature, above 0 °C		2	10	10	7	9
Temperature, below 0 °C		1	10	10	8	4
Pressure		7	1	1	1	1
Absorption / Adsorption		6	1	1	9	7
Chemical Resistance						
Acids (H2SO4)	**10%**	10	10	10	10	10
	30%	7	7	8	10	10
	95–98%	1	1	1	1	10
Bases (NaOH)	**10–15%**	1	10	10	10	10
	30–40%	1	10	10	10	10
Hydrocarbons (aliphatic)		7	1	1	1	7
Mineral Salts		10	7	7	10	10
Alcohols		7	7	10	10	1
Ketones (Acetone)		1	4	1	1	1

Maximum recommended operating pressure

Wall Thickness	Inner Diameter	bar (psi)	bar (psi)	bar (psi)	bar (psi)	bar (psi)
1.6 mm	0.8 mm	10.9 (158)	1.9 (28)	1.9 (28)	3.7 (54)	3.7 (54)
1.6 mm	1.6 mm	6.1 (88)	1.0 (15)	1.0 (15)	2.1 (30)	2.1 (30)
1.6 mm	2.4 mm	4.8 (70)	0.8 (12)	0.8 (12)	1.6 (23)	1.6 (23)
1.6 mm	3.2 mm	3.8 (55)	0.6 (9)	0.6 (9)	1.3 (19)	1.3 (19)
1.6 mm	4.8 mm	2.7 (39)	0.5 (7)	0.5 (7)	0.9 (13)	0.9 (13)
1.6 mm	6.4 mm	2.2 (32)	0.4 (6)	0.4 (6)	0.8 (12)	0.8 (12)
1.6 mm	8.0 mm	1.8 (26)	0.3 (4)	0.3 (4)	0.6 (9)	0.6 (9)
1.6 mm	9.5 mm	1.6 (23)	0.3 (4)	0.3 (4)	0.5 (7)	0.5 (7)
1.6 mm	11.1 mm	1.5 (22)	0.3 (4)	0.3 (4)	0.5 (7)	0.5 (7)
1.6 mm	12.7 mm	1.4 (20)	0.2 (3)	0.2 (3)	0.5 (7)	0.5 (7)
1.6 mm	15.9 mm	1.2 (17)	0.2 (3)	0.2 (3)	0.4 (6)	0.4 (6)
2.4 mm	4.8 mm	3.8 (55)	0.6 (9)	0.6 (9)	1.3 (19)	1.3 (19)
2.4 mm	6.4 mm	3.0 (44)	0.5 (7)	0.5 (7)	1.0 (15)	1.0 (15)
2.4 mm	8.0 mm	2.5 (36)	0.4 (6)	0.4 (6)	0.8 (12)	0.8 (12)
2.4 mm	9.5 mm	2.2 (32)	0.4 (6)	0.4 (6)	0.8 (12)	0.8 (12)
2.4 mm	11.1 mm	1.8 (26)	0.3 (4)	0.3 (4)	0.6 (9)	0.6 (9)
2.4 mm	12.7 mm	1.7 (25)	0.3 (4)	0.3 (4)	0.6 (9)	0.6 (9)
2.4 mm	15.9 mm	1.5 (22)	0.3 (4)	0.3 (4)	0.5 (7)	0.5 (7)
3.2 mm	6.4 mm	3.8 (55)	0.6 (9)	0.6 (9)	1.3 (19)	1.3 (19)
3.2 mm	9.6 mm	2.7 (39)	0.5 (7)	0.5 (7)	0.9 (13)	0.9 (13)
3.2 mm	12.7 mm	2.2 (32)	0.4 (6)	0.4 (6)	0.8 (12)	0.8 (12)
3.2 mm	15.9 mm	1.8 (26)	0.3 (4)	0.3 (4)	0.6 (9)	0.6 (9)

+1 800 426 0191
+1 360 679 2528
www.idex-hs.com

Pumps Reference

Part No.	Pump ID	Model Description	Min*	Max*	Differential Pressure Max bar*	Gear Material	Seals	Housing Material	Temp Min	Temp Max	System Pressure Max bar	Type	Cross Reference Part Number
MI0006	Z-186	GA-X21.CFS.B	1	99	1.4	Graphite	PTFE	SS - 316	- 46	+ 177	21	Suction Shoe	82092
MI0007	Z-181	GA-V21.CFS.B	2	252	2.8	Graphite	PTFE	SS - 316	- 46	+ 177	21	Suction Shoe	82114
MI0008	Z-183	GA-V23.CFS.B	4	504	2.8	Graphite	PTFE	SS - 316	- 46	+ 177	21	Suction Shoe	82115
MI0013	Z-120	GJ-N23.FF1S.B.B1	32	3950	3.5	PTFE	PTFE	SS - 316	- 46	+ 54	21	Cavity Style	82004
MI0015	Z-122	GJ-N25.FF1S.B.B1	455	5460	3.5	PTFE	PTFE	SS - 316	- 46	+ 54	21	Cavity Style	82006
MI0016	Z-140	GJ-N23.FF1S.B	32	3950	3.5	PTFE	PTFE	SS - 316	- 46	+ 54	21	Cavity Style	82001
MI0018	Z-142	GJ-N25.FF1S.B	455	5460	3.5	PEEK	PTFE	SS - 316	- 46	+ 54	21	Cavity Style	82003
MI0019	Z-130	GJ-N23.PF1S.B.B1	32	3950	5.2	PPS	PTFE	SS - 316	- 46	+ 54	21	Cavity Style	81529
MI0020	Z-150	GJ-N23.PF1S.B	32	3950	5.2	PPS	PTFE	SS - 316	- 46	+ 54	21	Cavity Style	81531
MI0022	Z-200	GB-P25.PVS.A.B1	292	3509	3.5	PPS	Viton®	SS - 316	- 29	+ 177	21	Suction Shoe	81281
MI0023	Z-201	GB-P35.PVS.A.B1	585	7020	3.5	PPS	Viton	SS - 316	- 29	+ 177	21	Suction Shoe	81282
MI0131	Z-1830	GA-T23.PFS.B	5	460	5.2	PPS	PTFE	SS - 316	- 46	+ 177	21	Suction Shoe	81473
MI0280	Z-1830	GA-T23.JFS.B	5	460	5.2	PEEK	PTFE	SS - 316	- 46	+ 177	21	Suction Shoe	L18489
MI0284	Z-140 HC	GJ-N23.FF1C.B	32	3950	3.5	PTFE	PTFE	Hastelloy®-C276	- 46	+ 54	21	Cavity Style	L20284
MI0306	Z-200	GB-P25.JVS.B	35	3480	3.5	PEEK	Viton	SS - 316	- 29	+ 177	21	Suction Shoe	220004
MI0310	Z-183	GA-V23.CFC.B	4	504	2.8	Graphite	PTFE	Hastelloy-C276	- 46	+ 177	21	Suction Shoe	L2383
MI0311	Z-142 HC	GJ-N25.FF1C.B	55	5480	3.5	PTFE	PTFE	Hastelloy-C276	- 46	+ 54	21	Cavity Style	L21812
MI0312	Z-186	GA-X21.JFS.B	1	99	2.3	PEEK	PTFE	SS - 316	- 46	+ 177	21	Suction Shoe	L20820
MI0313	Z-140	GJ-N23.JF1S.B	32	3950	5.6	PEEK	PTFE	SS - 316	- 46	+ 54	21	Cavity Style	L197735
MI0378	Z-201	GB-P35.JKS.B	73	7241	3.5	PEEK	Kalrez®	SS - 316	- 29	+ 177	21	Suction Shoe	L22609

** Absolute flow rates dependent on the drive used.*