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Industrial process and emission control experts

## PMIF series Porous Metal Products.

Continuous, particle-free gas  
sampling, even in harsh extremes.



# How PMIF filters work.

Force of inertia carries most particles through and out of the filter, which prevents clogging of the filter element.

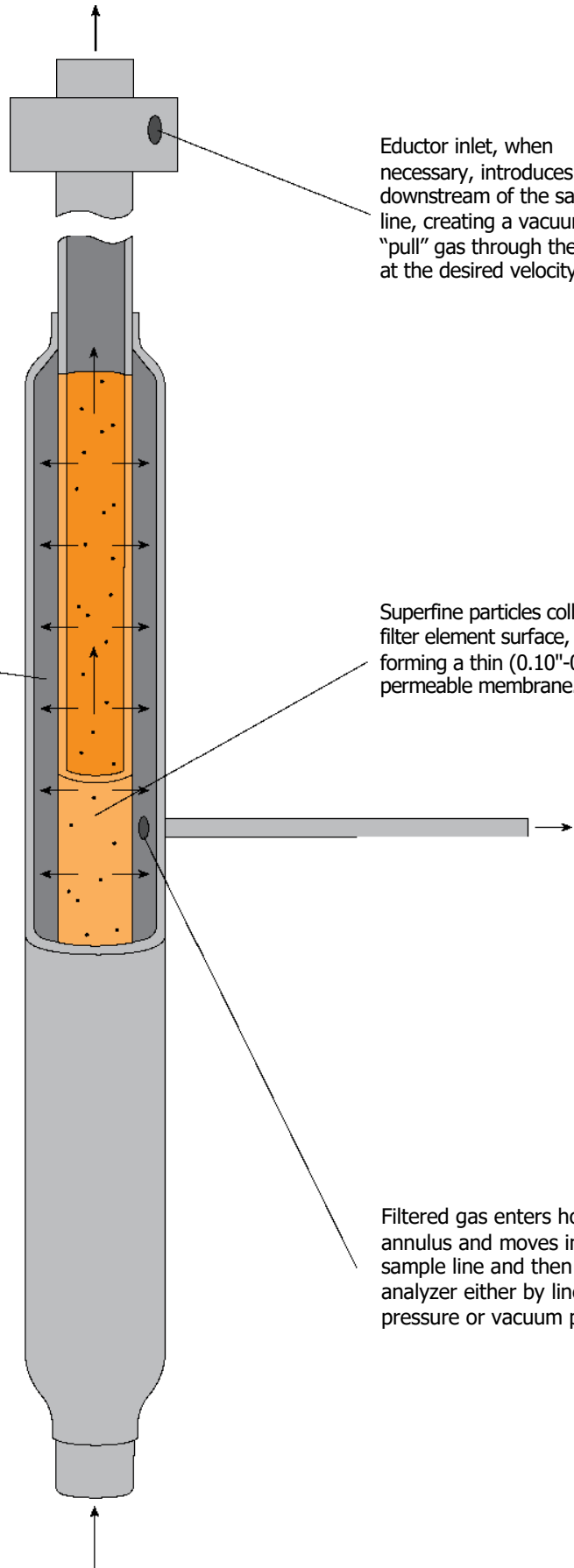
Eductor inlet, when necessary, introduces gas downstream of the sample line, creating a vacuum to "pull" gas through the filter at the desired velocity.

Gas moves through membrane and porous metal media at low velocity (0.005 fps), causing particles to be removed.

Superfine particles collect on filter element surface, forming a thin (0.10"-0.15") permeable membrane.

Unfiltered gas stream enters PMIF filter housing at 70-100 feet per second.

Filtered gas enters housing annulus and moves into gas sample line and then to the analyzer either by line pressure or vacuum pump.



## All-metal strength, plus cross-flow efficiency – the PMIF approach to gas filtration.



0.5µm (shown here, x100) is the recommended micrometer grade for filter applications. also provides filters with all-metal media in 0.2µm, 2µm, 5µm and 10µm.

All-metal, inertial gas sampling (PMIF) filters allow the collection of particle-free samples from virtually any gas stream, even those which are very hot or heavily contaminated. And, unlike other gas filters which may quickly plug and need to be thrown away, filters are designed to provide long-term – in many cases, permanent – filtration. Benefits of PMIF's exclusive design include:

**Continuous, clog-resistant filtration.** filters feature a cross-flow design which keeps most particles in the gas stream, greatly reducing obstruction of the filter element. As a result, filters can operate without clogging for great lengths of time, even when used with highly contaminated gas streams\*.

**Fast generation of high-purity samples.** The high precision of porous metal media, coupled with the development of a thin, dynamic membrane of superfine particles on the filter element surface, effectively trap particles of all sizes, resulting in reliable, essentially particle-free gas sampling. Plus, filters are designed with low internal volumes, so they produce fresh gas samples with minimal sample dwell times.

### High temperature tolerance.

Depending on the material of construction, filters will withstand temperatures up to 1450°F/790°C in oxidizing atmospheres, and upto1700°F/930°C in reducing or neutral atmospheres.

### High corrosion resistance.

For applications involving corrosive gases, filters can be constructed of special high-strength materials such as Nickel, Hastelloy® and Inconel® alloys.

### High pressure tolerance.

Unlike "soft" media, porous metal can be used in high-pressure applications with differential pressures well in excess of 1000 psid.

### Fast, efficient, in-situ cleaning.

If excessive particles are allowed to create a denser subsurface membrane on the filter element surface, removal can usually be achieved in seconds with a simple blowback – no shutting down, or removing the filter.

**Wide selection of materials.** offer the industry's widest array of metals and alloys to provide chemical compatibility for virtually any application. Standard construction generally consists of 316L stainless steel, but filters can also be made from a variety of other metals, including Inconel®, Monel®, Alloy 20, and Hastelloy®.

#### Material Code Material Porous Hardware Flange

A	316L SS	+	+	+
B	316 SS	--	+	+
C	304L SS	+	+	+
D	304 SS	--	+	+
E	347 SS	+	--	--
F	300 Series SS	--	+	+
G	430 SS	+	--	--
H	Nickel 200	+	--	--
J	Monel® 400	+	+	+
K	Inconel® 600	+	+	+
L	Hastelloy® C276	+	+	+
M	Hastelloy® X	+	--	--
N	Alloy 20	+	+	+
P	Carbon Steel	--	--	+

+ Available  
-- Not Economical

\* In high moisture applications, temperature must be kept above dew point.

#### Material Oxidizing Reducing

Neutral/

316L SS (std)	750°F/400°C	1000°F/540°C
Inconel® 600	1100°F/590°C	1500°F/820°C
Hastelloy® X	1450°F/790°C	1700°F/930°C

## Types of PMIF filters.

### Model 76-10IF Filter Assembly.

Model 76-10IF is the basic PMIF filter, offered standard with a 0.5 $\mu$ m porous metal filter element, constructed of 100% 316L or 316 stainless steel, or with an Inconel<sup>®</sup> filter element within a 316 stainless steel housing. Filters with 0.5" ID, 12" or 24"-long filter elements are standard product and are normally in stock. Other sizes and materials are available upon request.



### Model 76-11IF Standard External System.

The Model 76-11IF System consists of a Model 76-10IF filter connected to an inline eductor. By locating the eductor downstream from the filter's gas sampling tube, gas or air may be introduced into the system to induce axial flow through the filter element which achieves the necessary flow velocity through the filter. This is generally required in low-pressure applications, where gas velocity would be below the minimum 70 fps needed for optimal filter performance.



### Model 76-14IF Flange-Mounted External System.

When access is limited to a horizontal vessel or duct, Model 76-14IF Systems allow installation of a complete, external system by means of one 4" or 6" flange. Total external system width, including return piping, is 11.125". Standard materials for porous media, hardware, piping and flange are 316L, 300, and 304 series stainless steel. Others are available by request.



**Model 76-12IF In-Stack System.**

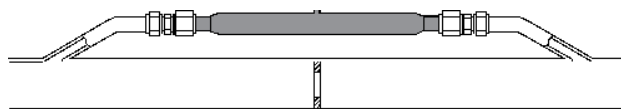
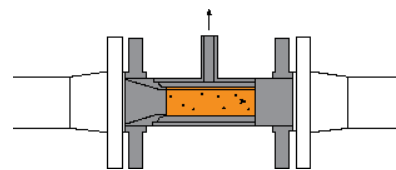
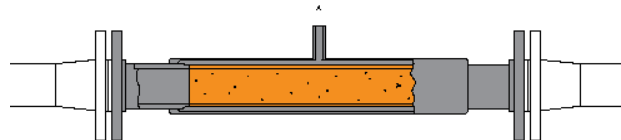
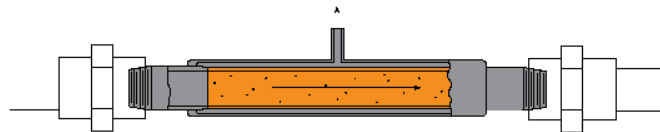
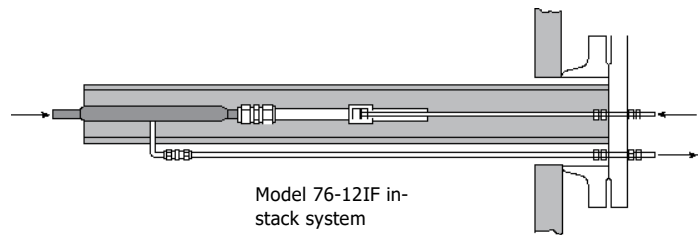
Model 76-12IF Systems allow placement of the filter inside the stack or pipe, without risk of fouling the filter element, using a compact, self-contained filter/educator assembly. In-stack systems are often chosen because of external space limitations, or because an external system would drop the gas temperature below its dew point, requiring the addition of heat tracing to pre-vent condensation. Standard filter element lengths range from 6" to 72", constructed of 316L stainless steel or Inconel® 600.

**Series 76-00IF Custom-designed Pipeline Systems.** Pipeline systems allow installation of the filter directly into the pipeline, eliminating the need for external mounting connections. Systems can be designed with threaded and flanged connections; the latter can also include a reduced ID system – a simple means to increase linear gas velocity without the use of an educator. Models can be used on pipes from 3/4" to 6" in diameter. Where in-pipe installation is not possible, recommended using a bypass filter arrangement, as shown in the illustration.

**Operating Parameters.**

Recommended linear velocity in the pipeline is 70-100 fps, or as required to maintain proper velocity of entrained solids. See the accompanying Flow/Velocity Table below. Mounting may be horizontal or vertical.

Sample flow rate should be controlled to avoid premature filter plugging. Recommended sample flow rate is 30-60 cc/min/sq. in. of the inside surface of the filter tube.



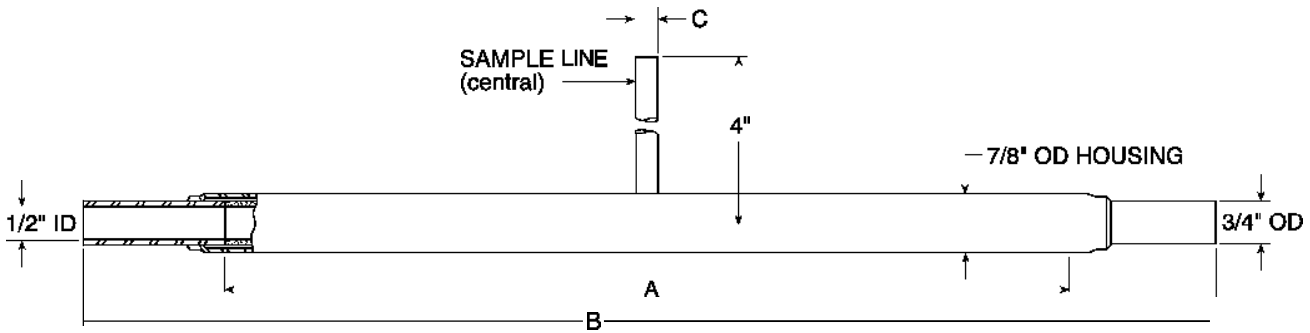
**Flow/Velocity Table**

Pipe Size (Sch. 40)	CFM@70FPS Axial Flow	CFM@100FPS S Axial Flow
3/4	16	22
1	25	36
1 1/4	44	62
1 1/2	59	85
2	98	140
2 1/2	140	199
3	216	308
3 1/2	288	412
4	371	530
5	584	834
6	843	1204

# Model 76-10IF – Filter

## Specifications

- Materials of Construction**
  - Standard – 316L SS porous media 316 SS housing. Code AB.
  - Inconel® 600 precision porous media, 316 SS housing. Code KB.
  - Hastelloy® X precision porous media, 316 SS housing. Code MB.
  - For other materials consult factory.
- All welded construction.
- Up to 1000 psi at 200°F.
- Catalog number: 76-10IF-AA-BB-XX-DD  
 76-10IF = Filter Assembly  
 AA = Element ID  
 BB = Porous length  
 XX = Standard media grade 0.5, 2  
 DD = Material code Porous/Housing



Part Description	Computer Part Number (CPN)	Sample Flow Liters/Minute Recommended/Max	A Porous Length	B Overall Length	C Sample Line Dia.
7610-1/2-6-XX-AB	76-10100-XXX	0.5/1	6"	10"	1/4"
7610-1/2-12-XX-AB	76-10200-XXX	1/2	12"	16"	3/4"
7610-1/2-24-XX-AB	76-10450-XXX	2/4	24"	28"	3/8"
7610-1/2-36-XX-AB	76-10650-XXX	3/6	36"	40"	3/8"
7610-1/2-48-XX-AB	76-10750-XXX	4/8	48"	52"	3/8"
7610-1/2-60-XX-AB	76-10850-XXX	5/10	60"	64"	3/8"
7610-1/2-72-XX-AB	76-10951-XXX	6/12	72"	76"	3/8"

**Examples:** 7610-1/2-24-0.5-AB – filter 1/2" ID x 24" porous length, 0.5 micrometer, 316L SS/316 SS.  
 7610-1/2-12-2-MB – filter 1/2" ID x 12" porous length, 2 micrometer, Hastelloy® X/316 SS.

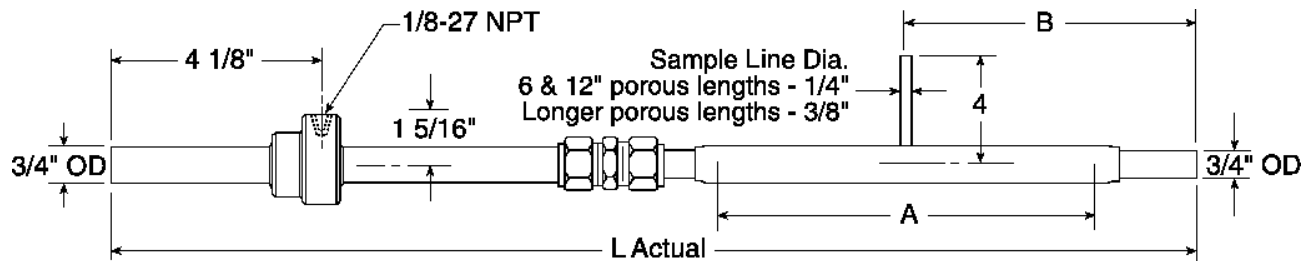
# Model 76-11IF – Filter with Educator

## Specifications

### Materials of Construction

- Standard – 316L SS porous media, 316 SS housing and connector, 300 SS educator. Code (AB)F.
- Special – Inconel® 600 porous media, 316 SS housing and connector, 300 SS educator. Code (KB)F.
- Hastelloy® X porous media, 316 SS housing and connector, 300 SS educator. Code (MB)F.
- For other materials consult factory.

- All welded construction, compression-type tube connector, no elastomeric seals.
  - Up to 1000 psi at 200°F.
  - Catalog number: 76-11IF-AA-BB-XX-(DD)D
- AA = Element ID  
 BB = Porous length  
 XX = Media grade 0.5 and 2  
 (DD)D = Material code (Porous/Housing and Connector)/Educator



Part Description	Computer Part Number (CPN)	Sample Flow Liters/Minute Recommended/Max	A Porous Length	B	C Sample Line Dia.	L Length	Total Run Length
76-11-1/2-6-XX-(AB)F	7611100-XXX	0.5/1	6"	5"	1/4"	19.5"	2'
76-11-1/2-12-XX-(AB)F	7611200-XXX	1/2	12"	8"	1/4"	25.5"	
76-11-1/2-24-XX-(AB)F	7611450-XXX	2/4	24"	14"	3/8"	37.5"	
76-11-1/2-36-XX-(AB)F	7611650-XXX	3/6	36"	20"	3/8"	49.5"	
76-11-1/2-48-XX-(AB)F	7611750-XXX	4/8	48"	26"	3/8"	61.5"	
76-11-1/2-60-XX-(AB)F	7611850-XXX	5/10	60"	32"	3/8"	73.5"	
76-11-1/2-72-XX-(AB)F	7611951-XXX	6/12	72"	38"	3/8"	85.5"	

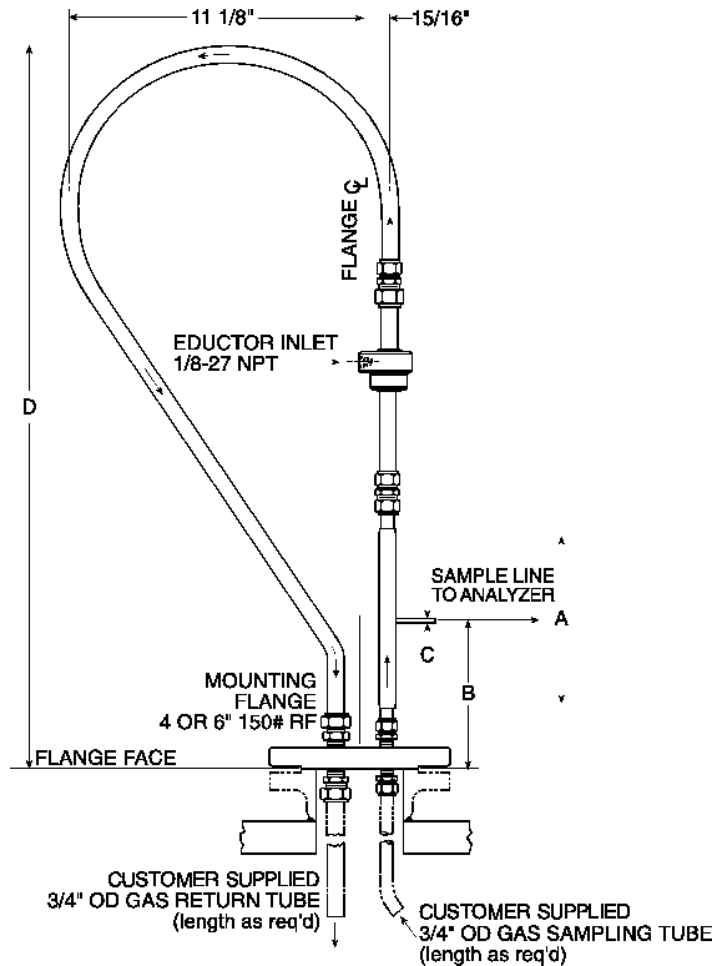
**Examples:** 7611-1/2-24-2-(AB)F – external system 1/2" ID x 24" porous length, 2 micrometer, 316L SS/316 SS/300 SS.  
 7611-1/2-12-0.5-(MB)F – external system 1/2" ID x 12" porous length, 0.5 micrometer, Hastelloy® X/316 SS/300 SS.

# Model 76-14IF – Flange Mounted External System

## Specifications

### Materials of Construction

- Standard – 316L SS porous media, 316 SS housing and connector, 300 SS hardware, 304 SS flange. Code (AB)FD.
  - Special – Inconel® 600 porous media, 316 SS housing and connector, 300 SS hardware, 304 SS flange. Code (KB)FD.
  - Hastelloy® X porous media, 316 SS housing and connector, 300 SS hardware, 304 SS flange. Code (MB)FD.
  - All welded construction, compression tube connections.
  - Up to 1000 psi at 200°F.
  - Catalog number: 7614-F-AA-BB-XX-(DD)DD
- F = Flange size 4" or 6"  
 AA = Element ID  
 BB = Porous length  
 XX = Media grade 0.5, 2  
 (DD)DD = Material code (Porous/Housing hardware/flange)



Part Description	Sample Flow Liters/Minute Recommended/Max	F Flange Size	A Porous Length	B	C Sample Line Dia.	D	Total Run Length
76-14-4-1/2-6-XX-(AB)FD	0.5/1	4"	6"	6.5"	1/4"	30.5"	
76-14-4-1/2-12-XX-(AB)FD	1/2	4"	12"	9.5"	1/4"	36.5"	
76-14-4-1/2-24-XX-(AB)FD	2/4	4"	24"	15.5"	3/8"	48.5"	
76-14-4-1/2-36-XX-(AB)FD	3/6	4"	36"	21.5"	3/8"	60.5"	10'
76-14-4-1/2-48-XX-(AB)FD	4/8	4"	48"	27.5"	3/8"	72.5"	12'
76-14-4-1/2-60-XX-(AB)FD	5/10	4"	60"	33.5"	3/8"	84.5"	14'
76-14-4-1/2-72-XX-(AB)FD	6/12	4"	72"	39.5"	3/8"	96.5"	16'

**Examples:** 76-14-6-1/2-24-0.5-(KB)FD – Flange-mounted system with 6" mounting flange, 1/2" ID, 24" porous length, 0.5 micrometer, Inconel® 600/316 SS/300 SS/304 SS. 7614-6-1/2-48-0.5-(MB)FD – Flange-mounted system with 6" mounting flange, 1/2" ID, 48" porous length, 0.5 micrometer, Hastelloy® X/316 SS/300 SS/304 SS.



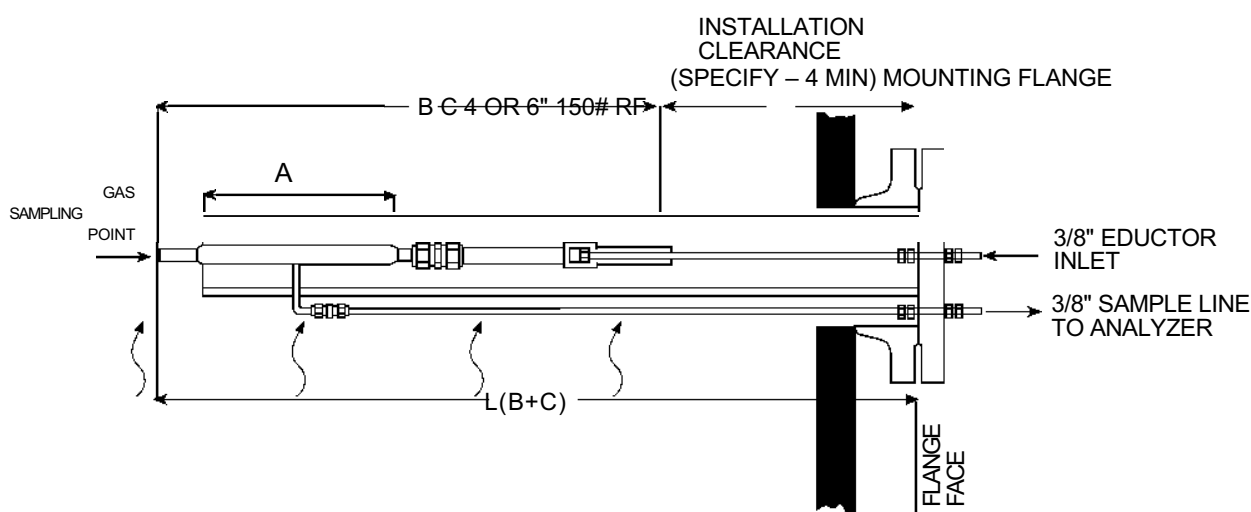
# Model 76-12IF – In-Stack System

## Specifications

### Materials of Construction

- Standard – 316L SS porous media, 316 SS housing and connector, 300 SS hardware, 304 SS flange. Code (AB)FD.
- Special – Inconel® 600 porous media, 316 SS housing and connector, 300 SS hardware, 304 SS flange. Code (KB)FD.
- Hastelloy® X porous media, 316 SS housing and connector, 300 SS hardware, 304 SS flange. Code (MB)FD.

- All welded construction.
- Up to 1000 psi at 200°F.
- Catalog number: 7612-F-AA-BB-XX-(DD)DD  
 F = Flange size 4" or 6"  
 AA = Element ID  
 BB = Porous length  
 XX = Media grade 0.5, 2  
 (DD)DD = Material code (Porous, Housing), hardware, flange



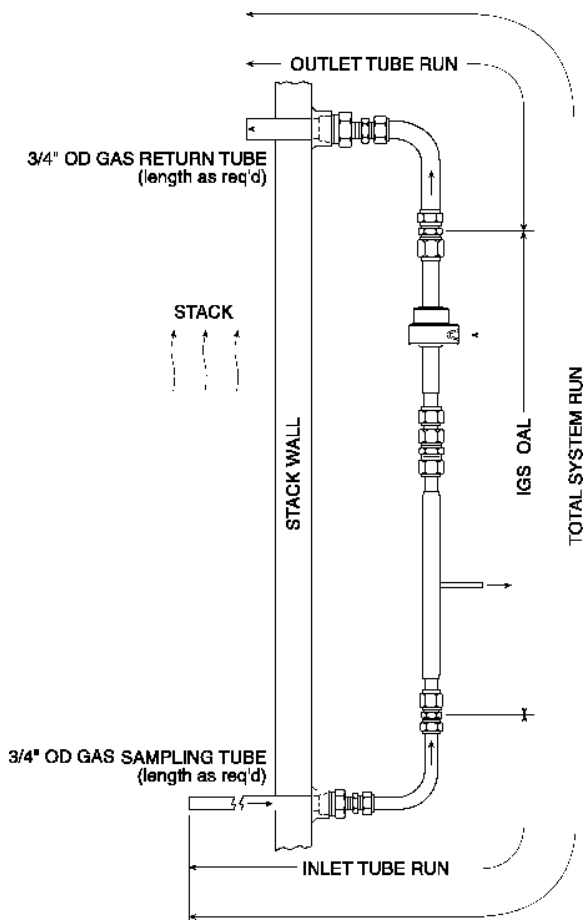
Part Description	Sample Flow Liters/Minute Recommended/Max	F Flange Size	A Porous Length	B	C Installation Clearance	L OAL Flange Face
7612-4-1/2-6-XX-(AB)FD	0.5/1	4"	6"	19.5"	*	**
7612-4-1/2-12-XX-(AB)FD	1/2	4"	12"	25.5"	*	**
7612-4-1/2-24-XX-(AB)FD	2/4	4"	24"	37.5"	*	**
7612-4-1/2-36-XX-(AB)FD	3/6	4"	36"	49.5"	*	**
7612-4-1/2-48-XX-(AB)FD	4/8	4"	48"	61.5"	*	**
7612-4-1/2-60-XX-(AB)FD	5/10	4"	60"	73.5"	*	**
7612-4-1/2-72-XX-(AB)FD	6/12	4"	72'	85.5"	*	**

\* Specify clearance - 4" minimum  
 \*\* L = B + C

**Examples:** 7612-4-1/2-24-2-(AB)FD, 18" installation clearance – In-Stack system with 4" mounting flange, 1/2" ID, 24" porous length, 2 micrometer, 316L SS/316 SS/300 SS/304 SS.  
 7612-4-1/2-12-0.5-(MB)FD, 18" installation clearance – In-Stack system with 4" mounting flange, 1/2" ID, 12" porous length, 0.5 micrometer, Hastelloy® X/316 SS/300 SS/304 SS.

# System Design Parameters

1. Determine process operating data for gas sampling application. Sample flow rate (liters/min.), gas temperature, gas dew point, characterize solids, solids loading, operating pressure.
2. Select porous length, based on required sample flow rate. (If near maximum, recommend use of next longer model.)
3. Select material based on gas temperature and/or corrosion requirements.
4. Select model depending on application needs.



Typical 76-111F external system arrangement

5. To establish eductor operating criteria:
  - a. Estimate system run in feet:  
 Model 76-111F total run length, plus inlet tube run, plus outlet tube run.  
 Model 76-121F use system run of 10 ft.  
 Model 76-141F total run length, plus length of sampling and return tubes.
  - a. Determine eductor supply pressure, (Fig. 1). Enter system run on horizontal axis. Move up to intersect the 85 FPS curve, move to left and read eductor supply pressure.
  - b. Determine eductor gas flow, (Fig. 2). Enter eductor supply pressure on vertical axis. Move right to intersect curve. Move down and read eductor gas flow.

6. Determine sample vacuum. At recommended maximum sample flow rates, vacuum required is nominally 10-20" H<sub>2</sub>O at the sample line. Higher vacuums may be required depending on application conditions; line losses to the analyzer must be considered.

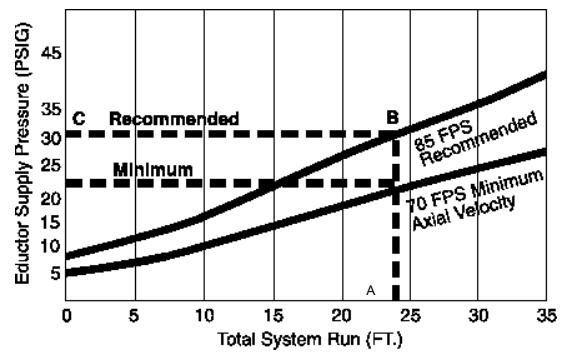


Fig. 1. Determination of eductor supply pressure

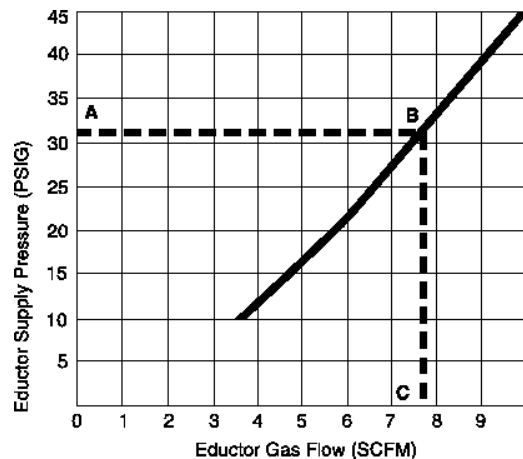
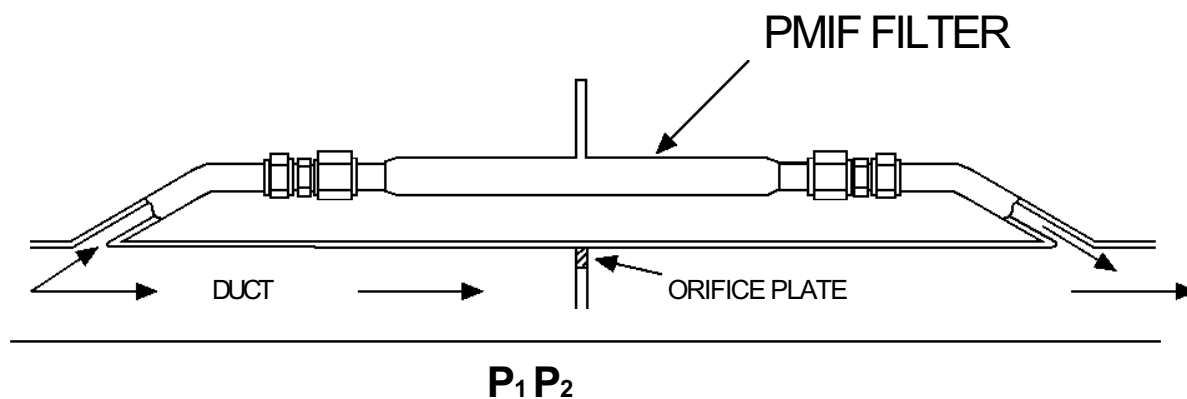


Fig. 2. Determination of eductor gas flow

# PMIF Notes

## Bypass Filter Arrangement



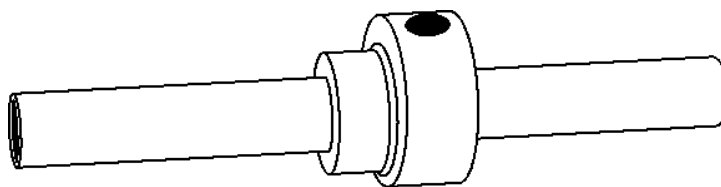
For sampling in positive-pressure systems from large ducts or pipes, such as an FCC catalyst regenerator stack, a model 76-10IF filter can be used without an eductor. The filter is mounted across an orifice plate that produces a minimum of a 2-psi differential across the filter, which will generate the required axial velocity in the filter. Smooth piping transitions into and out of the filter should be used to prevent solids from settling out.

## Clean Gas Sample Flow Control

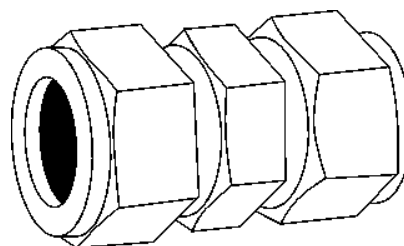
For maximum service life with filters, it is recommended that the clean sample flow rate be controlled to the required flow rate using control valves or other methods. This will assure minimum plugging and long on-stream life.

## Replacement Parts

To order standard connectors and eductors as replacements or spare parts, use the part numbers listed. Standard connector material is 316 SS; standard eductor material is 300 Series SS. Other materials available. Consult the factory.



Eductor P/N 100-226-09



Connector P/N SS-1210-6

## Where PMIF filters are used.



By virtue of their design and breadth of choice, PMIF filters are well suited to a variety of gas sampling applications. Here are three specific examples based on recent installations, followed by a list of other typical PMIF uses.

### **Fluid Catalytic Crackers.**

To help maintain productivity, CO and CO<sub>2</sub> levels are monitored in flue gases coming from catalyst regenerators in fluid catalytic crackers. The gases are sampled after they pass through a waste heat boiler, prior to entering a cyclone and passing out the stack, where the particle load is heavy, and temperatures remain constant at 450°F. A Model 76-11IF Filter System, insulated to prevent condensation, has operated continuously in one such application for more than 6 months with no need for maintenance.

### **Lime Kilns.**

Reliable O<sub>2</sub> analysis is required in dry process preheater lime kilns to reach maximum fuel efficiency, to maintain an oxidizing atmosphere for consistent product quality, and to ensure combustibles are kept out of the process gas. At the sampling point in the back end of the kiln, gas temperatures range from 1700°F to 2000°F, and contamination is heavy. A PMIF Model 76-11IF filter with an Inconel porous metal element has been configured with an exposed inlet tube to drop the temperature below 1000°F, resulting in continuous service for more than a year without replacement.

### **Utility Coal Pulverizers.**

A coal pulverizer for a utility boiler may process up to 60 tons of coal per hour – an environment that is very vulnerable to fire, requiring the fastest possible detection in order to “inert” the system quickly. One method is to use thermocouples, but they do not react until a fire has started and causes a rise in temperature. CO analyzers provide a faster response but are sensitive to dirty environments which may also clog conventional gas filters. A Model 76-14IF filter provides the ideal solution, and in a recent installation has operated for over a year with minimal maintenance.

### **Other typical PMIF sampling applications.**

- Open hearth steel furnaces
- Sulfur plant off-gas incinerator stacks
- Boiler flue gas for combustion control and emission monitoring
- Coking oven off-gas atmospheres
- General process control and emission control monitoring



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