

Fox Mini-Eductors

for Aspirating, Sampling, Mixing, and Vacuum-Generation

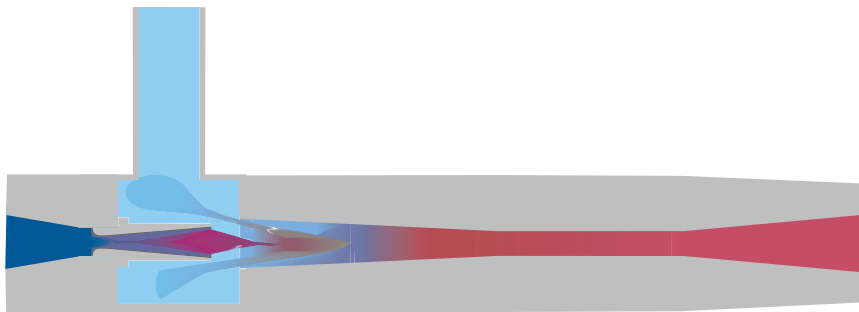


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FOX VALVE
DEVELOPMENT CORP
Hamilton Business Park
Dover, NJ 07801
973.328.1011
Fax 973-328-3651
email: info@foxvalve.com
Web Site: www.foxvalve.com

Fox Mini-Eductors

A complete range of stock Mini-Eductors available for shipment in 1 - 2 days to meet your Sampling, Aspirating, Vacuum-Generation, and Mixing needs:

Fox Mini-Eductors can be used with either liquids or gasses to eliminate or replace small pumps or fans in gas or liquid-handling applications. Fox has been providing thousands of mini-eductors each year for over twenty years for a huge range of industrial applications.

What's in a name? Industry uses many different names for the products we supply as Fox Mini-Eductors. These include aspirators, vacuum-generators, mixing tees, venturi vacuum pumps, and sampling jets

Fox offers a range of off-the-shelf mini-eductors in a variety of materials and capacities that can handle most straightforward sampling, mixing, and vacuum applications. These are described in detail in our Bulletin 401 - available from our website or by request via info@foxvalve.com.

Stock units are available 316 stainless, brass, Teflon, and CPVC. They can also be easily provided in Monel, Hastelloy, PVDF, and any other machinable metal. Standard end connections are NPT threads.

Typical applications: Fox Mini-eductors have been used in every conceivable application. Here is a selection of typical application:

Handling Gasses:

- Sampling - For aspirating stack or process gasses directly to analyzers
- Removing hot gasses - Exhausting gasses up to 1000°F from reactors, vessels
- Venting high-purity gasses - Common in semi-conductor mfg; all Teflon or high-purity ss mini-eductors are used
- Venting corrosive or dusty gasses - Removing gasses such as phosgene and acid vapors during chemical processes
- Creating vacuum for suction cup operation

Handling Liquids

- Additive Injection - For creating acid, caustic, or other solutions.
- Pump priming - Air conditioning start-ups

Customized/Production Mini-Eductors for OEM Applications:

- Instrumentation
- Chemicals/Additives/Concentrates
- Fuel Cells
- Refrigeration
- Biomedical Devices
- Sump/Drain

Since 1961, Fox Valve Development (Development IS our middle name) has produced venturi eductors optimized for use in a particular OEM application. These range from standardized analyzer/instrumentation/sampling systems to emptying oil sumps on locomotives and drillin equipment, and high-purity vapor removal on semiconductor processing machines.

Stock Fox Mini-eductors can usually be quickly modified to provide a 'proof-of-concept' test version, which may be followed by a few, slightly different prototypes. These are followed by development prototypes and then, production hardware. Customized mini-eductors, bought in quantity with an annual blanket order, can cost the same as quantity purchases of our stock, off-the-shelf mini-eductors. We can supply whatever material of construction, end connections, special mounting geometry, weight reduction, or special features you require.

Shown at right are some standard and special Mini-eductors in a variety of materials, including brass, 316 ss, TFE, and CPVC. Special features include one with two suction ports, one with a special discharge connection, and a TFE unit armored with a protective ss sleeve.



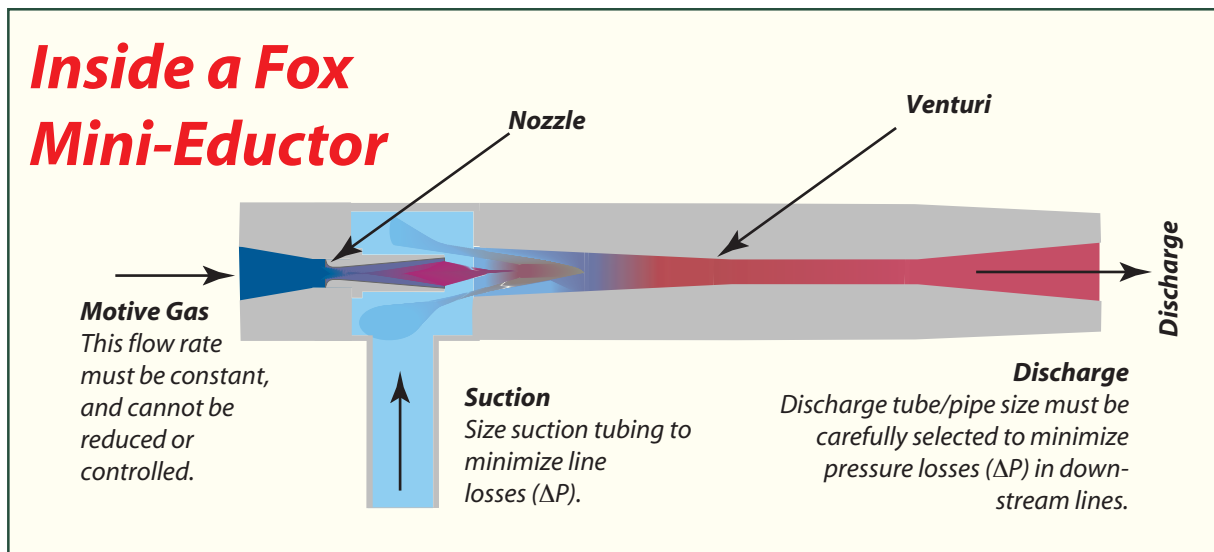
How Do Fox Mini-Eductors Work?

Mini-Eductors are used just the way a pump, fan, or chemical injection pump might be used in a process or system. However, instead of using electricity to rotate an impeller or compressor, the mini-eductor uses fluid mechanics to manipulate thermodynamics and obtain work from energy stored in the motive fluid. This enables pumping or mixing to occur with no moving parts, and therefore with no maintenance.

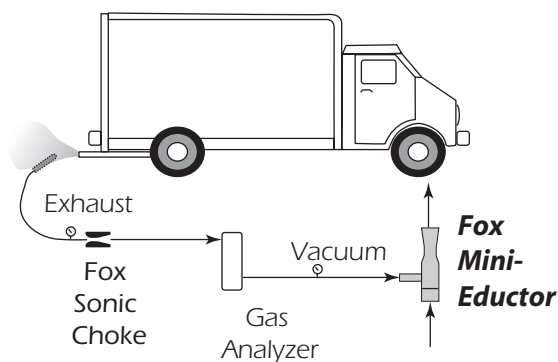
How do they work? The 'motive' fluid available to drive the eductor (compressed air, water, N₂, hydraulic oil, etc.) is discharged through a precision machined nozzle. The resulting high velocity jet creates vacuum and can pull in

another liquid or gas through the 'suction' port. These two fluid streams are mixed and discharged.

In order to quote the right hardware, we need you to define flow rates, fluid properties, and pressures at all three connections: Motive, Suction, and Discharge. Please note that the eductor accomplishes work by compressing or pressurizing fluid from the suction port up to a higher pressure at the discharge. Discharge pressure, discharge pipe size, and discharge pipe geometry are therefore critical to performance. Discharge pressure needs to be minimized.



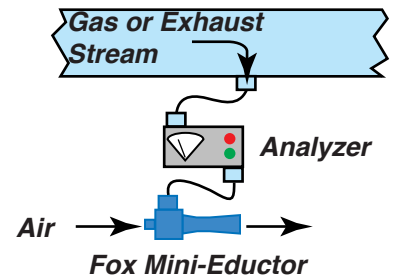
Typical Application #1 Vehicle Emissions Sampling



Many Vehicle Emission Labs (VEL's) use Fox eductors to draw samples into their analyzers. Fox chokes are also used to control known sample flow rates into the instrumentation.

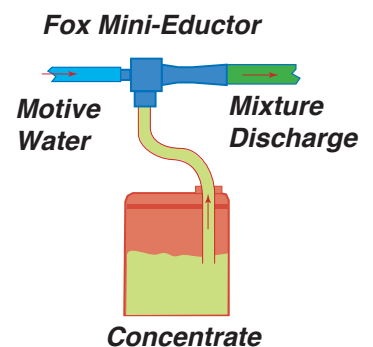
Typical Application #2 : On Line Gas Sampling

An air-driven mini-eductor is used to pull a sample from a process gas stream or exhaust stack through an on-line monitor or analyzer.



Typical Application #3 : Adding Concentrates/ Dilution

Fox Mini-Eductors are used to create solutions with additive or concentrates, or when small amounts of acid or caustic must be added to a stream to control



Fox Mini-Eductors Driven By...

Air or Other Gasses

Using Compressed Air, N2, H2, you can

- **Vent/Exhaust /Recirculate Gasses**
- **Sample Gasses**
- **Create Vacuum with No Moving Parts!**

Compressed air can therefore be used by a Fox Mini-Eductor to create vacuum that can be used to pump, sample, recirculate, vent or mix other gasses.

Because mini-eductors have no moving parts, they offer the maintenance-free way to sample or exhaust corrosive, explosive, dust-laden, or high-temperature gasses.

Below is a table showing what maximum shut-off vacuum these stock mini-eductors can create.

What Maximum, Shut-Off Vacuum Can Fox Mini-Eductors Create?

Eductor:	Motive Air Pressure:				
	20 psig	40 psig	60 psig	80 psig	100psig
-060	7"Hg	14	22	24	25
-030	4.5"Hg	13	20	23	23
-015	2"Hg	5	8.5	10	15

Motive air consumption for the three most common units are shown below.

How Much Air Do They Use?

Motive Air Pressure	20 psig	40 psig	60 psig	80 psig	100 psig
P/N 611210-060	1.7 SCFM	2.7	3.7	4.7	5.7
" -030	0.5 SCFM	0.75	1.0	1.3	1.5
" -015	0.13 SCFM	0.17	0.23	0.30	.35

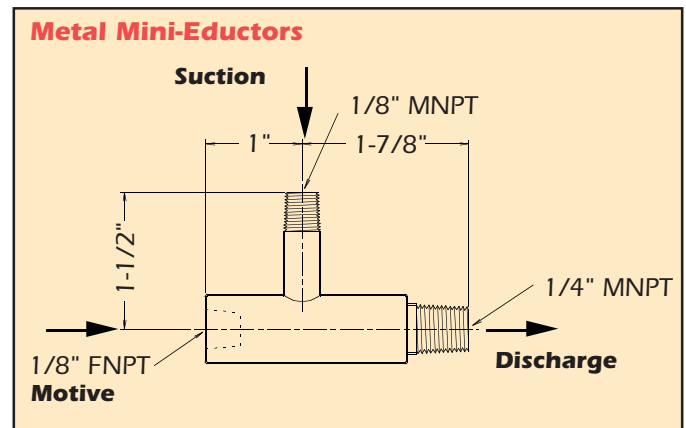
Four Different Sizes of Standard Mini-Eductors So You Can Match Motive Air /Gas Consumption to the Needs of Your Specific Applications

Three different sizes of standard Fox Mini-Eductors are always in stock to enable you to obtain, in 1 - 2 days, the right sized mini-eductor with the lowest motive air consumption that will still work in your application. They are stocked in 316 ss and brass.

These are identified by Part Number 611210 and a suffix that matches the motive nozzle orifice size. These are:

Fox Part Number	Motive Nozzle Orifice Dimension
611210-093	0.093 inches
611210-060	0.060 inches
611210-030	0.030 inches
611210-015	0.015 inches

Approximate dimensions of these off-the-shelf mini-eductors is shown below:



For more detailed information on how air-driven ejectors, of any size, can be used in industrial applications, please obtain Bulletin 251 from our website or by requesting it via info@foxvalve.com

Performance Curves of Mini-Eductors Driven By **Air**

For discharge pressure below 1 psig:

Mini-Eductor : Part No. 611210-060
Suction Air Flow Rate in SCFH; Air at 70 °F
Discharge Pressure < 1 psig (SCFM = SCFH/60)

Suction Pressure: " Hg Vacuum **Motive Air Pressure:** 20 psig 40 psig 60 psig 80 psig 100psig

0" Hg	150 SCFH	200	200	190	190
Air suction flow rate when suction pressure = 0 psig					
5" Hg	50 SCFH	130	165	160	150
10" Hg	—	60	120	120	110
15" Hg	—	—	60	80	75
20" Hg	—	—	15	45	50

The performance curves provided here can be used to **estimate** the performance of Fox Mini-Eductors when used with only with **air at about 70 °F**. For any of the following conditions, do not use this data: please request technical assistance from Fox.

This data cannot be used if:

- Air is much hotter /cooler than 70 °F
- Any other gas than air is present
- Discharge Tubing is smaller than 1/4"

For discharge pressure s of 5 psig :

Mini-Eductor : P/N 611210-060
Suction Air Flow Rate in SCFH; Air at 70 °F
Discharge Pressure =5 psig

Suction Pressure: " Hg Vacuum **Motive Air Pressure:** 20 psig 40 psig 60 psig 80 psig 100psig

		Part No 611210-060			
0" Hg	— SCFH	35	150	200	600
5" Hg	—	—	100	120	140

For the performance of other Fox Mini-eductors against discharge pressure, please contact Fox at info@foxvalve.com or call us at 973.328.1011 ext 0.

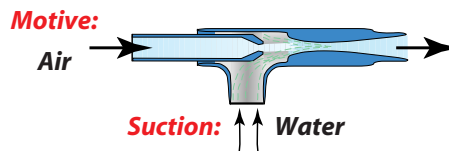
Mini-Eductor : Part No. 611210-030
Suction Air Flow Rate in SCFH; Air at 70 °F
Discharge Pressure < 1 psig (SCFM = SCFH/60)

Suction Pressure: " Hg Vacuum **Motive Air Pressure:** 20 psig 40 psig 60 psig 80 psig 100psig

0" Hg	35 SCFH	50	50	50	50
Air suction flow rate when suction pressure = 0 psig					
5" Hg	—	30	40	40	40
10" Hg	—	10	30	30	30
15" Hg	—	—	20	24	20
20" Hg	—	—	10	15	10

Below is performance of the very smallest Mini-Eductor we can make: Fox Part No 611210-015. The motive nozzle orifice diameter is 0.015" in diameter; motive air should be well-filtered. This unit is only available in 316 ss

Sucking Water w/Air-Driven Mini-Eductors



As a general rule, air-driven ejectors are not used to suck water or liquids because they are very inefficient due to the low momentum energy available from a very light motive fluid, like air. Nevertheless, there are certain applications, such as draining fuel lines, where the ability to drain a very small amount of liquid with an air-driven mini-eductor is very advantageous. Below is data on a -060 Mini-eductor driven with air, sucking in water

Fox P/N 611210 -060 Motive Air Pressure:

Suction Lift, Ft.	30 psig	60 psig	90 psig
0 ft	0.2 GPM	0.3	0.4
10 ft	—	0.2	0.25

Mini-Eductor : Part No. 611210-015
Suction Air Flow Rate in SCFH; Air at 70 °F
Discharge Pressure < 1 psig (SCFM = SCFH/60)

Suction Pressure: " Hg Vacuum **Motive Air Pressure:** 20 psig 40 psig 60 psig 80 psig 100psig

0" Hg	10 SCFH	15	18	18	15
Air suction flow rate when suction pressure = 0 psig					

Fox Mini-Eductors Driven By...

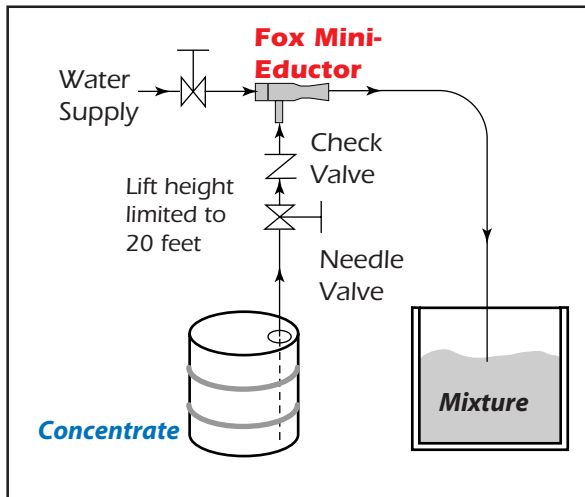
Water or Other Liquids

Any liquid at 20 psig or higher can be used to drive a Foxmini-eductor to pump or blend other liquids. (They are not very effective at entraining gasses or air but we do offer performance curves) Because mini-eductors have no moving parts, they represent the maintenance-free way to pump, dilute, or mix corrosive, caustic, or explosive fluids. They are frequently used to blend solutions. The motive flow rate is established as a constant flow rate by the eductor nozzle (assuming a fixed, regulated, inlet pressure.) Suction flow rate, and therefore concentration, is controlled with a needle valve on the suction side.

Please note that:

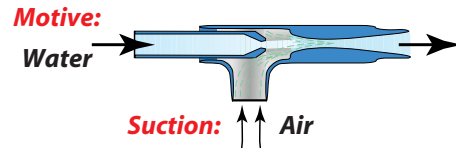
- a) Suction flow rate cannot be adjusted by changing motive flow rate or pressure.
- b) If city water is to be used as the motive supply pressure, a regulator should be installed and set to the lowest expected pressure.

The schematic below shows a typical installation of a Fox Mini-Eductor used to create a solution with an additive or concentrate. Note that the motive, or main, flow rate remains fixed,



while additive flow rate is adjusted with a needle valve. A check valve is a necessary safety feature on the additive feed line.

Sucking Air w/Water -Driven Mini-Eductors



Water-driven eductors are often used to entrain air. However, the small size of Mini-eductors introduces scaling factors that make suction air flow rates obtainable with liquid-driven mini-eductors rather poor.

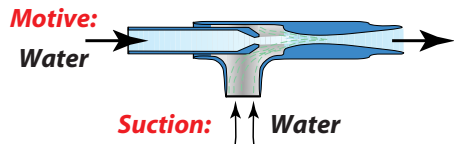
Mini Model #	Motive Water Pressure:				
	20 psig	40 psig	60 psig	80 psig	100psig
	Discharge Pressure = 0 psig				
-060	—SCFH	10	13	20	30 SCFH
-093	—SCFH	30	40	50	60 SCFH
	Discharge Pressure = 2 psig				
-060	—SCFH	5	8	10	12 SCFH
-093	—SCFH	—	15	20	25 SCFH

For more detailed information on how water-driven ejectors, of any size, can be used in industrial applications, please obtain Bulletin 103 from our website or by requesting it via info@foxvalve.com.

How Much Water Do They Use?

Motive Pressure:	20 psig	40 psig	60 psig	80 psig	100 psig
P/N 611210-093	1.3 GPM	1.7	2.0	2.3	2.5
" -060	0.7 GPM	0.8	0.9	1.1	1.2
" -030	0.15 GPM	0.22	0.25	0.28	0.3

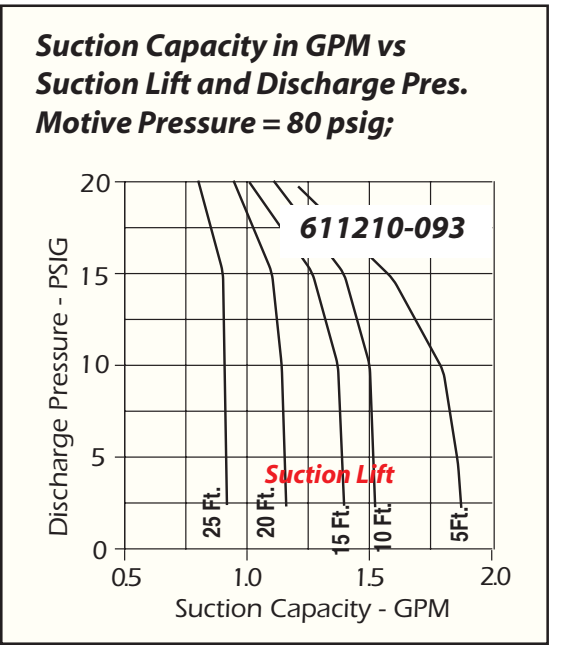
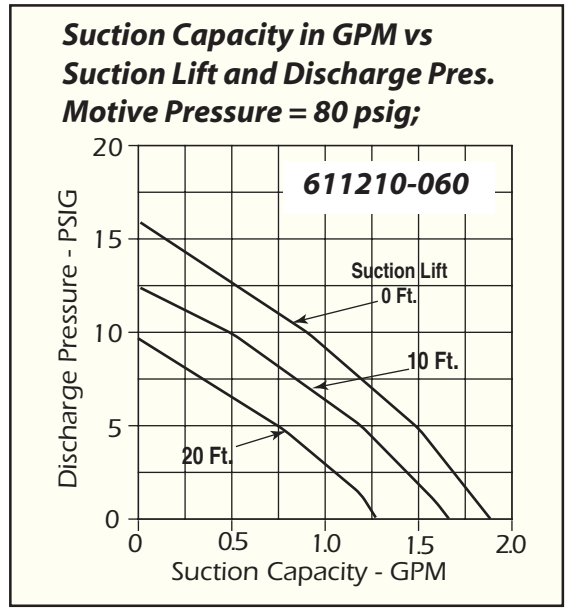
Performance Curves of Mini-Eductors Driven By: **Water**



The pressures at all three connections on the eductor: motive, suction, and discharge, all have a significant impact on eductor performance. We could, therefore, publish a very complex set of performance tables completely describing eductor operation - for use only with water. However, we think it more effective to publish a select, limited amount of sizing information and request our customers to contact us if your requirements are in any way different from the narrow range of operating conditions described in these representative performance charts.

At right, Fig shows how Suction Lift effects flow capacity, along with discharge pressure, for P/N 611210-060 when running at 80 psig.

Fig shows how Suction Lift effects flow capacity, along with discharge pressure, for P/N 611210-093 when running at 80 psig. The design of the -093 mini uses more motive water to enable discharge against significant discharge head, or backpressure.



Mini-Eductor : Part No. 611210-030
Suction Water Flow Rate in GPM;
Suction Lift < 1 ft

Discharge Pressure: psig	Motive Water Pressure:		
	30 psig	60 psig	90 psig
0 psig	0.24	0.4	0.5
2 psig	---	0.2	0.4
4 psig	---	0.1	0.35
6 psig	---	---	0.23
8 psig	---	---	0.1

Gas Sampling with Fox Mini-Eductors

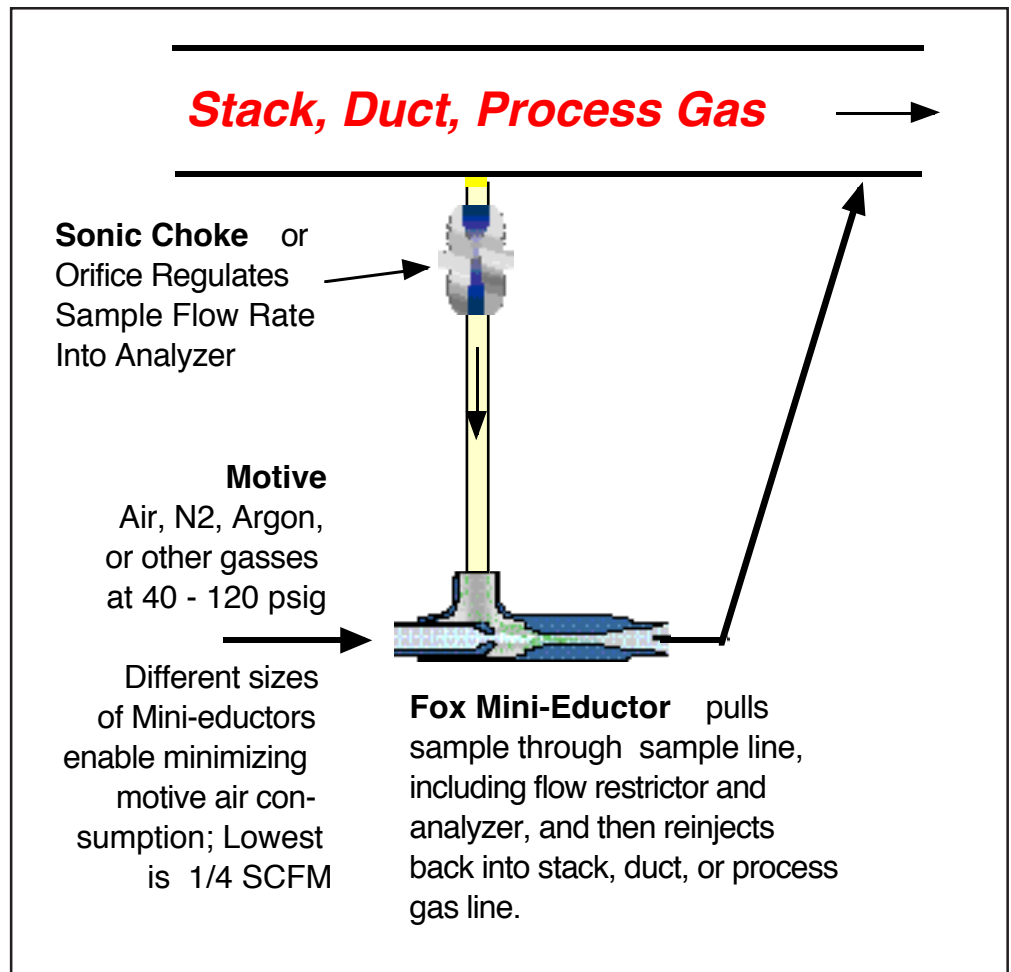
Thousands of Fox Mini-eductors are included as vacuum sources in analyzer systems each year, including those manufactured by some of the largest instrumentation suppliers in the US and Europe.

Since sample flow rates are usually quite low, the resulting pressure drop (ΔP) through small 1/4" (6 mm) sample lines is usually small enough to be ignored when selecting a mini-eductor. However, if sample lines are both small (1/8" or 1/4") and long (over 60 ft, 20 m) then a calculation of sample line ΔP must be undertaken.

Note that eductor discharge lines should be 3/8" or larger, unless the tiny -015 Mini-eductor, which discharges extremely low flow rates, is being used. Installing undersized discharge lines on a sampling eductor can create undue backpressure that will degrade eductor performance.

Regulating Sample Flow Rate -

Fox Sonic Chokes have often been used to establish fixed, accurate, repeatable sample flow rates into analyzers for decades. Vehicle Emission Labs were one of the first to use chokes to regulate exhaust flow rates into gas analyzers. Chokes are an ideal way to precisely regulate flow rates of high-purity, high-temperature, explosive, or corrosive gasses. Request Fox Bulletin 025.



The following are somewhat special sampling applications where stock Fox Mini-Eductors were modified to provide the ideal solution:

- **High Purity Gasses** - Two different Fox mini-eductors are commonly used in semi-conductor plants: a) High-purity mini-eductor: electropolished with VCR ends, and b) Our Teflon Mini-eductor, with Viton, Kalrez, or EPDM O-ring. (Metal Mini-eductors don't have O-rings since they can be welded together.)
- **Ceramic-Lined Mini-Eductors**- Used when sampling abrasive particulates for particle-size analyzers.
- **High Temperatures**- Mini-eductors can be provided in high temperature alloys useful to 1600 °F.
- **Corrosives** - Materials such as Hastelloy, Inconel, Monel, and Titanium can be specified.
- **Disassembleable** - When dealing with particulate-laden gasses, some systems require that mini-eductors need to be disassembleable.

Please call or email us with any special sampling requirements.
info@foxvalve.com

Development and Production of Fox Mini-Eductors for Use in OEM Equipment

Fox Supplies Thousands of Air and Gas Ejectors to OEM's for Use on a Broad Range of Industrial Equipment

Fox has been through the process of taking an initial phone call or email from a project engineer and taking it through the many stages that lead to the supply of optimized production mini-eductors for use in OEM equipment such as medical, instrumentation, aerospace, or gas sampling systems. Fox has Annual Blanket Orders from many manufacturers for monthly releases of mini-eductors in quantities ranging from 4 per month to 300/month. Fox excels at this process: there is a reason why 'development' is in our company name:

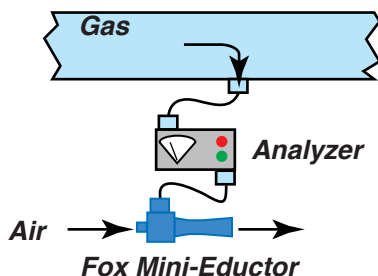
- **Quick Supply of First Prototype based on Stock Ejector for Concept Trial**

Our first goal is to see if the remachining or modification of a stock mini-eductor can serve as a useful 'proof of concept' or test unit to verify that a Fox ejector can come close to meeting the requirements within your OEM equipment - such as venting gasses, establishing vacuum, purging lines, recirculating refrigerants. If the application permits modification of a stock unit, shipment can occur in one week.

Typical OEM Applications:

On-Line Process Gas or Emissions Sampling

An air-driven mini-eductor is used to pull a sample from a process gas stream or exhaust stack through an on-line monitor or analyzer, which is programmed to signal dangerous conditions or unexpected gas composition.



- **Building a Prototype**

The next step is the custom manufacture of one or more prototypes with an ejector internal design optimized around your precise requirements. These are machined in-house at Fox Valve and can include whatever end connections, materials of constructions, and special features to make the equipment ideal for inclusion in your system.

- **Production Hardware**

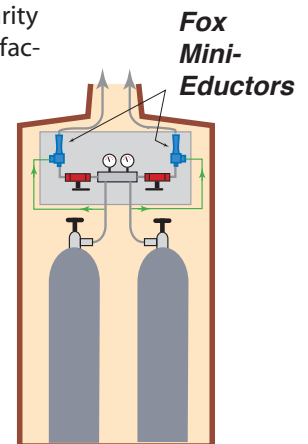
This is the final product, typically machined at Fox Valve in our CNC lathes. Quantity pricing is significantly lower than the highly engineered prototype. Annual blanket orders, where Fox can schedule a large manufacturing run and ship hardware in monthly releases, maximizes the quantity discount an OEM can obtain.

- **Testing**

Certain OEM customers require testing of each and every part before shipment. This can include hydrotest, leak test, or a performance test.

Gas Cabinets for Ultra-High Purity Semiconductor Manufacturing Processes

Various manufacturers of high-purity gas cabinets for micro-chip manufacturing use all 316 stainless or all-Teflon Fox mini-eductors to evacuate and sample the corrosive and toxic gases that remain in the piping/tubing common in this industry - including gallium arsenide and hydrogen fluoride.



Fox Mini-Eductors

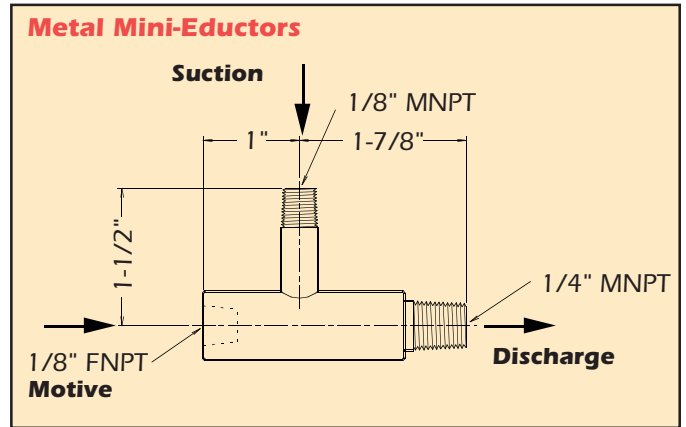
Dimensions and Ordering Information

Stainless, Brass, and Other Metals

Standard mini-eductors manufactured in brass, 316 stainless. Other materials are available such as hastelloy, monel, and other high alloys.

Fox Part No. 611210. They are available from stock in brass and 316 ss, in four different internal sizes, which are described by their nozzle orifice diameter, in inches: -015", -030" -060" & -093" .

Use a suffix to denote material of construction:
 Stainless : -ss; Brass - BR, Teflon - TFE
 Fox P/N 611210-060-ss is a -060 unit in 316 ss.

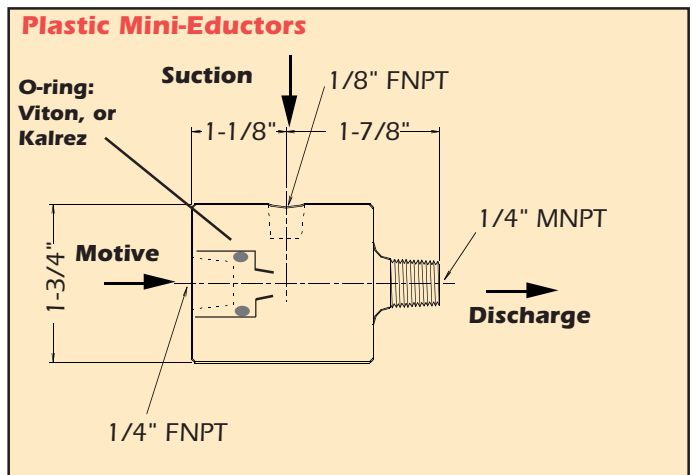


Teflon, CPVC and Other Plastics

Plastic Mini-Eductors are available from stock in TFE and CPVC with .060" nozzle size only. Other materials and sizes per quotation. Nozzle sealed with Viton O-ring.

If Larger Eductors are Needed...

Mini-Eductors represent only the very smallest eductors and ejectors that Fox Valve manufactures. Fox stocks a complete line of air jet ejectors and liquid eductors in line sizes up to 3", in ss, c.s., and PVC. Larger sizes are available. Please request additional product information for these larger ejector/eductors.



To Receive a Quotation:

Request and complete our Application Data Sheet.

Additional Technical Literature

The following materials are available upon request:

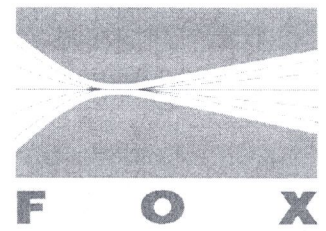
Bulletins:

- 103 — Fox Liquid Eductors
- 251 — Air Jet Ejectors
- 203 — Steam Jet Ejectors and Vacuum Systems
- 206 — Ejectors for Natural Gas Vapor Recovery
- 271 — Hydrogen Ejectors for Fuel Cells
- 301 — Solids Conveying Venturi Eductors
- 350 — Solids Conveying Eductors used in Food Plants
- 551 — Plastic-Lined Eductors for Corrosive Applications
- 025 — Sonic Chokes & Critical Flow Venturies



FOX VALVE
DEVELOPMENT CORP
 Hamilton Business Park
 Dover, NJ 07801
 973.328.1011
 Fax 973.328.3651
 email: info@foxvalve.com
 Web Site: www.foxvalve.com

Fox Mini Eductor Data Sheet for Gas-Sampling Applications



Please fill in the blanks so we can quote on your application!

PROCESS TO BE SAMPLED

Required Sample to Mini-Eductor
(Controlled by a valve on sample line)

Required Gas Flow Rate:

What gas? _____
 Gas MW (Air=29) _____
 Gas Temp? _____

Sample Line:

A) Distance from Process to Eductor:

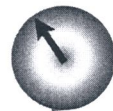
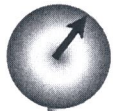
Existing Tubing that must be used

B) If yes - what diameter?



Needle Valve
Controls Sample
Flow rate

ANALYZER



Motive Gas? _____

Pressure = _____

• Sample flow rate CANNOT
be controlled by regulating
the motive flow

FOX MINI EDUCTOR

Discharge

Discharge Pressure Equals

A) Destination Pres. +

B) Pressure loss
through tubing

Where does discharge:

A) Back to Process?:

B) Vent to atm at 0 psig?

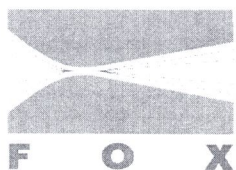
0 psig

Discharge Line:

A) Distance to Destination

Existing Tubing that must
be used?

B) If yes - what diameter?



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Fox Gas Sampling Mini-Eductor
DATA SHEET SCHEMATIC