Fox Mini-Eductors
for Aspirating, Sampling, Mixing, and Vacuum-Generation

Bulletin 400 A
Fox Mini-Eductors enable use of a high pressure fluid to generate suction for a variety of small pumping, mixing, sampling, or vacuum-generation applications. They have been used since 1961 in a very wide range of industrial applications, from agriculture to fuel cells to aerospace. Fox offers a complete line of stock mini-eductors in a variety of materials and capacities. Our off-the-shelf corrosion-resistant units, in 316 stainless, Teflon, or CPVC, enable handling of corrosive liquids and gasses with no moving parts. Flow rates as low as 1/4 SCFM (0.42 Nm³/h) of air or 0.1 GPM can be used to drive Fox mini-eductors.

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

**Typical applications:** Fox Mini-Eductors have been used in every industry, from mixing fertilizer to sampling radioactive gas. Some typical uses include
- **Sampling** - For aspirating gas or liquid samples into analyzers
- **Additive Injection** - For diluting/mixing acid, caustic, or other solutions.
- **Vacuum-Generation** - For vacuum chambers, suction cups
- **Recirculating Gasses** - For return of small gas flow rates, like hydrogen, methane, hot gasses, back to reactors or fuel cell stacks
- **Mixing** - Fertilizer, herbicide, and chemical solutions
- **Conveying** - For handling <10 pph of very fine powders from a feeder.

**How Do Fox Mini-Eductors Work?**

Mini-Eductors are used in the same way as a pump in a process or system. However, instead of using electricity to drive a rotating impeller or compressor, the mini-eductor uses fluid mechanics to create suction from the 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, N₂, H₂, water, hydraulic oil, diesel fuel 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.
Compressed air is available in almost every industrial setting. It 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 gases. Three standard Mini-Eductors are stocked that, although they resemble each other externally, have very different internal geometries. The motive nozzle orifice sizes are .015”, .030” and .060” - with similarly proportioned internals. Motive air consumption varies, therefore, by a factor of four with each eductor size change, enabling users to choose a Mini-eductor that minimizes their consumption of compressed air, GN2, or other gas.

**Performance Curves:**
The curves at right show the entrained air flow rate, in SCFH, for varying conditions of motive air pressure and suction pressure. Atmospheric suction conditions is, of course, at 0” Hg vacuum. For long suction lines, as may exist on a sampling system where the analyzer is located far from the sample source (such as stack, vehicle or process), the line losses or ∆P through the suction tubing must be estimated and used as the ‘suction pressure’. (See Page 7 for use in sampling systems.) This data assumes a discharge pressure of about 0 - 1 psig. Call factory to convert this data to other gasses or for operation at other temperatures and pressures.

**How Much Air Do They Use?**
See Fig 6 at right.

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**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.

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**Figure 3**

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**Figure 4**

**Suction Capacity, in SCFH, Motive = 40 psig**

<table>
<thead>
<tr>
<th>Suction Pressure - In Hg Vacuum</th>
<th>Suction Capacity - SCFH</th>
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</thead>
<tbody>
<tr>
<td>30</td>
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<td>25</td>
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<td>5</td>
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<td>0</td>
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</tbody>
</table>

Discharge Pressure = 0 PSIG

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**Figure 5**

**Suction Capacity, in SCFH, Motive = 80 psig**

<table>
<thead>
<tr>
<th>Suction Pressure - In Hg Vacuum</th>
<th>Suction Capacity - SCFH</th>
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<tbody>
<tr>
<td>30</td>
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<td>0</td>
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</table>

Discharge Pressure = 0 PSIG

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**Figure 6**

**Motive Air Consumption (SCFM)**

<table>
<thead>
<tr>
<th>Size</th>
<th>Air Pressure (PSIG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.060”</td>
<td>40  60  80</td>
</tr>
<tr>
<td>.030”</td>
<td>2.7  3.7  4.7</td>
</tr>
<tr>
<td>.015”</td>
<td>0.73 1.0 1.3</td>
</tr>
</tbody>
</table>

Use the table above to estimate air consumption of these three standard mini-eductors. Please call the factory for data at any other condition.
Any liquid at 20 psig or higher can be used to drive a Fox Mini-Eductor and pump other liquids. Because mini-educitors 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 fixed by the eductor nozzle, assuming constant, regulated inlet pressure. Suction flow rate, and therefore concentration, is controlled with a needle valve on the suction side.

The above schematic shows a typical installation of a Fox Mini-Eductor used to create a solution with an additive or concentrate. The 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.
Using Fox Mini-Eductors in OEM Equipment

- Analyzers
- Sampling
- Hydraulics
- Refrigeration
- Acid Dilution
- Semi-Conductors

Customized and Optimized for OEM Users

Fox Mini-Eductors have been incorporated into OEM equipment for over thirty years. Fox makes it easy to evaluate whether a mini-eductor can enhance the performance of your system/equipment. Although we stock a range of differently sized mini-eductors, there is no reason for our OEM customers to compromise performance by settling for what happens to be a standard unit.

- For certain OEM applications, Fox will accept an order for one eductor, but will custom-modify 2 or 3 others based on our experience. You can then evaluate these, hopefully zeroing in on an optimized configuration.
- Stock mini-eductors have all NPT ends. End connections for production units can include any required end connection with little impact on quantity pricing.

Typical 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.

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.

Dilution of Acid or Caustic Concentrates:

Fox Mini-Eductors are often used when small amounts of acid, caustic or other additives are required to be introduced into a main stream to control pH or otherwise change chemical formulation.
**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 P/N 611210 to define: a) mini-eductor size, and b) material of construction.

For example: Fox P/N 611210-060-ss is a -060 unit in 316 ss. These units are also available with an enlarged suction port for feeding finely powdered solids.

**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:**

- 101 — Fox Liquid Eductors
- 261 — Steam Jet Heaters
- 203 — Steam Jet Ejectors and Vacuum Systems
- 271 — Hydrogen Ejectors for Fuel Cells
- 280 — Air Jet Ejectors
- 301 — Solids Conveying Venturi Eductors
- 025 — Sonic Chokes & Critical Flow Venturies

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Gas Sampling with Fox Mini-Eductors

For Use in Analyzer and Instrumentation Systems

Thousands of Fox Mini-eductors have been installed in analyzer systems since 1961. Fox mini-eductors are included as vacuum sources within hundreds of analyzer systems sold each year, including by some of the largest suppliers in both the US and Europe.

Since sample flow rates are usually quite small, pressure drop (P) through small 1/4” (6 mm) lines is usually less than 1/2 psig and therefore does not have much effect on mini-educator selection. However, if sample lines are both very small (1/8” or below) and rather long (over 60 ft, 20 m) then a calculation of sample line P must be undertaken.

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. (See Fig. 3) 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 semiconductor plants: a) High-purity mini-educator: electropolished with VCR ends, and b) Our Teflon Mini-educator, 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