

Fox Gas Venturi Ejectors



- **Venting Hot, Corrosive, Explosive or Dusty Gasses**
- **Mixing and Diluting**
- **Vacuum to 1 psia**
- **Sampling Stack Gas to Analyzers**

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- Air, N₂, H₂, Argon, etc.
- Natural Gas/Hydrocarbons
- Steam
- Gas temps to 1800°F

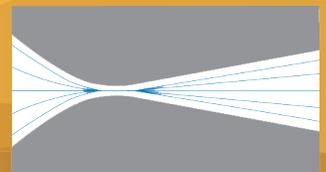
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- Stainless, cs, TFE, Titanium, Monel Inconel, etc.
- Stock Ejectors 1/4" to 6"
- Custom Ejectors to 42"



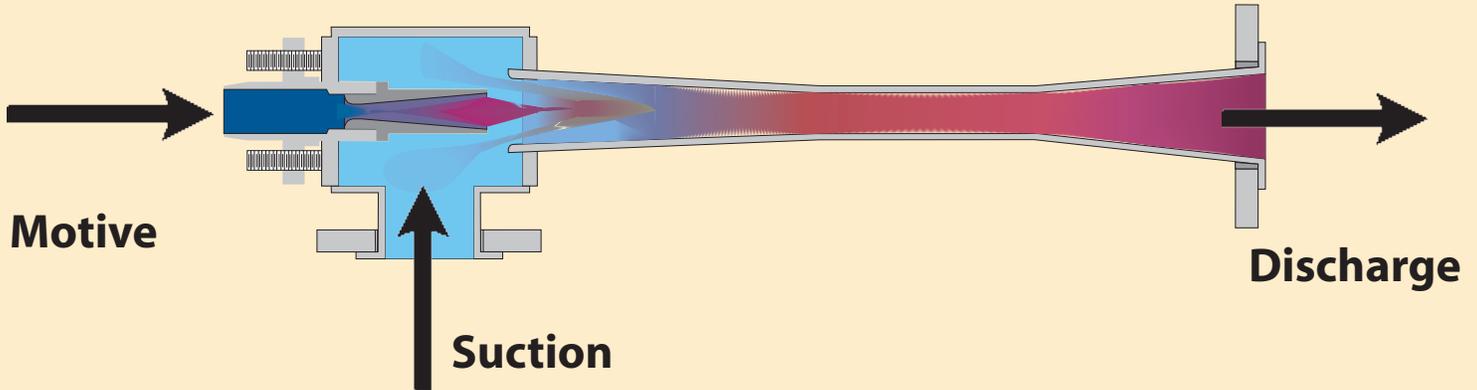
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Fox Venturi Products
 Dover, NJ 07801 USA
 973.328.1011
 Fax: 973.328.3651
 Email: info@foxvalve.com
www.foxvalve.com



Fox Gas Venturi Ejectors

Fig. 1



Off-the-Shelf Gas Ejectors
shipped in 2 - 3 days:

— OR —

**Custom Engineered
Ejectors**
shipped in 2 - 8 weeks

Fox Venturi ejectors have been used to eliminate blowers and fans in gas-handling, exhausting, gas-dilution, vacuum and fume removal applications since 1961. With no moving parts, Fox ejectors can provide reliable, maintenance-free gas venting in applications where the alternative of using a blower or fan is both unreliable and unreasonably expensive. This is especially true when handling hot, corrosive, explosive or dust laden gasses and fume. Motive gas can be air, natural gas, N₂, H₂, steam, argon - or any gas.

Off-the-Shelf Gas Ejectors

Off-the-Shelf Gas Ejectors 1/4 - 6" line sizes

Fox stocks Off-the-Shelf Gas Ejectors both assembled and unassembled, in sizes 1/4" to 6" (6 - 150 mm) in c-s, stainless, and PVC (up to 3" only), that can ship in a few days. The huge advantage of maintaining a large inventory of unassembled ejectors means Fox can resize or modify existing components, and weld together an optimized gas ejector often in a week. When gas properties differ widely from air, off-the-shelf ejectors, typically optimized for use with air, are poor substitutes for correctly sized ejectors, optimized around actual operating conditions. These are nevertheless often available in a week.

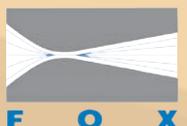
Custom Engineered Ejectors

Custom-built air ejectors 1/4 - 42" line sizes

For can supply custom-engineered and custom-built gas ejectors for deep vacuum, gas blending, and gas compression. After receiving a completed data sheet, Fox can usually provide a quote in 1 - 2 days. Such ejectors can include options including MAWP to 10,000 psig, weld certs, weld X-rays, hydrotests, special cleaning and any flanges.

For a quotation, please complete attached Application Data Sheet (see last page) and email to Fox Valve at info@foxvalve.com

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Email: info@foxvalve.com
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Fox Gas Venturi Ejectors



No Moving Parts

Fox Air and Gas venturi ejectors have no moving parts. No shafts, no motor starters, no seals, no maintenance. Their rugged construction and simplicity of design enables operation in corrosive, dusty, or high-temperature environments.

Eliminating Blowers or Fans in Corrosive, Explosive, Toxic, or Dusty Gas-Handling Applications

Ejectors eliminate the need for blowers or fans with XP motors, Teflon-coated blades, or other very expensive blower options that add enormously to cost but still don't protect your process from intermittent failure.

Fig. 2



Fox ejectors are used to eliminate motors, bearings and seals when handling corrosive or explosive gasses - providing 24/7 reliability.

Air Ejectors Don't Need Compressed Air

Many ejector applications do not require use of compressed air at 50-100 psig to accomplish the needed fume or vapor venting - although the ejector can always be designed to use an existing compressed air supply. For continuously operating air ejectors that must vent or exhaust from a process and discharge to a low pressure, a matched blower running at 2 - 3 psig can be provided. This blower can be located far from the corrosive, explosive, or dusty location of the ejector.

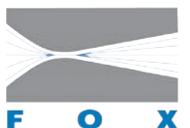
Reliability

If you need 24/7 reliability, lower installed cost, and reduced maintenance, use ejectors for your demanding gas handling applications.

Oil Field and Nat Gas processing, Engine Testing, and Aerospace Applications

Fox gas ejectors have been engineered and installed in demanding applications in the above industry for 40+ years.

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Email: info@foxvalve.com
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Fox Gas Venturi Ejectors

FAQs

1) What Motive Flow rate is required? Is there a simple 'Rule of Thumb' we can use to estimate air requirement?

There is no simple rule or equation or chart that is useful for predicting motive flow for air or nat gas or hydrogen at all temps and all pressures. The best way to get the right answer, fastest, is to complete the Fox Data Sheet data sheet or otherwise describe the pressures, temps, and flow rates - and email to info@foxvalve.com. We can then input into our proprietary computer algorithms that will predict performance, motive flow, etc. You will usually get a response within 24 hrs, if not that same day and a quote in one day. Or you can call us and speak with an engineer. Anyone you may speak with at Fox will be a graduate engineer

2) How fast can we get one?

Fox has a large inventory of stock air ejectors that are stored both assembled and unassembled, in line sizes from 1/2" to 6" in carbon steel, stainless, and PVC (to 3" only). If your application has a low discharge pressure, the chances are good that components of stock ejectors can be quickly modified to become an optimized venturi jet for your specific application - and can ship in a week or less. Completely custom ejectors, for deep vacuum or higher discharge pressures may require 4 - 8 weeks - which can often be expedited with a rush premium.



Fox maintains a large inventory of stock gas ejectors in stainless and carbon steel.

Fig. 3

3) Can we control the suction gas flow rate by adjusting the Motive flow rate?

In certain applications, and only when discharging to low pressure, this can work over a limited range. However, as a general rule it is always best to maintain a constant MOTIVE gas flow rate and adjust the suction gas flow with a dedicated valve on the suction line.

4) What's the deepest vacuum I can pull with an air ejector?

Most applications need to simply vent or exhaust vapors. The maximum vacuum level - at the no-flow, or shut-off condition - is usually irrelevant. But here is a quick guide with air at 80 - 100 psig, off-the-shelf ejectors can pull down to about 10 psia (or -20" Hg vacuum). Custom built single stage ejectors can reach 2 - 3 psia. Two stage ejectors can reach 1 psia.

5) How and where are Fox ejectors manufactured?

Fox ejectors below a 5" line size are machined from bar at our plant in New Jersey. We are not locked into fixed geometries by castings made overseas or anywhere else, and we do not simply thread together stock components. We have complete machining and welding capability in-house, which is why we can usually offer an expedited option for rush projects.

Fox Gas Venturi Ejectors

FAQs

6) We need the ejector to handle a large gas flow rate, but, in order to protect process equipment on the suction side, the ejector must be designed so it never pulls a vacuum deeper than 10 inches of water. Can Fox do that?

Any ejector that can suck in a large gas flow rate will pull a significant vacuum level if the suction gas flow rate, or suction load, stops. An ejector cannot be designed with a limited shut-off vacuum level. There are various solutions - one easy one is to install a vacuum break valve on the suction line, that opens to bleed in free air, thus protecting the process vessel from vacuum.

7) We need to use an ejector to blend two gasses in a precise mixture ratio. Can that be done?

Since the motive flow goes through a sonic choke in the ejector nozzle, the motive flow is held constant if motive pressure is constant (use a pressure regulator.) If suction inlet pressure is also fixed (such as atmospheric at 14.7 psia), placing a Fox sonic choke on the suction port of the ejector will establish a fixed suction flow rate. Since both flows are fixed, mixture ration is established. This approach can only be used for fixed, constant flow rates - and will not work to maintain a constant mixture ratio with varying flow rates.

8) Can an ejector suck up liquids from a sump using compressed air?

Yes - but this approach is only used for limited liquid flow rates - like emptying very small sumps that collect refrigerants, hydraulic oil leaks, fuel.

9) Can we get a straight-through ejector so the suction gas does not need to make a 90° turn.

Yes - in-line gas ejectors are available for certain

applications but they are:

- a) limited to low discharge pressure applications,
- b) are significantly less efficient than standard ejectors,
- c) Are not typically in-stock at Fox Valve, and
- d) are more expensive that stock ejector.

This is usually a high-cost penalty for avoiding installation of one elbow to accommodate a stock ejector.

10) What gas temperatures can a Fox ejector handle?

Stainless is ok for high gas temps up to about 1200°F. Inconel is used for gases up to about 1600°F, and other nickel alloys can be used up to 2000°F.

11) What size ejectors are available from Fox?



Fox manufactures a complete line of mini-ejectors for gas sampling through 1/4" and larger lines.



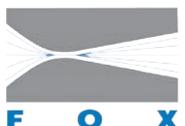
This 39 foot long air ejector has 42" flanges and was used to evacuate a high altitude test chamber.

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Email: info@foxvalve.com

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More Applications of Fox Gas Venturi Ejectors

Venting Explosive, Corrosive, or Dusty Gasses

When process tanks, vessels, or chambers are filled with liquids or slurries, hazardous gasses must often be vented during the filling process or due to temperature changes.

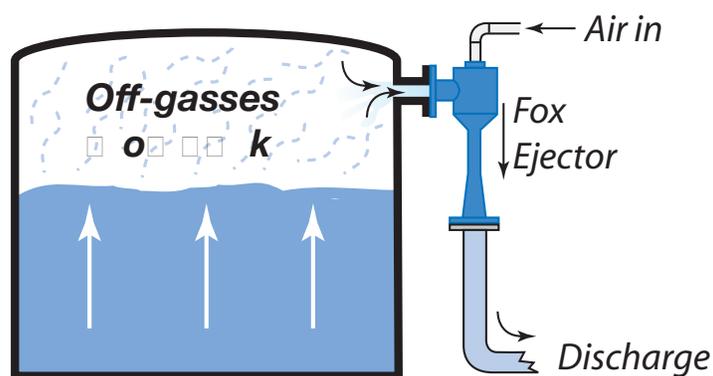


Fig. 4

Venting Trucks, Tankers and Railcars

Fox ejectors are frequently used to evacuate explosive or hazardous gasses from trucks and railcars. Multiple trucks can be connected to a pipe manifold which is then connected to the ejector suction port. The ejector can then discharge gasses to a scrubber, flare header or other destination.

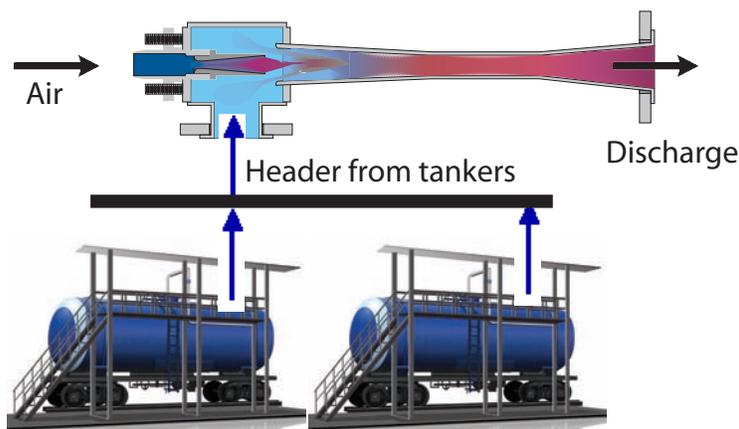


Fig. 5

Extracting Hydrocarbon Vapors

Fox ejectors are frequently installed to remove gas buildup in the headspace in tanks and vessels.



Purging Gas Pipelines

Fox ejectors are often used to purge and evacuate miles of pipeline sections before maintenance.



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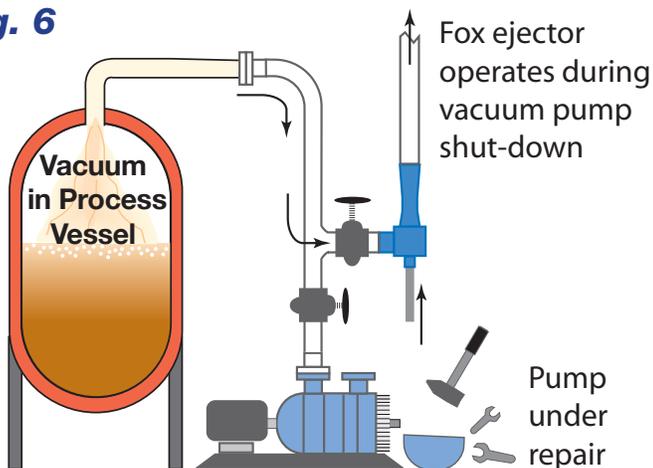


More Applications of Fox Gas Venturi Ejectors

Back-Up/Emergency Vacuum Source

Fox ejectors are often used as a back-up vacuum source, or emergency vacuum supply, for processes that otherwise rely on mechanical vacuum pumps for process vacuum. These ejectors get switched into operation if the vacuum pump fails or requires a scheduled maintenance.

Fig. 6



Gas Turbine and Rocket Engine Testing

Fox ejectors have been installed on many rocket and jet engine test stands to create deep vacuum on exhaust, simulating high altitude, or diluting hot gas streams at temps up to 1800° F. Materials can be stainless or nickel alloys for extreme high temperatures.



(See also photo of Fox two stage air ejector system (see Fig. 14) installed atop the hypersonic wind tunnel at Princeton.)

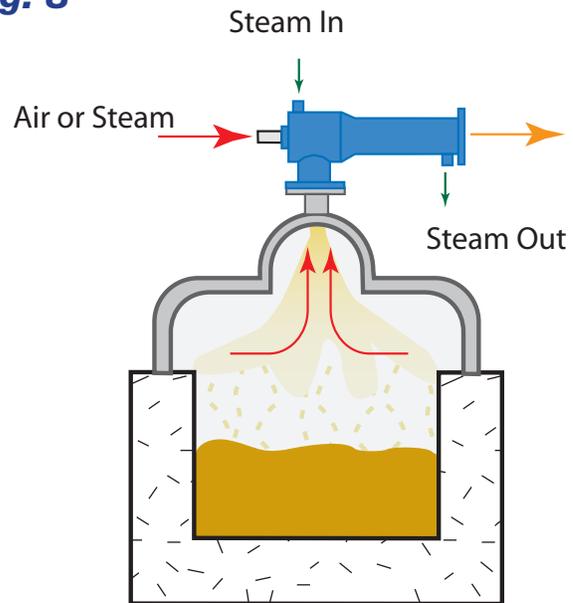
Fig. 7

Sulfur Fumes and H₂S Gas Venting

Sulfur fumes need to be removed constantly from sulfur pits to prevent venting to atmosphere. A steam jacket on the air ejector maintains high internal temperatures within the ejector, preventing solidification of the sulfur and possible build-up inside the ejector itself.

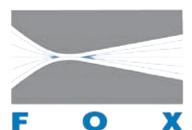
Jacket ejectors; Fox has been supplying gas ejectors with heat jackets, acoustical insulation, and other special features since the 1970's.

Fig. 8



Sulphur pit venting with a steam jacketed Fox air ejector.

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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 -

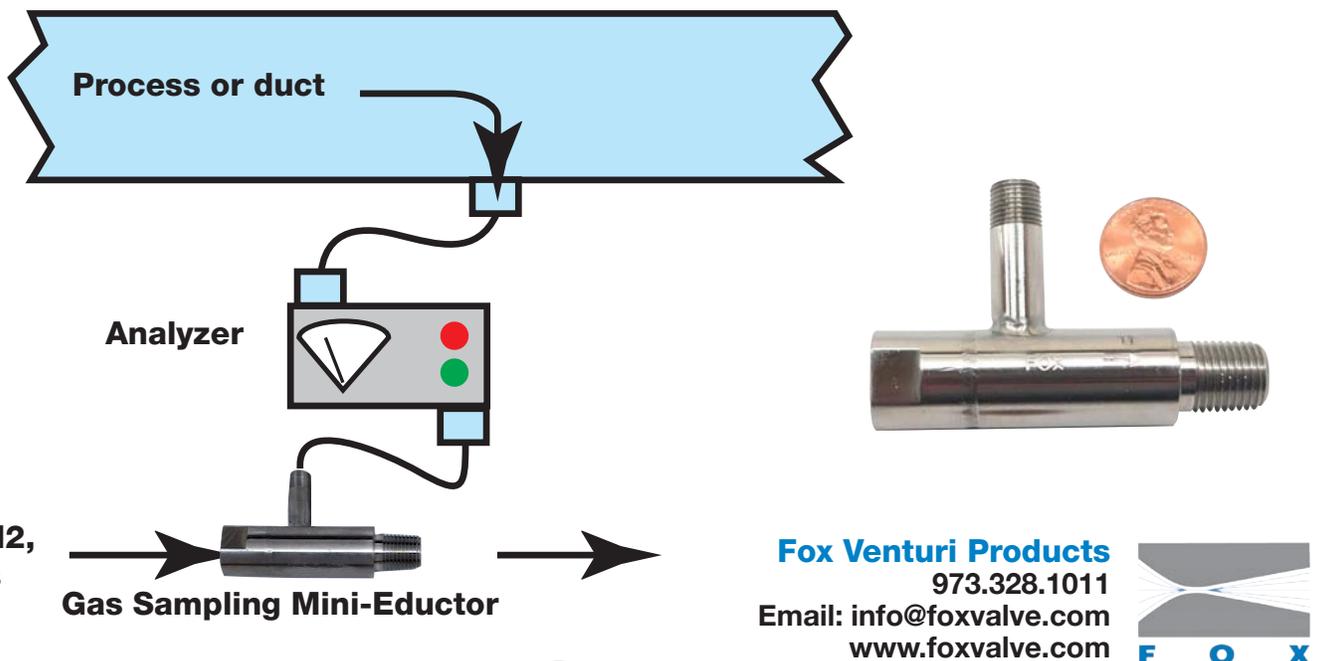
Fox Sonic Chokes have often been used to establish fixed, accurate, repeatable sample flow rates into analyzers. Chokes are an ideal way to precisely regulate flow rates of high-purity, high-temperature, explosive, or corrosive gasses. Request Fox Bulletin 025.

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

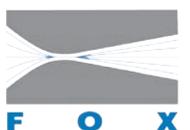
- **High Purity Gasses** - Two different Fox mini-eductors are commonly used in semi-conductor plants:
 - a) High-purity mini-eductor: electropolished with VCR ends, and
 - b) Our Teflon Mini-eductor, with Viton, Kalrez, or EPDM O-ring. (Metal Mini-eductors don't have O-rings since they can be welded 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, TFE, Inconel, Monel, and Titanium can be specified.

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

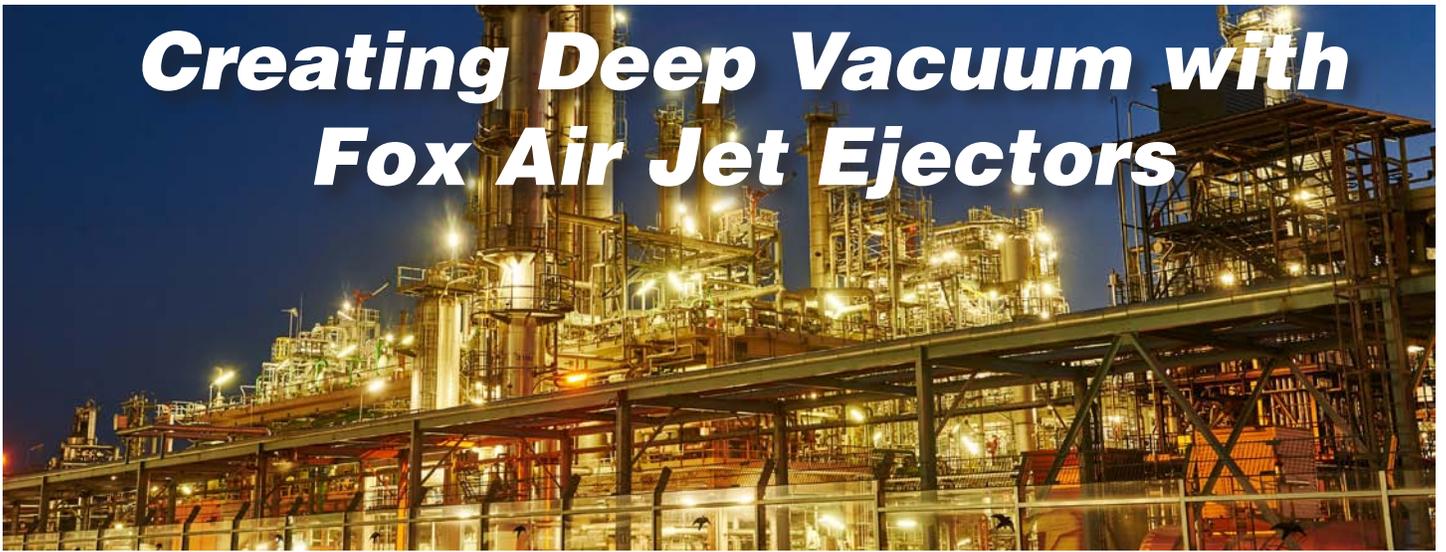
Fig. 13



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Creating Deep Vacuum with Fox Air Jet Ejectors



Vacuum to 1 psia

Some applications require that very deep vacuum levels are obtained with ejectors. Usually, steam jet ejectors are used when very deep vacuum levels are required (below 0.5 psia or 20 Torr.) Steam ejectors are ideal for this application. They are typically staged, with each ejector pulling progressively deeper vacuum. The motive steam from each proceeding stage can be condensed in intercondensers and drained away, keeping equipment size small.

Air ejectors can also be staged to pull progressively deeper vacuum levels, but each ejector stage gets bigger and bigger since the motive air from previous stages cannot be eliminated.

Two stage ejectors require custom-built, high performance ejectors designed to work in tandem. No stock ejectors can be used. Since the approximate, minimum cost for a custom-engineered ejector is \$3000, the minimum cost for a two stage ejector is about \$6000. Below is a photo of a two-stage Fox ejector system installed on the roof of Princeton's hypersonic wind tunnel. Each ejector is about 20 feet long.

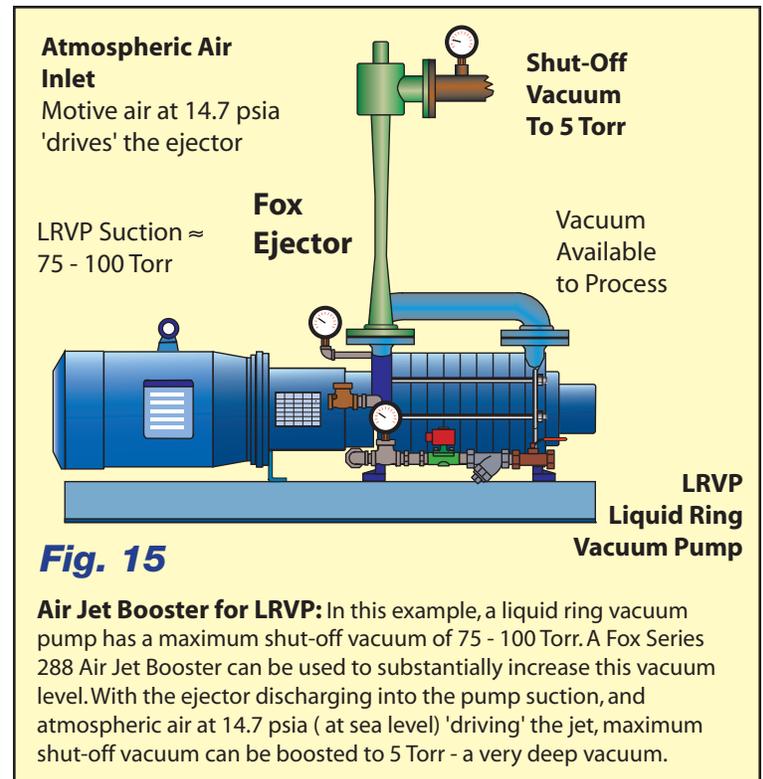


This photo shows a two-stage Fox air ejector installed on the roof of a hypersonic wind tunnel at Princeton University. Each stage is a 14" ejector.

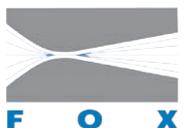
Fig. 14

Air Jet Boosters for use with Liquid Ring Vacuum Pumps

Liquid ring vacuum pumps (LRVP) are used throughout industry to provide moderate vacuum levels for a variety of industrial tasks. The level of vacuum they can pull is limited by the temperature of the sealing liquid. With an atmospheric air-powered ejector, the user can bypass this limitation and achieve much deeper vacuum levels. LRVP's that previously could only pull down to 40 - 50 Torr of vacuum can reach 5 - 10 Torr with no additional power requirement.



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Development and Production of Air Ejectors 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 hardware. Fox has Annual Blanket Orders from many manufacturers for monthly releases of ejectors 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 ejector 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.

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.

About Fox Valve...

Fox Valve Development Corp. was founded in 1961 to build high-performance, custom-engineered venturi controls for aerospace applications, primarily in bipropellant rocket engines. Fox's reputation in the 1960's as venturi specialists with superb in-house manufacturing soon attracted inquiries from diverse industries seeking venturi products tailored to their needs. Our problem-solving skills, familiarity with materials, and manufacturing expertise led Fox into

broader range of industrial applications. One by one, standard product lines emerged as we serviced different industries, all based on our one core technology - venturies. Current major products include:

- Solids Conveying Ejectors and Systems
- Steam Jet Ejectors & Thermocompressors
- Mini-Ejectors/Gas Sampling
- Natural Gas/Vapor Recovery Ejectors
- Hydrogen Ejectors for Fuel Cells

To Receive a Quotation:

Please Complete Application Data Sheet on Page 16.

Additional Technical Literature

The following pdf literature are available upon request:

Bulletins:

- 301 — Solids Conveying Venturi Ejectors
- 203 — Steam Jet Ejectors and Vacuum Systems
- 206 — Ejectors for Natural Gas Vapor Recovery
- 271 — Hydrogen Ejectors for Fuel Cells
- 551 — Plastic-Lined Ejectors for Corrosives
- 025 — Sonic Chokes & Critical Flow Venturies
- 103 — Fox Liquid Ejectors

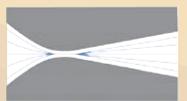
Fox Venturi Products

Dover, NJ 07801 USA

973.328.1011

Email: info@foxvalve.com

www.foxvalve.com



Application Data Sheet - *Fox Air, Steam, or Gas Jet Ejectors* for Continuous Venting, Exhausting, or Aspiration of Gasses

Fox Venturi Ejectors from Fox Valve
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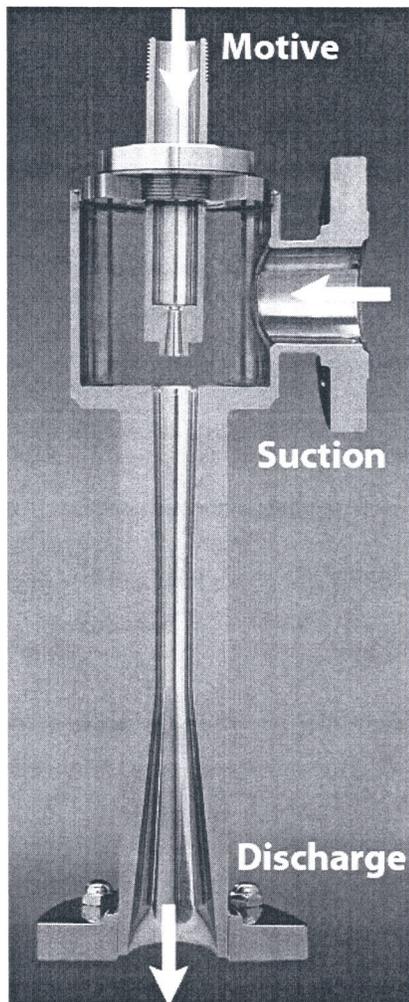


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Company Name: _____ Contact Name: _____

Company Address: _____

Phone: _____ Fax: _____ E-Mail: _____



Motive Gas

Gas Type: _____
Molecular Weight: _____ Temp.: _____ °F
Pressure: _____ psig Flow Rate: _____ lb/hr

Suction Gas

Gas Type: _____
Molecular Weight: _____ Temp.: _____ °F
Pressure: _____ psig OR _____ psia
Flow Rate: _____ lb/hr

Discharge Conditions

Pressure: _____ psig OR _____ psia

Do you wish to consider the use of a blower (air at 3-10 psig) instead of compressed air? Yes No

Construction/End Connections:

Preferred End Connections: NPT Flanges - _____ Other: _____

Material of Construction: Carbon Steel Stainless Steel PVC Sanitary/CIP
 Teflon (wetted parts) Other: _____

Special Requirements (Code Welding, MAWP, testing, QA, etc.) _____

Comments: _____