Ejector Technical Document
Ejector Selection

The ejector is a crucial piece of equipment for proper operation of a vacuum gas feed system. The system as a whole cannot operate if the ejector does not function. This technical bulletin will provide important information on ejector selection and system design. This document will mention water operated chlorine gas ejectors for simplicity, but ejectors can be operated by air or Nitrogen and various gas and ejectors can be used to inject various gas and liquid chemicals.

**Ejector Overview**

**Function**
An ejector has several very important functions within the gas feed system. It needs to generate the operating vacuum, create the chlorine solution, and prevent the back flow of water into the vacuum lines.

*Operating Vacuum*—Hydro Instruments’ ejectors are designed to generate a vacuum of 25” mercury (Hg) or greater and generate sufficient suction to achieve the stated feed rate. Inadequate vacuum can produce unreliable gas feed.

*Chlorine Solution*—The ejector is where the chemical is injected into the water stream.

*Back Flow Prevention*—A check valve prevents back flow of water during shut down.

**Operation**
A vacuum of 25” Hg or greater is generated by supply water passing through the ejectors venturi nozzle. As the supply water under high pressure is passed through a small orifice its velocity increases resulting in a drop in pressure. By creating an adequate pressure differential (∆P) of water between the ejector inlet (supply pressure, P_{\text{supply}}) and the ejector outlet, this pressure drop becomes great enough to create a vacuum and draw the feed chemical through the system and into the water stream. If this pressure differential is not maintained, an insufficient vacuum will be produced or no vacuum at all.

**Design**
Hydro Instruments’ ejectors consist of the following common components:
- Water inlet & solution outlet
- One piece nozzle or nozzle/throat combination
- Vacuum connection for gas inlet
- Check valve

The one piece nozzle for smaller 3/4” ejectors and nozzle/throat combinations for larger 1-1/4” and high capacity ejectors are specific to the gas feed rate and the available hydraulics.

All Hydro Instruments’ ejectors have an integral check valve to prevent process water from entering the gas feed systems piping and equipment while the system is idle. Some high capacity ejectors also incorporate a drain valve in the event the primary check valve fails.

**Hydraulics**
The combined pressure at the point of application and piping friction loss is known as the back pressure. A higher back pressure requires a higher ejector inlet pressure and more supply water to make the ejector function correctly.

Hydraulic operation curves have been developed to assist with system design. These curves specify minimum supply pressures and flow rates to be supplied to the ejector against a given back pressure.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Pressure</td>
<td>The water pressure that exists at the inlet of the ejector.</td>
</tr>
<tr>
<td>Back Pressure</td>
<td>The pressure that exists at the outlet of the ejector.</td>
</tr>
<tr>
<td>Friction Loss</td>
<td>The pressure drop due to friction within the water pipe line; both the supply line and solution line.</td>
</tr>
<tr>
<td>Water Flow Rate</td>
<td>The flow rate of water supplied to the ejector expressed in gallons per minute (GPM) or cubic meters per hour (M³/HR) etc...</td>
</tr>
</tbody>
</table>
Ejector Selection

Hydro Instruments offers a wide range of ejectors to meet individual application needs. Choosing the right ejector is very important for proper and reliable operation of the gas feed system. Should the wrong ejector be chosen, problematic system operation and unwanted downtime can be the result.

Ejectors for specific applications (e.g. variable orifice, anti-siphon and diaphragm-less) can enhance performance, safety and/or minimize maintenance requirements.

**Standard 3/4” and 1-1/4” Ejectors**

These ejectors are general purpose ejectors recommended for most applications. Several different designs are available for a wide range of capacities. See Table 1 for additional information.

- **Feed Capacity:**
  - Up to 100 PPD Cl₂ (2.4 Kg/h) for 3/4” ejectors
  - Up to 600 PPD Cl₂ (12 Kg/h) for 1-1/4” ejectors

- **Maximum Back Pressure:**
  - 145 PSI (10 bar) for standard models
  - 250 PSI (17.2 bar) for ejectors with body plates

**Anti-Siphon Ejectors**

Anti-siphon ejectors are primarily used in systems where the ejectors water supply being shut off presents the possibility of causing a negative head (i.e. siphon) at the point of application. For example, if the ejector solution line or water main drains when the ejector supply water is shut off.

The siphon will cause the vacuum regulator in the gas feed system to continue to operate, allowing gas to be fed directly into the water piping system. Hydro Instruments’ anti-siphon ejectors are outfitted with an anti-siphon valve and specially designed ejector nozzle to break the siphon and prevent chemical from unintentionally being drawn into the piping.

- **Feed Capacity:**
  - Up to 100 PPD Cl₂ (2.4 Kg/h) for 3/4” anti-siphon ejectors
  - Up to 600 PPD Cl₂ (12 Kg/h) for 1-1/4” anti-siphon ejectors
  - Up to 2,000 PPD Cl₂ (40 Kg/h) for 2” anti-siphon ejectors

- **Maximum Back Pressure:**
  - 145 PSI (10 bar) for 3/4” and 1-1/4” anti-siphon ejectors
  - 250 PSI (17.2 bar) for 3/4” and 1-1/4” anti-siphon ejectors with body plates
  - 100 PSI (6.9 bar) for 2” anti-siphon ejectors

**Diaphragmless Ejectors**

Diaphragmless ejectors are primarily used in application with a high back pressure and/or for system with frequent on/off cycling that would stress an ejector with a rubber diaphragm.

The diaphragmless ejector incorporates a spring-loaded check valve that functions without the use of a rubber diaphragm. Vacuum opens the check valve and an absence of vacuum allows the spring combined with water pressure to close the check valve.

- **Feed Capacity:**
  - Up to 100 PPD Cl₂ (2.4 Kg/h) for 3/4” ejectors
  - Up to 600 PPD Cl₂ (12 Kg/h) for 1-1/4” ejectors

- **Maximum Back Pressure:**
  - 15-145 PSI (10 bar) for standard models
  - 15-250 PSI (17.2 bar) for ejectors with body plates
  - 15-300 PSI (20.7 bar) for EJH-143-CL2-HP high pressure ejector
High Capacity Fixed Orifice Ejectors
Fixed orifice ejectors are general purpose ejectors recommended for most applications. Several different designs are available for a wide range of capacities. See Table 2 for additional information.

**Feed Capacity:**
- Up to 2,000 PPD Cl2 (40 Kg/h) for 2” ejectors
- Up to 10,000 PPD Cl2 (200 Kg/h) for 3” ejectors
- Up to 10,000 PPD Cl2 (200 Kg/h) for 4” ejectors

**Maximum Back Pressure:**
100 PSI (6.9 bar)

High Capacity Variable Orifice Ejectors
Variable orifice ejectors are used primarily where a wide range of gas feed rates are needed. These ejectors allow external, manual adjustment of the nozzle orifice size to increase or decrease ejector capacity, minimize water usage and thereby minimize power consumption of booster pumps.

**Feed Capacity:**
- Up to 2,000 PPD Cl2 (40 Kg/h) for 2” ejectors
- Up to 10,000 PPD Cl2 (200 Kg/h) for 3” ejectors
- Up to 10,000 PPD Cl2 (200 Kg/h) for 4” ejectors

**Maximum Back Pressure:**
100 PSI (6.9 bar)

High Capacity Enhanced Performance Ejectors
Hydro Instruments’ line of high capacity, enhanced performance ejectors are able to feed chemical with less supply pressure and water usage, thereby also reducing power consumption of booster pumps. These ejectors use an integral spring-less check valve to prevent vacuum reduction to the gas feed system and external drain valve to more reliably keep vacuum lines and equipment free of water.

**Feed Capacity:**
- Up to 2,000 PPD Cl2 (40 Kg/h) for 2” ejectors
- Up to 10,000 PPD Cl2 (200 Kg/h) for 3” ejectors

**Maximum Back Pressure:**
100 PSI (6.9 bar)

Chlorine Dioxide Ejectors (ClO₂)
Hydro Instruments’ chlorine dioxide ejectors are designed with three vacuum connections to draw multiple chemicals into a mixing chamber before being drawn into the water stream. The process wetted parts are made from CPVC to withstand the high temperatures generated with this chemical injection process.

**Feed Capacity:**
- Up to 28 GPH ClO2 for 3/4” ejectors
- Up to 120 GPH ClO2 for 1-1/4” ejectors

**Maximum Back Pressure:**
145 PSI (10 bar)

**Ejector Nozzle Selection**
For each ejector there are several nozzle or nozzle/throat combinations available. Nozzle/throat combinations must be selected appropriately for the desired chemical feed rate capacity.

The information needed to select the proper ejector nozzle or nozzle/throat combination is:

1. Maximum capacity of the gas/liquid feed system.
2. Supply pressure available to the ejector.
3. Supply water flow rate available to the ejector.
4. Back pressure at the outlet of the ejector.
### TABLE 1

<table>
<thead>
<tr>
<th>Application</th>
<th>Standard 3/4” and 1-1/4” Ejectors</th>
<th>Anti-siphon</th>
<th>Diaphragmless</th>
<th>Chlorine Dioxide (ClO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General purpose</td>
<td>Where a negative head at the application point could exist.</td>
<td>Systems with frequent on/off cycling and/or with very high back pressure</td>
<td>One, two or three chemicals for chlorine dioxide generation and injection.</td>
</tr>
<tr>
<td>Capacity</td>
<td>Up to 100 PPD Cl₂ (2.4 Kg/h) for 3/4” ejectors</td>
<td>Up to 100 PPD Cl₂ (2.4 Kg/h) for 3/4” ejectors</td>
<td>Up to 100 PPD Cl₂ (2.4 Kg/h) for 3/4” ejectors</td>
<td>Up to 28 GPH ClO₂ for 3/4” ejectors</td>
</tr>
<tr>
<td></td>
<td>Up to 600 PPD Cl₂ (12 Kg/h) for 1-1/4” ejectors</td>
<td>Up to 600 PPD Cl₂ (12 Kg/h) for 1-1/4” ejectors</td>
<td>Up to 600 PPD Cl₂ (12 Kg/h) for 1-1/4” ejectors</td>
<td>Up to 120 GPH ClO₂ for 1-1/4” ejectors</td>
</tr>
<tr>
<td></td>
<td>Up to 2,000 PPD Cl₂ (40 Kg/h) for 2” ejectors</td>
<td>Up to 2,000 PPD Cl₂ (40 Kg/h) for 2” ejectors</td>
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<td>Up to 2,000 PPD Cl₂ (40 Kg/h) for 2” ejectors</td>
</tr>
<tr>
<td>Max. Back Pressure</td>
<td>145 PSI (10 bar)</td>
<td>145 PSI (10 bar)</td>
<td>15-145 PSI (10 bar)</td>
<td>145 PSI (10 bar)</td>
</tr>
<tr>
<td></td>
<td>250 PSI (17.2 bar) for ejectors with body plates</td>
<td>250 PSI (17.2 bar) for ejectors with body plates</td>
<td>15-250 PSI (17.2 bar) for ejectors with body plates</td>
<td>15-300 PSI (20.7 bar) for EJH-143-CL2-HP high pressure ejector</td>
</tr>
<tr>
<td>Check Valve Type</td>
<td>Diaphragm w/ Self centering O-Ring, O-Ring or Gasket</td>
<td>Diaphragm w/ Self centering O-Ring for 3/4” ejectors</td>
<td>Check-bolt w/ O-Ring</td>
<td>Diaphragm w/ O-Ring</td>
</tr>
<tr>
<td>Available for:</td>
<td>Cl₂, SO₂, NH₃, CO₂</td>
<td>Cl₂, SO₂, CO₂</td>
<td>Cl₂, SO₂, CO₂</td>
<td>ClO₂</td>
</tr>
</tbody>
</table>

### TABLE 2

<table>
<thead>
<tr>
<th>Application</th>
<th>High Capacity Fixed Orifice</th>
<th>High Capacity Variable Orifice</th>
<th>High Capacity Enhanced Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General purpose</td>
<td>Where a wide range of gas feed rates are needed</td>
<td>General purpose Systems with less supply pressure and/or less supply water</td>
</tr>
<tr>
<td>Capacity</td>
<td>Up to 2,000 PPD Cl₂ (40 Kg/h) for 2” ejectors</td>
<td>Up to 2,000 PPD Cl₂ (40 Kg/h) for 2” ejectors</td>
<td>Up to 2,000 PPD Cl₂ (40 Kg/h) for 2” ejectors</td>
</tr>
<tr>
<td></td>
<td>Up to 10,000 PPD Cl₂ (200 Kg/h) for 3” ejectors</td>
<td>Up to 10,000 PPD Cl₂ (200 Kg/h) for 3” ejectors</td>
<td>Up to 10,000 PPD Cl₂ (200 Kg/h) for 3” ejectors</td>
</tr>
<tr>
<td></td>
<td>Up to 10,000 PPD Cl₂ (200 Kg/h) for 4” ejectors</td>
<td>Up to 10,000 PPD Cl₂ (200 Kg/h) for 4” ejectors</td>
<td>Up to 10,000 PPD Cl₂ (200 Kg/h) for 3” ejectors</td>
</tr>
<tr>
<td>Max. Back Pressure</td>
<td>100 PSI (6.9 bar)</td>
<td>100 PSI (6.9 bar)</td>
<td>100 PSI (6.9 bar)</td>
</tr>
<tr>
<td>Check Valve Type</td>
<td>Diaphragm w/ O-Ring</td>
<td>Diaphragm w/ O-Ring</td>
<td>Check-ball w/ O-Ring &amp; Drain valve</td>
</tr>
<tr>
<td>Available for:</td>
<td>Cl₂, SO₂, NH₃, CO₂</td>
<td>Cl₂, SO₂, CO₂</td>
<td>Cl₂, SO₂, CO₂</td>
</tr>
</tbody>
</table>
EJH-143-CL2-HP
High pressure, diaphragmless ejector

All Standard ¾” and 1-¼” ejectors with body plates.
Anti-siphon ejectors with body plates.
Diaphragmless ejectors with body plates.

All High Capacity Fixed Orifice ejectors.
All High Capacity Enhanced Performance ejectors
All High Capacity Variable Orifice ejectors.

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FIGURE 1