Carbon Dioxide Feed Systems

Instruction Manual

All Hydro Instruments Carbon Dioxide feed systems are carefully designed and tested for years of safe, accurate field service. All Hydro Instruments Carbon Dioxide systems are tested, at customer specified conditions prior to shipment. All Hydro Instruments products are made of the finest materials. To insure best operation, read these instructions carefully and completely and store them where all maintenance personnel will have access to them

The information contained in this manual was current at the time of printing. The most current versions of all Hydro Instruments manuals can be found on our website: www.hydroinstruments.com

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Operation & Maintenance Manual

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Hydro Instruments Torque Specifications

Item	Min in*lbs.	Max in*lbs
Yoke Bolts	20	25
Body Bolts	20	25
Meter block Bolts	20	25
Vacuum Fittings	15	20
Inlet Plug	10	15
Dummy Plug	7	10
Yoke Half Dog	240	300

SECTION I: SAFETY INFORMATION

Take Care with Carbon Dioxide

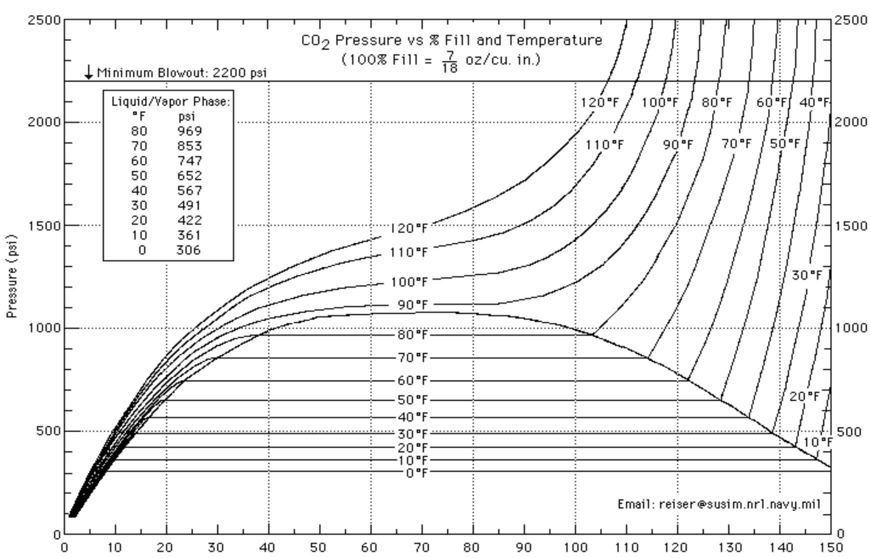
Carbon Dioxide cylinders contain both liquid and gaseous CO_2 that is under pressure. The pressure inside the cylinder is dependent on temperature and fill percentage and can be seen in figure one below. CO_2 cylinders contain copper "burst disks" which will blow out above a certain pressure and release the contents of the bottle into the air in a relatively safe manner. This burst pressure is in the range of 2200 to 2800 psi.

Carbon Dioxide is colorless and will be odorless at low concentrations. At concentrations above 6% in air the odor can become noticeable and above 11% in air unconsciousness will occur and may result in serious injury or death. If starting to feel a headache, visual impairment, heavy breathing or ringing in the ears, leave the area and move to fresh air immediately. Notify appropriate personnel if conditions persist. **Carbon Dioxide gas detectors should be installed where appropriate.**

Upon rapid expansion of CO_2 (pressure drop) the gas can solidify to "dry ice". Dry ice formation will drastically lower the pipe temperature and weaken its mechanical strength, possibly causing a leak. To prevent this from happening, flow rates from 50 lb. cylinders should not exceed 25 scfh (70 PPD; 1.5 kg/hr.). Bulk container flow rates will vary based on size and pressure; contact the manufacturer for feed rate limitations. The downstream pressure after the pressure reducing valve should be between 60-100 psi to prevent dry ice formation in the valve.

Basic safety rules with 50 lb. cylinders should be followed. These include, but are not limited to: storing the cylinders in an upright fashion, wrapping a safety chain around each cylinder, storing cylinders away from direct sunlight, and never placing heaters or heat lamps directly on cylinders. Use only carbon steel or appropriate material pressure lines and include a pressure relief valve (set at 150 psi) to prevent damage of vacuum equipment. This relief valve should vent to the outside.

Figure 1. CO_2 Pressure



SECTION II: DESIGN AND INSTALLATION NOTES

1. The “all vacuum” system means that the system will shut off at the vacuum regulator inlet assembly should the vacuum line be broken, if water to the ejector is stopped for any reason, or if the regulator is physically damaged.
2. Use the following design formula to find a feed capacity (system should be designed based on max water flow rate):

   Water flow rate (GPM) x .012 x chemical dosage (PPM)=Chemical feed rate (PPD)

   Or

   Water flow rate (m^3/hr.) x chemical dosage (PPM)=Chemical feed rate (gr/hr)

   If the dosage is unknown and the system is being used for pH control, the feed rate can be estimated from the calcium carbonate content:

   Water flow rate (MGD) x 3.66 x carbonate concentration (ppm)=Chemical feed rate (PPD)

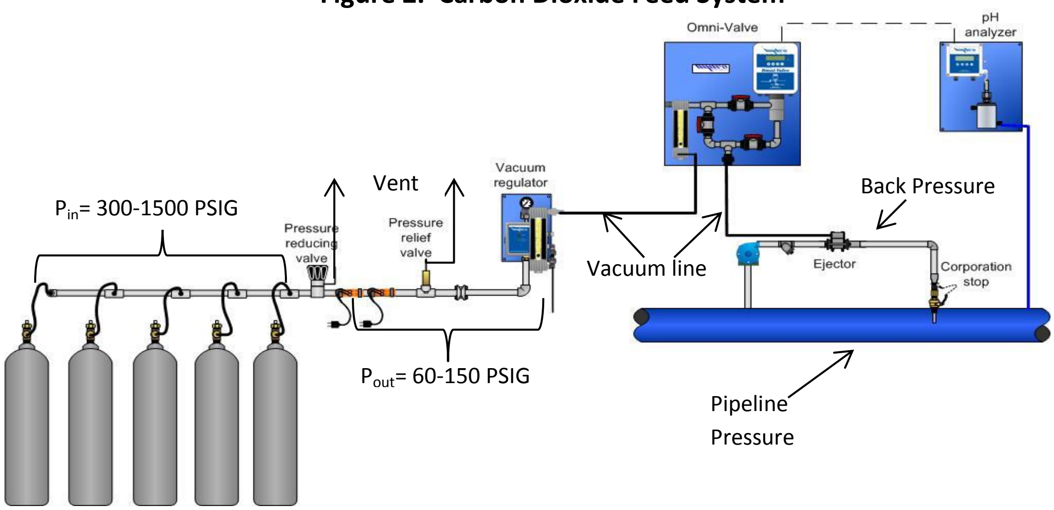
   Or

   Water flow rate (m^3/hr) x 0.44 x carbonate concentration (ppm)=Chemical feed rate (gr/hr)

   Note: *When designing a system based off carbonate concentration, it is a good design principle to double the estimated CO_2 feed rate. This will account for other alkalinity components, mixing inefficiencies, etc.*

3. Total back pressure is the pressure in the pipeline that is to be injected with CO_2 plus any frictions losses between the ejector and the pipeline. Friction losses will increase the ejector back pressure and should be minimized. This can be done by increasing the pipe diameter and minimizing the number of elbows in between the ejector and the point of injection.
4. It is preferable to locate the ejector at the point of chemical injection in order to eliminate the need for long solution lines.
5. Hydro Instruments provides up to 100 ft. (30 m) of black polyethylene tubing for vacuum lines between the vacuum regulator and the ejector. Please specify if you will need more. Refer to Hydro Instruments’ tubing guide for sizing.
6. Remote meters on the regulator are calibrated for chlorine gas. To find the Carbon Dioxide feed rate multiply the visual reading by 0.78.

Figure 2. Carbon Dioxide Feed System



SECTION III: SYSTEM INSTALLATION

1. Installation of Manifold

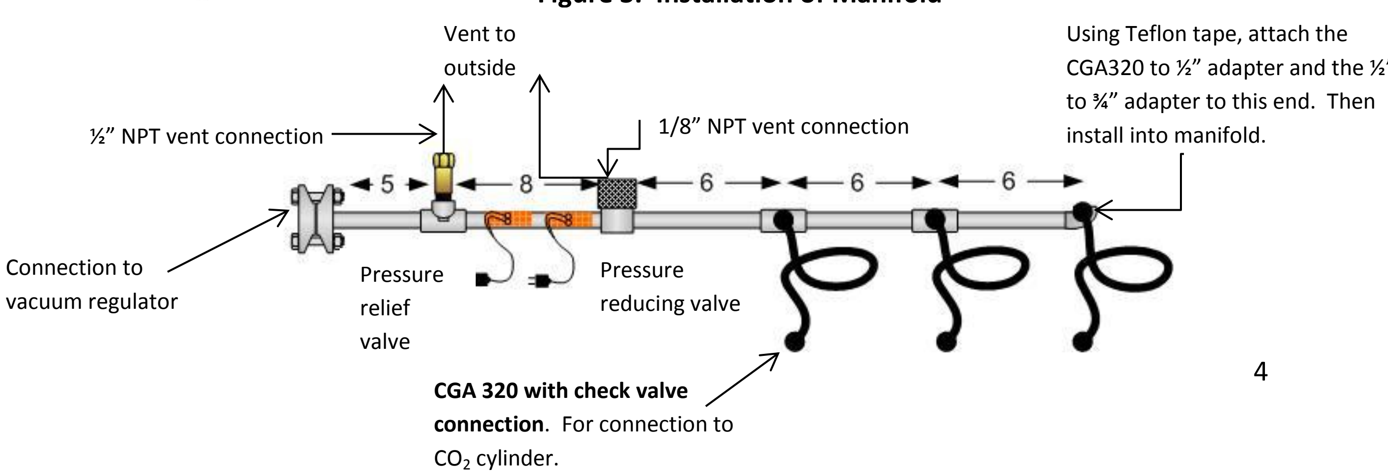
All Hydro Instruments' manifolds come with a pressure reducing valve, pressure relief valve, manifold union, and piping tees for the number of connections requested. All threads on the manifold will also be sealed with Teflon Tape. If using a bulk container(s), there will be no tees and flexible connectors and the user will be required to make the appropriate connections to the ¾" manifold. Larger systems (above 200 PPD / 4 kg/hr) will be supplied with two 25W heaters and they should be plugged in 15 minutes before operation and remain on during operation. Refer to Figure 3 for installation.

a. Using the mounting brackets firmly secure the manifold in place. If using 50 lb. cylinders the manifold should be located above them.
b. If using cylinders secure them in place with the appropriate chains.
c. Attach the check valve side on the flexible connector to the CGA320 cylinder valve on the CO_2 cylinder.
d. Attach the CGA320 to ½" NPT adapter to the other side of the flex connector. Wrap Teflon tape around the ½" thread, and then attach the ½" NPT to ¾" NPT adapter to the ½" thread.
e. Wrap Teflon tape around the ¾" thread and insert into one of the tees on the manifold.
f. Repeat steps C-E with other remaining cylinders.
g. Attach 1/8" FNPT vent piping to the pressure reducing valve. Also make sure that the inlet and outlet of the PRV are in line (and not at an angle) with the manifold system. Improper installation of the reducing valve will result in improper function.
h. Attach ½" FNPT vent piping to the pressure relief valve.

2. Installation of Vacuum Regulator

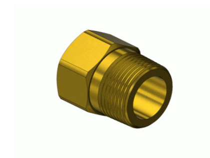
a. Examine the vacuum regulator for obvious damage.
b. All CO_2 vacuum regulators are wall mounted. Securely fasten the vacuum regulator to the wall using mounting screws. Note that the mounting holes on the panel are 9/32".
c. Install Carbon steel pipe from the ¾" NPT union on the manifold to the inlet of the vacuum regulator.
d. Depending on the size ordered mount the appropriate fittings and tubing into the vent and solution feed lines.

Figure 3. Installation of Manifold



Inlet → Outlet
Flexible connector

CGA 320 to ½" NPT adapter



½" NPT to ¾" NPT adapter

Note: *The larger brass side of the flexible connector has the inlet check valve; it will also have an arrow indicating the direction of flow. This side should be connected to the cylinder and orientated properly. On the other side attach the CGA 320 to ½" adapter (middle) then the ½" to ¾" adapter (right).*

3. Installation of Hydro Ejector

a. Remove the diffuser from the ejector assembly and place two wraps of Teflon on diffuser threads.
b. **DO not** install diffuser into pipe line when assembled with ejector.
c. Turn the diffuser by hand into the NPT threads of the pipe (3/4" or 1 ¼" depending on ejector/system capacity). Place wrench on diffuser and tighten **one half turn maximum.**
d. Reconnect diffuser to ejector making sure O-rings are on each side of nozzle and diffuser.
e. After ejector test (see below) connect the appropriate polyethylene tubing from the vacuum connection of the regulator to the ejector.

Testing the Ejector

a. Ejector should be installed downstream at a sufficient distance so that treated water is not recirculated through the booster pump. On the inlet side of the ejector, a water inlet valve, a Y-strainer and a pressure gauge should be installed in that order.
b. Start booster pump, or allow water flow through the ejector. You should feel suction at the top fitting of the ejector.
c. If ejector is pulling vacuum then connect the polyethylene tubing from the vacuum connector port to the ejector top fitting.

4. Units with Switchover Modules and/or Remote Meters

a. **Switchover Modules**
   1) Connect the two lines from the vacuum regulators to the side tube connectors.
   2) Connect the single line out to the remote meters to the top tube connector.

b. **Remote Meters**
   1) Connect the line in to the bottom tube connector.
   2) Connect the line out to the feed point to the top connector.

SECTION IV: SYSTEM VACUUM TEST

1. With all of the equipment properly installed (see section III) and the carbon dioxide cylinders closed. Start the ejector booster pump.
2. Check the remote meter tube to see if the ball has settled to the bottom. If the ball is bouncing then there is a vacuum leak. Recheck the fittings if this is the case.
3. Check if the red indicator has dropped on the front of the vacuum regulator. If it is showing then the system is working properly. If not, then there is either a vacuum leak in your vacuum line or at the regulator itself.
4. Turn off water to the ejector and wait 5-10 minutes. Rotate the reset knob all the way around, if the red flag ***cannot*** be reset then your system is vacuum tight.
5. Once determined that the system is vacuum tight, disconnect vacuum tubing at the top of the vacuum regulator and allow air into the system. Return the reset knob to the full position.

SECTION V: START UP OF CARBON DIOXIDE FEED

If using bulk storage containers skip steps 1-3

1. Assuming cylinders are connected to the manifold, open carbon dioxide cylinder(s) valves slowly and allow gas to fill the manifold. **Close the cylinders immediately after.**
2. Wait 5-10 minutes and listen and inspect for leaks in your system. Use the pressure gauge as a leak indicator.
3. Once determined leak free, open carbon dioxide cylinder(s) ½ turn so that the valve is fully opened and can be quickly closed in the event of an emergency.
4. Turn on water supply or booster pump to ejector and set rate valve to flow rate. Remember the carbon dioxide feed is 0.78 times the visual reading indicated on the tube.

SECTION VI: SHUT DOWN PROCEDURE/SWITCHING CYLINDERS

1. Close the CO_2 valve(s). Wait for the pressure gauge to drop to zero.
2. Shut off the water supply through the ejector.
3. If switching cylinders remove only the CGA 320 check valve connecting the cylinder to the flexible connector.
4. Remove old cylinder and place new one into position.
5. Reattach the CGA 320 check valve connector to the new cylinder.
6. Repeat section V.

SECTION VII: RATE VALVE OPERATION

Turn the rate valve counter-clockwise to open it completely. Further turns will completely remove the rate valve from the flow meter tube, which will result in a loss of CO_2 feed.

The O-ring seal for the rate valve is locked in place under the valve bonnet and does not come out when the rate valve is pulled out of the bonnet.

SECTION VIII: TROUBLESHOOTING

1. **Pipes are "sweating"**
   a. This can occur based on the evaporation of carbon dioxide gas. This can sometimes cause moisture to condense on the colder pipes. To minimize this, lower feed rate or adjust the pressure reducing valve so that the difference between the inlet and outlet pressure is smaller. Generally, the outlet pressure should be between 60-100 PSI.

2. **Dry Ice Formation**
   a. This can occur based on the evaporation of carbon dioxide gas. If dry ice formation has happened then stop feeding and wait for the system to heat up. Once the Carbon Dioxide has returned to a gas, add more heaters, lower the feed rate, or adjust the pressure reducing valve such that the difference between the inlet and outlet pressure is smaller.

      Warning: *Dry Ice is very cold and can cause burns on contact.*

3. **Carbon Dioxide is escaping through the pressure relief valve.**
   a. The pressure is too high; this could be a cause of the heaters going bad or being still plugged in during times of not feeding. This could also be a result of the PRV set to high or not working.

4. **No CO_2 Feed**
   a. This is often caused by no vacuum being created by the ejector. Check your hydraulics and the ejector performance chart to make sure you are operating properly. If not, you may need a different nozzle of larger booster pump. Other common explanations are air leaks in the vacuum line, dirt/debris clogging line, and out of gas in cylinders/storage tank.

5. **Pressurized Leak**
   a. Operating personnel should always be prepared in the event of a leak, and if a leak occurs they should be taken care of as quickly and as safely as possible. When searching for a leak:
      1) Have an air breathing pack readily available and personnel should know how to use it.
      2) Have an exhaust fan to blow toxic air outside to a safe location. It is also advisable to close the gas feed cylinders/tank and run the ejector to flush the CO_2 out of the system.
      3) Have two factory trained personnel working on the system at a time to ensure safety.

SECTION IX: SERVICING SYSTEM COMPONENTS

1. **Vacuum Regulator**
   a. Cleaning the rate valve
      1) Unscrew the rate valve knob and stem (by hand) completely out of the top meter block.
      2) Replace O-rings on the rate valve stem.
      3) Lubricate the new O-rings lightly with Flourolube grease before replacing the rate valve and knob into the top meter block.
   b. Cleaning the Meter Tube
      1) While holding the glass meter tube (to prevent it from falling) unscrew the inlet plug at the base of the bottom meter block, until the meter tube can be removed.
      2) Remember to be careful not to lose the stops or ball in the following steps.
      3) Remove the white stops at either end of the tube (you could use a paper clip).
      4) Soak the tube in warm water with a cleaner like lime away or Muriatic Acid. Also, brush the inside of the tube with a pipe cleaner.

         NOTE: Always follow safety precautions with Muriatic Acid and other chemicals.

      5) Dry the meter tube and reinstall the ball and stops.
      6) It is recommended that new meter tube gaskets be used when reinstalling the meter tube.
      7) Remove the inlet plug completely and inspect the O-Rings. If it has been more than 12 months since they were changed or if there is any noticeable damage, the O-Rings should be replaced.
      8) Reinstall the inlet plug, meter gaskets and meter tube, making sure to center the tube on the top and bottom meter gaskets.
      9) Tighten the inlet plug with reasonable force to make a seal. Do not use excessive force.

NOTE: All other vacuum regulator repairs should be done by the factory or authorized repair personnel.

WARNING: *If the vacuum regulator leaks gas out the vent or any other place on the body the problem is most likely caused inside the inlet valve assembly. It is not recommended that the inlet valve assembly be disassembled because if it is not done properly dangerous leakage of pressurized gas could result.*

2. Ejector/Check Valve Assembly

a. Loss of Vacuum at the Ejector: If vacuum is lost at the ejector and water supply is sufficient then the nozzle is most likely clogged, broken or loose. Before working on the ejector it must first be isolated so that water will not leak when the ejector is removed.

1) First detach the intake side of the ejector from the pipe line.
2) For 78 PPD or lower ejectors rotate the complete ejector body counter clockwise. This loosens the threaded portion of the nozzle from the diffuser. It also eliminates the need for pliers on the nozzle which could damage the plastic.
3) Inspect the nozzle for: pipe scale, stones, dirt, iron buildup, manganese, calcium, etc.
4) The nozzle should be soaked and brushed with warm water mixed with a cleaner like Muriatic Acid.
5) Using two new gaskets the ejector can now be reassembled

When reassembling the ejector the nozzle and diffuser should be screwed together hand tight leaving the ejector body 90 degrees to the left of its final position. Once the nozzle and diffuser are hand tight, the ejector can then be turned the final 90 degrees.

WARNING: *Do not use excessive force in tightening the nozzle, diffuser and ejector assembly. The ejector is constructed of PVC and excessive force can break the parts.*

b. Servicing the ejector check valve assembly: If water leaks back into the system, this means that the ejector check valve has failed. This could be caused by incorrect assembly, a failed gasket, o-ring or diaphragm, or foreign material lodged in the check valve.

1) For gasket check valve ejectors, carefully remove the raised seat screw in the center top of the ejector body with a pair of pliers. Under this plug is a rubber gasket. Replace the seat if it is damaged or if the hole is plugged shut.
2) For gasket check valves, reinstall the seat screw tightening with pliers. Be careful not to over tighten using only reasonable force.
3) Remove the four bolts holding the ejector body together.
4) Inside you will find a diaphragm assembly and a spring.
5) The diaphragm assembly can usually be unscrewed by hand. If it is too tight, carefully try snap ring pliers. Note that a plastic support diaphragm is on the top side of the rubber diaphragm.
6) Inspect the rubber diaphragm for holes or weak points. For o-ring check valves, inspect the OH-CEM-210 or 3RS-203 O-ring. Replace if damaged.
7) Reassemble the diaphragm assembly.
8) Install the assembly in the recess between the ejector body halves being careful to install the spring properly below the assembly.

3. Switchover Module

General: This device requires no outside setting or adjustment. The switchover module allows gas to flow from one of the two intake ports at a time, keeping the other sealed. It will continue to feed from the first side until the vacuum level rises sufficiently at which time an internal spring loaded mechanism automatically switches to open the second intake port and close the first intake port.

NOTE: *In low capacity systems where the feed rate is less than 10 PPD or the time between switching is more than two weeks, it is recommended that the module be "exercised" weekly. If the module is left in one position for long periods of time, it may have a tendency to stick in one position. To exercise the module it can be disconnected from both vacuum regulators with the ejector still connected and operating. Use a finger or thumb to close the open intake port of the module until it switches to feed from the other port. Repeat this process 5 to 10 times.*

NOTE: *For safety reasons, close the Carbon Dioxide feed valves before servicing the unit.*

a. Servicing the module
    1) Remove the four screws that secure the top cap onto the main body.
    2) Remove the four screws that secure each of side caps onto the main body.
    3) Remove the diaphragm assemblies and the toggle mechanism noting their orientations for reassembly.
    4) Inspect the guide pin to ensure that is free of dirt or burrs. If not, clean and polish it with alcohol until it is able to slide freely.
    5) Inspect the O-ring seats on the diaphragm assemblies. Ensure that they are free of any residue and should be cleaned with alcohol being careful not to scratch them.
    6) Replace the O-rings and replace the diaphragms.
    7) Reassembly the module.