MPS
MIDWEST
PRESSURE
SYSTEMS

Technical Manual

Manufacturer - Midwest Pressure Systems, Inc.
Model 420TAAV090
Air/Gas Pressure Booster

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1. Design Specifications

Midwest Pressure Systems, Inc. (MPS) gas pressure boosters are designed for ease of operation and maintenance. Experience has shown that an MPS booster will normally provide years of satisfactory performance with minimal maintenance. Carefully review this manual which is designed to provide information on installation, start up, operation and maintenance. If you have questions, please contact Midwest Pressure Systems, Inc. Model 420TAAV090 is designed for air, nitrogen or other inert gas pressure boosting.

Booster design meets these ATEX specifications: CE 0575 Ex II 2 G T4

Designed in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1

Model 420TAAV090 Engineering Specifications	
Maximum gas discharge pressure - psi (bar)	1,305 (90)
Gas temperature range - ˚F (˚C)	-15 to 250 (-26 to 121)
Maximum cycle rate - cycles per minute (Note 1)	100
Gas displacement per cycle - cf (liters)	.0073 (.207)
Maximum gas displacement - cfm (liters per minute)	.73 (20.7)
Pressure boost (multiple of drive air pressure) (Note 2)	9.0
Gas inlet and discharge connections FNPT	1/4
Seal vent connection FNPT	1/8
Maximum drive pressure - psi (bar) (Note 3)	125 (8.6)
Air temperature range - ˚F (˚C)	32 to 167 (0 to 75)
Air displacement per cycle - cf (liters)	.054 (1.53)
Maximum air displacement - cfm (liters per minute)	5.4 (153)
Drive air inlet connection FNPT	1/2
Drive air exhaust connection FNPT	1/2
Drive air cylinder bore diameter - inches (millimeters)	4.0 (102)
Gas boost cylinder bore diameter - inches (millimeters)	2.0 (50.8)
Piston rod diameter - inches (millimeters)	1.5 (38.1)
Stroke - inches (millimeters)	4.0 (102)
Weight - pounds (kilograms)	31 (14)
Ambient Temperature - ˚F (˚C) (Note 4)	-15 to 167 (-26 to 75)

Note 1: A cycle consists of a forward and reverse stroke.
Note 2: This is a nominal operating pressure boost ratio, not the maximum pressure boost ratio.
Note 3: Nitrogen may also be used for the drive gas.
Note 4: Where ambient temperatures fall below 0˚C (32˚F) a heater is required for the drive air.

2. Materials of Construction and Torque Specifications

Boost gas wetted materials
Anodized aluminum and stainless steel

Pneumatic drive materials exposed to the environment
Anodized aluminum for excellent general environmental corrosion resistance

External bolts, nuts, and washers
18-8 SS for excellent marine and general environmental corrosion resistance

Dynamic seal material
Carbon-fiber-filled Teflon piston rings and rod seals

Gas wetted static seals
Viton

Air drive seals
Buna-N

Material specifications for individual components are listed in Sections 10, 11, 12 & 13.

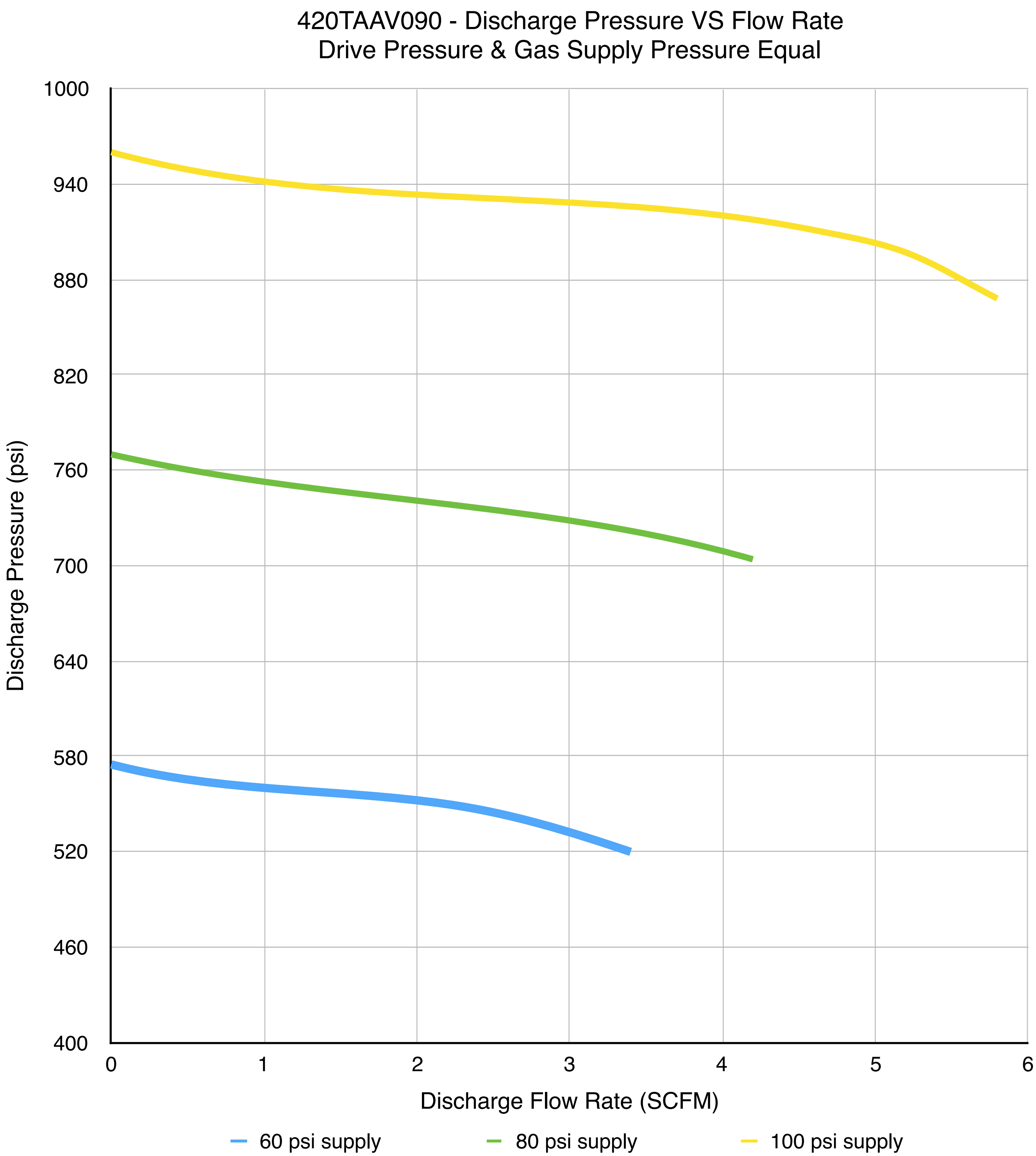
Fastener Torque Specifications

⚠ This booster utilizes high strength fasteners. Replacement fasteners must be of the same grade and material or the booster could experience catastrophic failure.

Fastener Description	Size Inch TPI	Type	Torque Lb-Ft (N•m)
Piston Rod Nuts	1/2-13 UNC	18-8 SS hex head locknut • 11/16 wrench	25 (33.9)
3/4”, 1” & 2” SHCS	3/8-16 UNC	18-8 SS socket head cap screw • 5/16 hex key	25 (33.9)
6.5” & 7” SHCS	3/8-16 UNC	18-8 SS socket head cap screw • 5/16 kex key	15 (20.3)
Control Valve Mounting Screws	1/4-20 UNC	18-8 SS socket head cap screw • 3/16 hex key	7.9 (10.7)

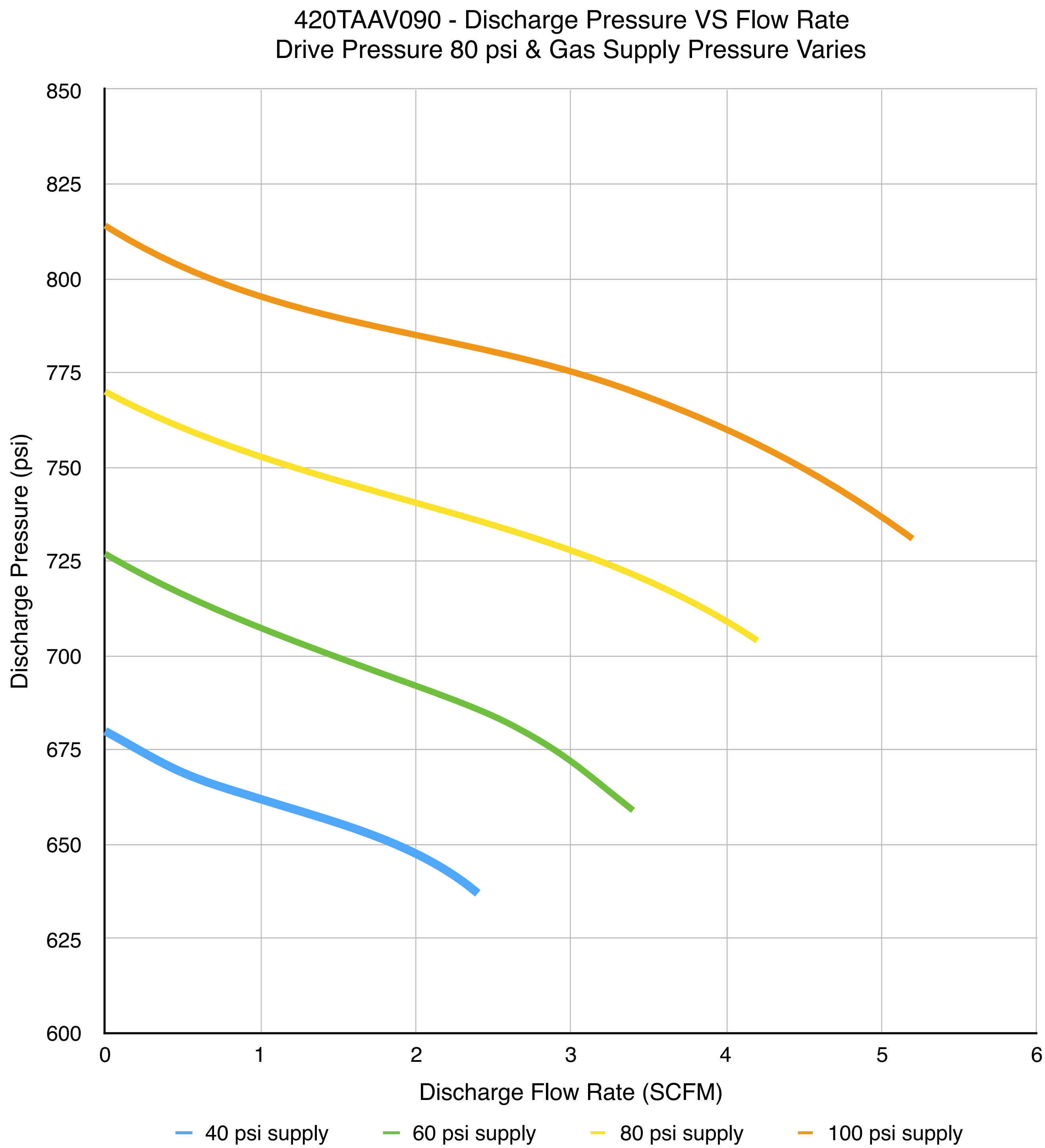
3. Flow Curves

The graph below shows the performance curve of the 420TAAV090 air pressure booster. In the graph, the drive and supply pressures are equal. Use this curve to size the 420TAAV090 air pressure booster for a given application.



3. Flow Curves

The graph below shows a performance curve of the 420TAAV090 gas pressure booster. In the graph, the drive pressure is held constant at 80 psi and gas supply pressures vary as shown below. Use this curve to size the 420TAAV090 gas pressure booster for a given application.



4. Boost Cylinder Operation

The piston in the drive cylinder is attached to the piston in the boost cylinder. As the drive piston reciprocates, it compresses the gas in the boost cylinder. The controls which cause the drive cylinder to reciprocate are described in Section 5 entitled, “Drive Air System Operation”.

The boost cylinder is a two-stage design (see Diagram 1 below). A volume difference between chamber A and chamber B is created by the size of the piston rod. As the pistons cycle to the right the change in volume causes the gas to increase in pressure as it enters chamber B through a check valve. At the end of stroke the pistons change direction and cycle to the left. As the pistons cycle to the left the gas in chamber B is compressed into the discharge line. At the same time chamber A is pressurized with supply gas. At the end of stroke the pistons change direction and cycle to the right, starting a new cycle.

The distance piece is designed to ensure that the gas in the boost cylinder is isolated from the air in the drive cylinder. There are piston rod seals at each end of the distance piece, and the distance between the rod seals is greater than the stroke length of the booster. Consequently, the section of piston rod which penetrates the drive cylinder never penetrates the boost cylinder and vice versa.

There is a 1/8 inch NPT gas vent port with a breather installed. Any air that leaks past the air seal, or gas which leaks past the gas side rod seal will flow out of this vent.

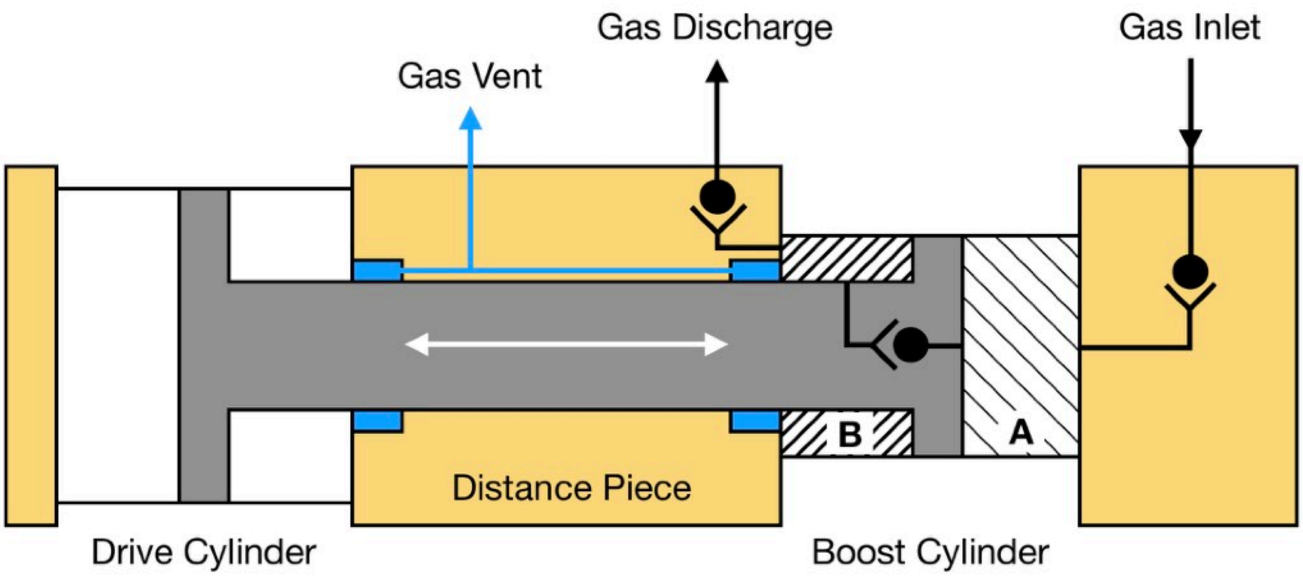


Diagram 1: Booster cylinder operation diagram

The maximum discharge pressure (MDP) is related to the sum of the drive piston area times the drive air pressure (DAP) and the stage one piston area times supply air/gas pressure (SP) divided by the stage two piston area. This booster uses a four inch diameter drive piston, a two inch diameter boost piston and a one and a half inch piston rod resulting in a drive piston area of 10.8 square inches, a stage one piston area of 3.1 square inches and a stage two piston area of 1.4 square inches. See Equation 1 below.

$$MDP = [(10.8 * DAP) + (3.1 * SP)] / 1.4$$

Equation 1: Maximum Boost Pressure Equation

For example, with an 80 psi drive air pressure and an 80 psi supply gas pressure the maximum discharge pressure is 794 psi. With an 60 psi drive air pressure and a 100 psi gas supply pressure, the maximum discharge pressure would be 684 psi. When the booster attains the maximum discharge pressure, the forces inside the booster are balanced and the booster stalls. When the discharge pressure drops below the maximum pressure, the booster automatically restarts. Boosters often only reach about 95% of the maximum discharge pressure due to frictional forces inside the booster.

5. Drive Air System Operation

The sketch below shows the 4-way valve extended to the left. This causes drive air to fill drive cylinder chamber "B" and opens chamber "A" to exhaust. The air piston is driven to the left. The drive air supply also feeds pilot valve "A" and pilot valve "B". Both of these valves are closed, and the pilot ports at the end of the 4-way valve are open to atmosphere through breather vent "A" and breather vent "B". All of the piping connections shown in the sketch are machined into in the valve manifold and cylinder end caps. There is no external tubing.

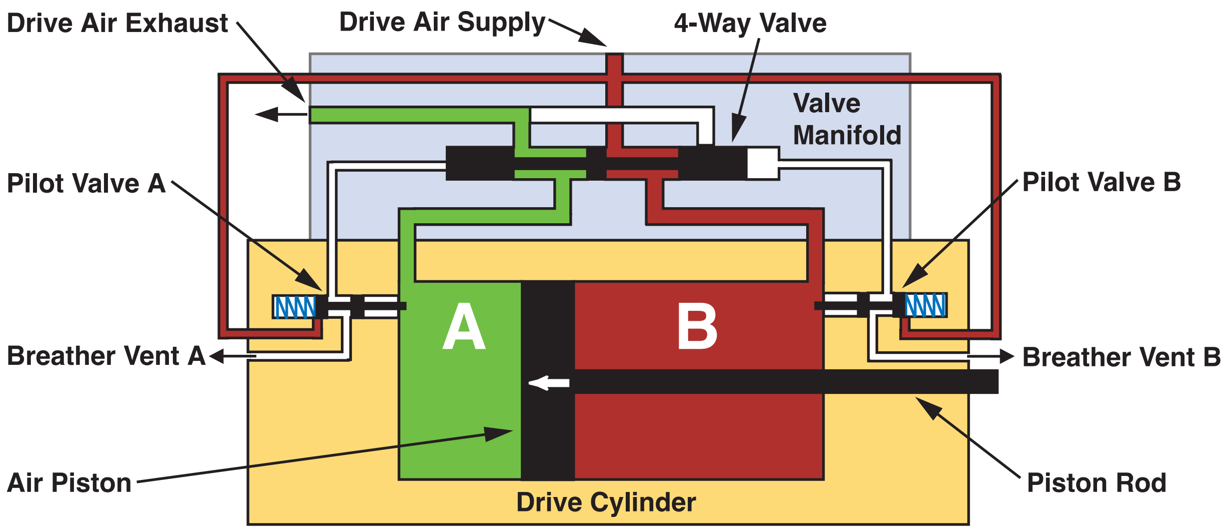


Diagram 2: Drive section operational diagram

In the sketch below, the air piston has reached the end of its stroke and opened pilot valve "A". This closes breather vent "A" and sends pilot air to the left pilot port on the 4-way valve. The 4-way valve shifts to the right, opens chamber "B" to exhaust and supplies drive air to chamber "A". The air piston moves to the right. When the piston moves off the end cap a spring returns pilot valve "A" to its normal position which closes off the air supply and vents the pilot air from the 4 way valve. This process is repeated on the right end of the drive cylinder which causes the air piston to reciprocate automatically.

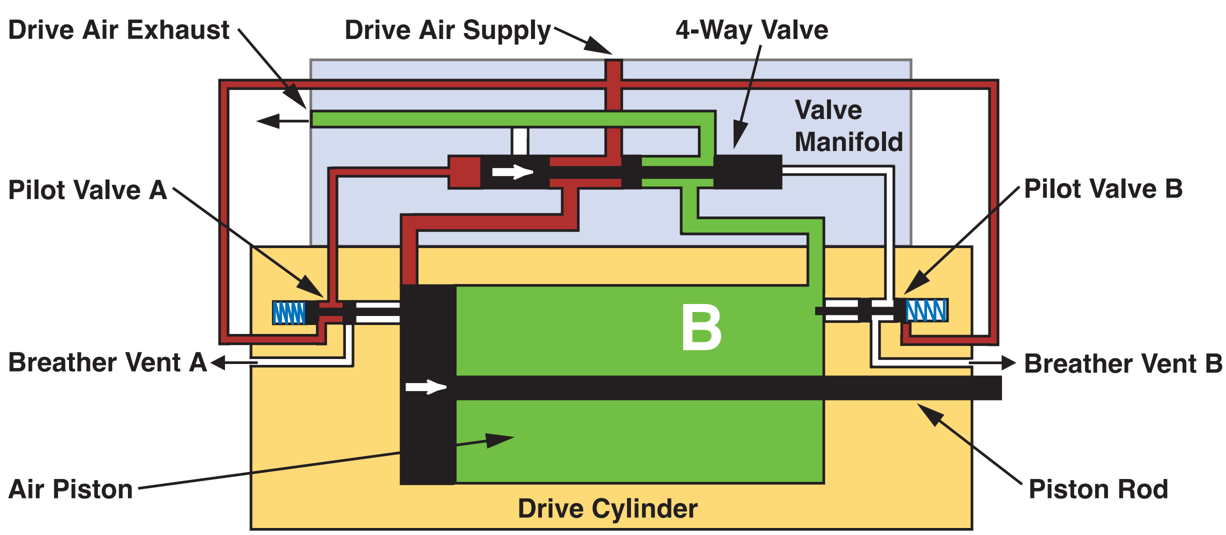


Diagram 3: Drive section operational diagram

6. Installation

1 Mounting

1a The booster has mounting brackets on each end with two 13/32 inch diameter mounting holes centered at the corners of a 2.0 inch by 20.8 inch rectangle. The booster can be mounted in any orientation using 3/8 inch mounting bolts.

2 Air Supply Connection

2a The drive air line connection is 1/2 female NPT. For convenience of piping location, the drive air connection can be rotated to face the drive air end cap or the boost end cap. The piping should be installed to prevent stresses from acting on the air inlet port which could cause a pilot leak and booster operating failure. The booster drive air must be ISO 8573.1 CLASS 2 or better. Lower quality air can cause the formation of ice in the cycling valve and exhaust mufflers which will cause the booster stop running or run erratically. If ambient temperatures fall below freezing, the air supply line must be heated to prevent ice formation on the exhaust mufflers which would cause the booster to stop running or run erratically.

2b A drive air filter with a 5 micron or better rating must be installed to prevent particulates from entering the booster. Ensure that the piping or tubing installed between the filter and the booster is very clean and will not corrode. Particulates can damage the cycling valve and cause the booster to stop running. Inadequate filtration can result in premature wear of the air piston and rod seal resulting in reduced operating life. A supply air pressure regulator and pressure gauge will enable control of the drive air pressure which determines the boost pressure. A shutoff valve enables isolation of the booster from the drive air supply for maintenance.

3 Gas Inlet and Discharge Connections

3a The process gas inlet and discharge ports are 1/4 inch female NPT ports. The gas inlet must include a 5 micron or better filter. This filter will protect the check valves and piston seals. Inadequate filtration can cause check valve failure preventing the booster from building pressure. The booster piston and rod seals produce fine dust particles as they wear, consequently the discharge line may need a 5 micron or better filter to protect downstream components.

3b If the maximum boost pressure of 1305 psi (90 bar) can exceed the pressure rating of downstream components or piping, a safety relief valve must be installed. Installation of a pulsation dampener on the discharge line will reduce the amplitude of the pressure pulsations generated by the booster.

4 Vent Line Connection

4a The vent line port is 1/8 inch female NPT.

4b The booster rod seals are not bubble tight. The small amount of air and gas leakage that occurs flows to the vent port. This leakage rate is typically 0.1 to 0.6 standard cubic feet per hour.

⚠ The booster must be well-supported. Inadequate mounting supports can put stress on the piping connections. Piping stresses can cause a gas leak which could result in a leak or explosion.

⚠ In hazardous environments, the booster must be mounted in a manner which enables electrical continuity to ground to prevent build-up of electrostatic charge which could trigger a fire or explosion.

⚠ The gas piping components must have a pressure rating suitable for the intended service. Inadequately rated connections could fail and cause a leak or explosion.

⚠ The piping connections must be installed in a manner which prevents piping stresses from acting on the booster gas inlet and discharge manifolds. Stress on the manifold can cause distortion and cause a leak or explosion.

⚠ Improper seal material selection or operating temperatures outside the recommended range for the booster can cause a gas leak which will shorten the operating life of the booster.

⚠ This booster can raise the pressure of the inlet gas supply to a maximum of 1305 psi. Downstream components must be rated to meet this pressure or be protected by a safety relief device.

7. Startup

1 Supply Gas to the Booster

1a The maximum allowable discharge pressure for the boost section of the assembly is 1305 psi (90 bar). The maximum discharge pressure is equal to the drive piston area times the drive air pressure plus the stage one piston area times supply air/gas pressure divided by the stage two piston area. If the drive air pressure is 60 psi and the supply gas pressure is 100 psi, then the maximum discharge pressure will be 684 psi. See Equation 1 from Section 4 below.

$$((10.1 * 60) + (100 * 3.7)) / 1.4 = 684 \text{ psi}$$

Make sure the booster's discharge pressure will not be exceed 1305 psi (90 bar).

⚠ Under certain conditions of high supply gas pressures it is possible to exceed pressures above the maximum allowable discharge pressure of 1305 psi (90 bar).

1a Supply process gas to the booster. The gas should flow through the inlet check valve, boost cylinder, and discharge check valve. If it does not, check to make sure the supply and discharge lines are connected to the correct ports. Check the process gas wetted components for leaks.

⚠ Operating temperatures or pressures outside the recommended range for the booster can cause a leak or explosion.

2 Supply Drive Air to the Booster

2a The air section of the booster is rated for a maximum of 125 psi. Make sure that the maximum value will not be exceeded. When drive air is supplied to the booster the booster will begin to cycle. If the process gas discharge line is closed, the booster will pressurize the discharge line to the maximum boost pressure described in the "Boost Cylinder Operation" section of this manual and stop cycling. If there is discharge flow, the booster will automatically cycle as fast or slow as necessary to meet the required flow rate, as long as the flow requirement is within the operating envelope of the booster. While the booster is cycling, check the drive air wetted components for leaks.

8. Operation

1 Operating Conditions

1a Insulate the booster and piping if the operating temperature is high enough to create a burn or ignition hazard.

1b Make sure the drive air exhaust silencer is installed. Boosters without a silencer can produce sound levels above 85 decibels.

⚠ High operating temperatures may cause burns as workers come into contact with the booster and associated piping.

2 Operating Characteristics

2a The booster will reciprocate as long as drive air is supplied and process gas flow is required. The booster cycle rate will automatically adjust to meet the required flow rate.

⚠ High operating temperatures may be an ignition source which could cause a fire or explosion in a hazardous location.

3 Operating Life

3a The operating life of the booster seals is related to the distance the seals travel. At a 70 cycle per minute operating speed, the booster seals can provide over 2000 hours of service.

⚠ Operation of the booster without a drive air exhaust silencer may cause hearing damage to exposed workers.

4 Rod Seal Leakage

4a The booster rod seals are not bubble tight. The process gas leakage that occurs flows to the vent port. This leakage rate is typically 0.1 to 0.6 standard cubic feet per hour.

9. Maintenance and Warranty

1 Lubrication

1a All of the booster dynamic seals are carbon fiber filled Teflon® and the control valve dynamic components are made from honed and lapped stainless steel with no elastomeric seals. No lubrication of any kind is required for the booster.

2 Filters

2a The booster air and gas supply filter elements should be replaced periodically.

3 Repairs

3a The booster seals and valves can be replaced after they have worn out. Use seal kit Model Number K420TAAV090. Always perform pressure, leak and functional tests on a repaired booster before returning it to service.

⚠ An improperly assembled booster could cause a component failure which could result in leak or explosion.

3b The booster has been designed to utilize high strength fasteners. If it becomes necessary to replace any of the socket head cap screws on the booster, the replacement fasteners must be of the same grade.

⚠ Use of the wrong fasteners on the booster could cause a gas leak or explosion.

3c When rebuilding the booster, use the torque values listed in Section 2.

⚠ Improper torque values can cause a failure which could result in a leak or explosion.

3d Use proper assembly and disassembly techniques. Socket head cap screws should be incrementally tightened and loosened using a cross-pattern. Static o-rings should be lightly greased to aid installation. Surfaces in contact with the filled-Teflon® rod seals and piston seals should not be greased.

4 Warranty

4a Midwest Pressure Systems, Inc. warrants these boosters to be free of defects in material and workmanship for a period of one year after installation. We will either repair or replace a failed unit returned by the customer. No other warranty is expressed or implied. Proof of the installation date is required. This warranty does not apply to equipment which has been abused, and is voided by failure to use a well-maintained inlet filter.