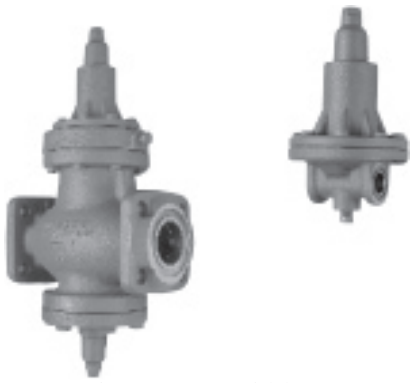
LOW PRESSURE DROP FEATURE FOR PRESSURE REGULATORS

For Ammonia, R-22, R134a, R404a, R-507 and other common refrigerants

BULLETIN 23-100B
Type LPD



September 2006
Installation Information

Features

- Permits Regulator Operation and ½ psi Pressure Drop
- Fully Modulating Pilot Regulator
- Adaptable to any of the A4 Family of Regulators
- Available with Pilot Electric Shut-Off and other Variations

Description

The Low Pressure Drop (LPD) Package when added to any of the standard Type A4 family of regulators will allow operation with ½ psi pressure drop. Reduction of pressure drop in a suction line from 2 psi to ½ psi can frequently result in great power savings, especially below 0°F. This is often at a rate, which will pay back the LPD extra cost in a few months.

Purpose and Application

The Low Pressure Drop assembly added to one of the Type A4 inlet or outlet pressure regulators permits full flow modulation with pressure drops down to ½ psi. Minimum pressure drops are especially important in the suction lines of any low temperature refrigeration system because excessive pressure drops will severely penalize compressor capacity as well as increase power costs. When it is necessary to combine capacity modulation with minimum pressure drop in a refrigeration control application, the LPD Package added to the proper Type A4 Regulator is an ideal answer.

The significance of power savings can be illustrated by the following example: A typical R502 system operating with a –30°F evaporator will suffer a 7% to 10% loss in capacity if a 2 psi pressure drop Evaporator Pressure Regulating Valve is used instead of one sized and equipped to operate with a ½ psi pressure drop. The loss in capacity means higher operating costs.

Nearly all application of and A4A-LPD will be in a low temperature suction line controlling evaporator pressure. The A4AO-LPD Outlet Pressure Regulator will most frequently be used in a low temperature suction line as a crankcase pressure-regulating valve preventing peak load excessive pressure from reaching the compressor.

All Type A4 Regulating Valves arranged for Low Pressure Drop operation must also be sized for Low Pressure Drop operation. The capacity of a regulator at ½ psi pressure drop will be 50% of the capacity at 2 psi pressure drop for the same inlet conditions.

Installation

The arrow cast into the side of the main regulator body indicates the proper direction of refrigerant flow. The main regulator should be in a horizontal pipe with the adjusting stem perpendicular to the ground. Space must be allowed above and below the valve for adjustment and servicing.

The LPD assembly should preferably be installed in a warm ambient at the main valve but can also at a remote location. Provision must be made to prevent condensate from forming in the high-pressure line. In most installations, insulation will prevent condensate from collecting in the line. The remote location can be up to approximately 20 feet away. Figure 2 and 4 show pilot line sizes in terms of nominal iron pipe size. Equivalent sizes in steel or copper tubing can be used as the installation permits. However, interconnecting lines should be the same size as those shown. It is important to install the LPD pilot device with the body arrow as shown in the drawings.

Protect the inside of all regulators and valves from moisture, dirt and chips during installation. It is generally advisable to install its companion, close coupled strainer ahead of the main regulator. On systems operating at low temperatures, a strainer can be used and cleaned for the first several weeks of operation. The screen assembly should then be removed to eliminate whatever very small pressure drop it causes. The system can continue operation without the screen until possible alterations or repairs to the system are made which might introduce dirt.

Like all pressure regulators of this type, The A4-LPD can control flow only in the direction of the arrow on the body. If some unusual reversal of pressure occurs in the system so that the pressure downstream exceeds the pressure upstream, the Main Valve Modulating Plug will be blown down from its seat and backward flow will occur. This reverse flow will cause the valve to make a chattering noise.

Principles of Operation

The forces required to open or close the standard inlet or outlet pressure regulating valve are two in number: 1) The pressure difference across the valve power piston creates the opening force. (Approximately the same pressure difference across the valve seat creates a closing force, but this is less in intensity than the opening force on the piston because the area of the seat is much less than the area of the piston.) 2) The direct and opposing force of a spring creates the closing force. By varying the amount of pressure flowing to the top of the piston, the main valve will modulate between open

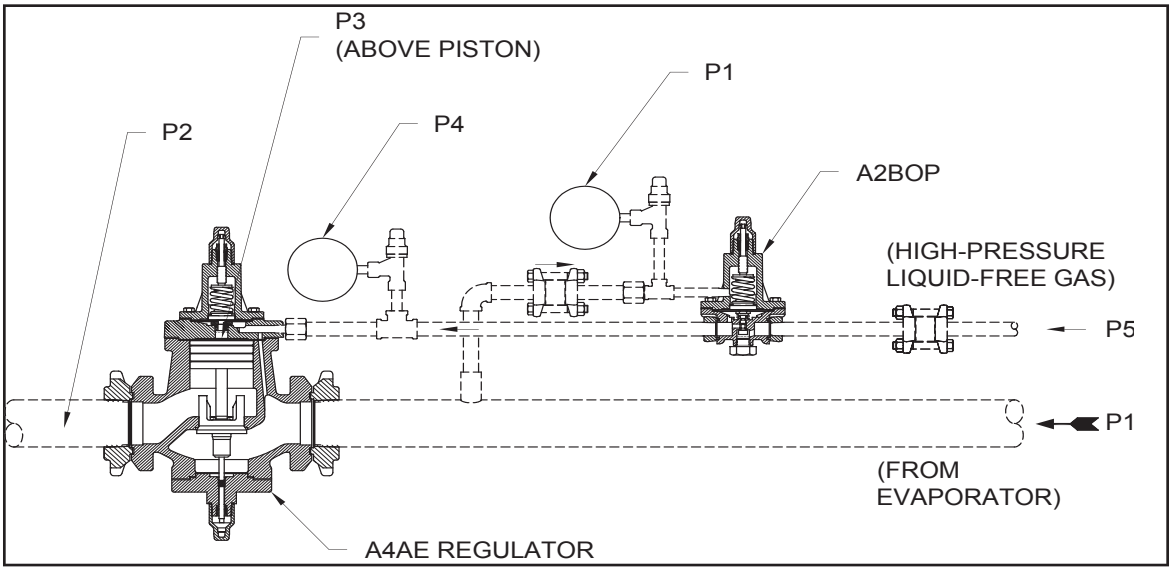


Fig 1

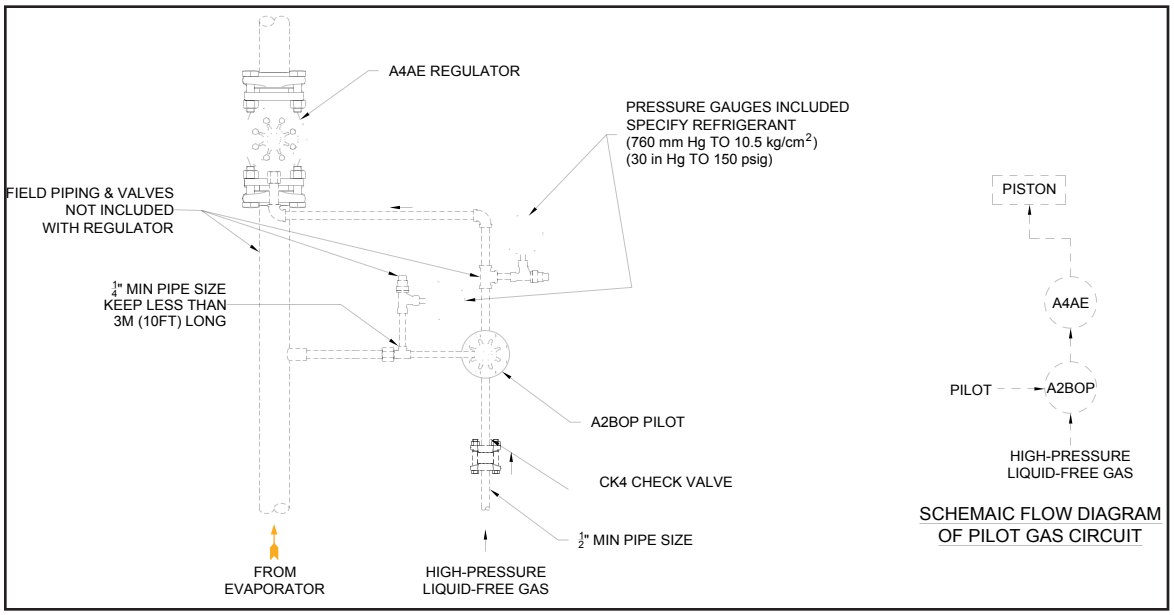


Fig 2

and closed.

The closing force of the spring must be adequate to provide reliable and tight closure. The opening force must, first of all, overcome the closing force and then supply added force to open the valve. With the conventional, industry-wide evaporator pressure regulator, a minimum of 2 psi pressure drop across the main valve is required for the valve to be fully open. Over sizing a regulator does not change the basic requirement of a 2 psi pressure drop to hold the valve fully open, because, regardless of regulator size, the same approximate proportions exist between piston and port areas and relative closing spring force.

The principles of operation patented by Refrigerating Specialties Company for the LPD Regulator is as follows (See Figs 1 and 3): Provide from a high pressure reference gas source (P5) refrigerant pressure to the pilot-package inlet line. Reduce this high pressure (P5) to a lower pressure (P4) and control it to follow the main regulator upstream pressure (P1), always at a fixed differential, usually about 5 psi, above that pressure. (P4 – P1 = 5 psi). Use this controlled following pressure (P4) through the pilot circuit and to the top of the piston as pressure (P3) where it will operate the main valve independently of the main line pressure drop.
[The pilot regulator on the Inlet Pressure Regulator system is set at a point above the evaporator pressure (P1) by an amount equal to the constant differ-

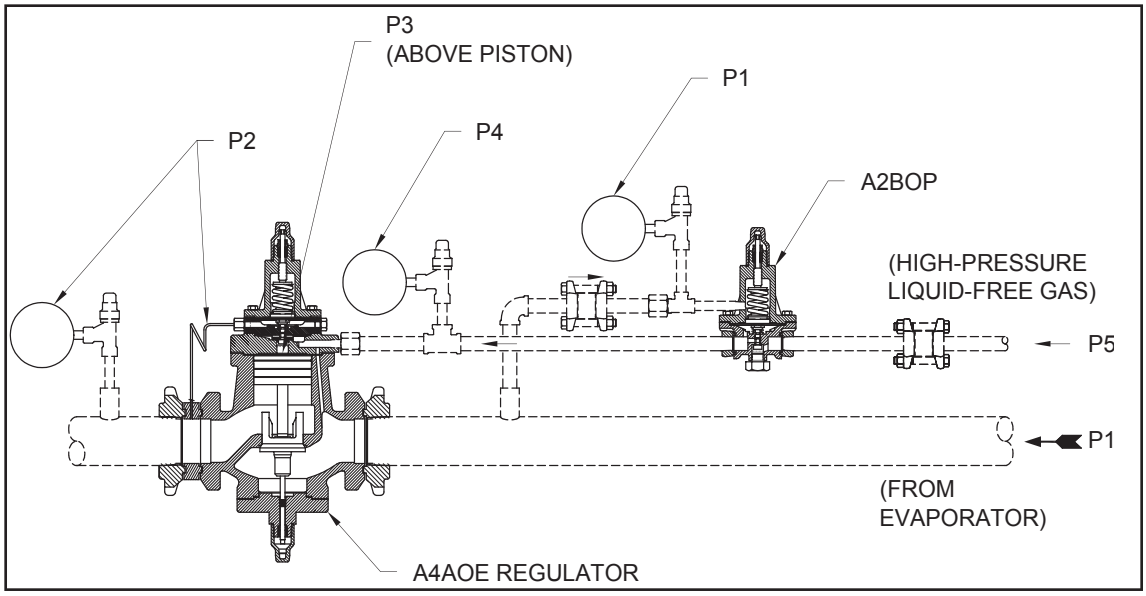


Fig 3

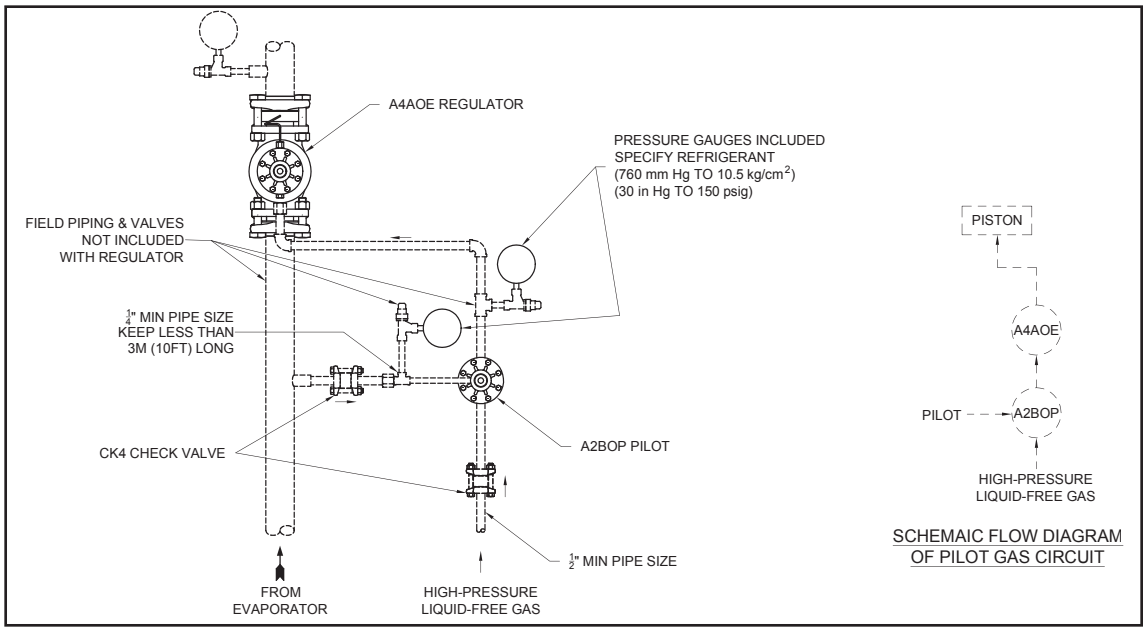


Fig 4

ence (5 psi) between the evaporator pressure (P1) and the following pressure (P4). The pilot regulator on the Outlet Pressure Regulator system is set at the desired outlet pressure.] Insure that the controlled following pressure (P3) is sufficiently higher that the upstream pressure (P1) to provide reliable operation at all times, but not so high at any time as to cause excessive leakage around the regulator piston to the downstream side (P2) and reduce evaporator capacity.

The higher pressure (P5) source can be condensing (head) pressure vapor, or in the case of a multistage system, intermediate pressure vapor. If the LPD assembly uses for the high pressure gas an intermediate pressure source, which may, at any time, be below the pressure at the main regulator inlet, two pilot line check valves must be used. (See Figures 2 and 4.) Advanced planning of the arrangement of the refrigeration system and placement of the regulator will frequently be all that is necessary to make the high pressure vapor convenient to use without extra piping. To insure a constant supply of vapor, it may be desirable to insulate the high pressure line or wrap it with electric heater cable to evaporate any liquid that is present.

Adjustment

Before adjustment is started, gauges must be installed as shown in Figure 2 and 4, and the refrigeration system must be fully charged and running at a temperature near that desired.

First, the Compensated Pressure Regulator (A2BOP) must be adjusted so that its outlet pressure (P4) stays a 5 psi **above** the Main Regulator **inlet** pressure (P1). Turn the adjusting stem clockwise to raise the outlet pressure (P4); counter-clockwise will lower the outlet pressure (P4). The Compensated Pressure Regulator (A2BOP) has a pipe connection in the Bonnet, through which an external or compensating pressure is introduced, causing the outlet pressure set point to vary up and down with this compensating pressure. With the LPD Package, the compensating pressure used is the Main Regulator inlet pressure (P1).

The compensating pressure (P1) fed to the Compensated Pressure Regulator (A2BOP) Bonnet is on the same side of the diaphragm as the spring and will vary the force on top of the diaphragm as the pressure in the Bonnet is changed. The effect is the same as if with no external pressure in the bonnet, the pressure adjusting stem was turned in or out by someone watching the main regulator inlet pressure change and matching his adjustments to the changes. The device then is a Compensated Outlet Pressure Regulator maintaining a constant positive difference between its outlet pressure and the Main Regulator inlet pressure.

By manually setting the outlet pressure (P4) to be 5 psi above the main regulator inlet pressure (P1), the outlet pressure (P4) will vary up and down, on a 1 to 1 basis, as the Main Regulator inlet pressure (P1) changes, always remaining exactly 5 psi above the inlet pressure.

Second, the Pilot Regulator can be adjusted to control the pressure desired. Setting this pilot regulator to start moving the main regulator as the desired pressure is reached accomplishes this. The adjusting stem, located under the sealing cap on the top of the pilot regulator, is turned clockwise to raise or counter-clockwise to lower the pressure being controlled. This applies to both the inlet and outlet pressure regulators. See Regulator Bulletin 23-05 for more general information.

If, after both of the above adjustments have been made and the system has reached balanced operating conditions, the Compensated Pressure Regulator settings only were lowered, (perhaps because it was set too high initially – say 25 psi, when 5 psi is desired), the set point for a main inlet pressure regulator will be raised or the set point for a main outlet pressure regulator will be lowered. A higher differential setting would create an opposite change in set point. An excessively high setting of the differential pressure without a corresponding adjustment on the pilot regulator will hold the main valve open all of the time. If the differential pressure was set too low, the main valve would remain closed all of the time, if the Pilot Regulator were not readjusted.

Electric Shut-Off

Pilot electric shut-off is available with each of the LPD regulators described in this bulletin. The letter "S" added to the Regulator Type will indicate this feature. Downstream pressure exceeding upstream can still blow backwards through the valve.

External Equalizer

Controlled pressures sensed at connection "D" in each Figure 3 and 4 can be reconnected in the field to any alternate suitable point. For Inlet Pressure Regulators (Fig 1) this would be some point upstream from the main valve, possibly at the evaporator. For Outlet Pressure Regulators (see Fig 3) this would be some downstream point, possibly at the compressor suction.

Manual Opening Stem

To manually open the main valve, remove the bottom sealing cap and turn the stem counterclockwise. In the manually opened position, the regulator cannot automatically control set-for pressures. The sealing cap must be securely replaced after the manual opening stem is turned in to the automatic position.

Service Pointers

Perhaps the greatest single foe of good regulator performance is "dirt". This may account for as much as 90% of all field problems. The strainers will collect most of the dirt and, if properly installed and maintained, eliminate most of the problems.

Gauges are a vital tool used in diagnosing regulator problems. They will tell whether or not the hand shut-off valves are open as they should be, and whether or not the differential regulator is doing its job and if the main regulator is controlling, as it should.

An incorrectly sized regulator can produce symptoms such as "valve will not open fully", or "too much pressure drop", or "regulator hunts too much." Regulators must be sized at full load for the pressure drop desired, ½ psi, 1 psi, 1-1/2 psi, and at the evaporator temperature required. Do not use a 2 psi pressure drop capacity table when it is desired to achieve less than 2 psi pressure drop.

Based upon the same evaporator temperature, a LPD equipped evaporator pressure regulator will have a 100 tons capacity at a 2 psi pressure drop, a 70 tons capacity at a 1 psi pressure drop, or a 50 tons capacity at a ½ psi pressure drop. Other things being equal, the refrigerant flow capacity for any given valve is greater for a high pressure drop than for a low pressure drop. Thus, if a regulator is sized for 100 tons using a 2 psi pressure drop capacity table and then an attempt is made to operate at, say 1 psi drop, the regulator will lack capacity, the evaporator temperature will rise and the system will level out at somewhat less than 100 tons with a some what more than 1 psi drop.

An existing regulator can be converted to a LPD Regulator but, as explained above, the capacity will be less at a pressure drop below the original selection.

High pressure liquid used as a pressure source for the LPD Package is not recommended because it will cause erratic valve performance unless the precautions to evaporate the liquid mentioned under the Principles of Operation section are taken. Consult the factory for design assistance in all applications using liquid as the high pressure source.

The section under 'Adjustment' describes some of the conditions resulting from improper setting of the Compensated Pressure Regulator.