TANK BLANKETING & VAPOR RECOVERY APPLICATIONS

INTRODUCTION

Tank blanketing is a method of controlling vapor pressure in a liquid storage tank. The main purpose of tank blanketing is to prevent air and moisture from entering the tank. The tank blanketing process may be used with positive and negative tank pressure.

TANK BLANKETING WITH POSITIVE PRESSURE

Gas blanketing and vapor recovery are two techniques that can safely and effectively put a cap on volatile vapors in tanks and other process vessels, thus keeping them from escaping into the atmosphere. There are nearly two hundred volatile and hazardous pollutants that must be controlled to prevent the emission of vapors during storage, handling, and processing operations.

The combination of gas blanketing and vapor recovery devices maintains a constant pressure in the tank's vapor space above stored liquid. As a result, tanks containing volatile vapors can "breathe" during pumping operations or if the ambient temperature changes (causing the vapor to expand or contract).

Tank Blanketing (also called Pad)

"Tank Blanketing" or "Padding" allows the use of a low-pressure blanket of gas, such as nitrogen, to maintain a protective gaseous environment above any liquid stored in a tank or vessel. The low-pressure gas blanket fills the void vapor space above the liquid stored in the tank. A gas blanketing system reduces the high-pressure source of gas to a lower pressure forming a blanket over the liquid. Low-pressure blanketing systems commonly protect tanks containing volatile organic liquids.

The positive pressure gas blanket helps prevent outside air, moisture, and other contaminants from entering the storage tank. In addition, the positive pressure of the system provides a head pressure above the liquid to reduce vapor loss which helps protect the tank from corrosion. Storage vessels without adequate protection against corrosion or contamination can cause serious problems if left unattended.

When the tank suddenly cools, the vapors inside condense causing the tank pressure to decrease. This causes the regulator to open which allows the blanketing gas into the tank. Blanketing regulators also maintain a constant tank pressure while removing liquid from the tank. The positive pressure prevents the tank from collapsing.

Inlet pressures at the regulator typically range up to 300 psig (20,7 bar), and the blanketing system's set pressure is normally 2 inches of water column (5 mbar) or less. The set pressure is kept as low as possible to minimize consumption of blanketing gas.

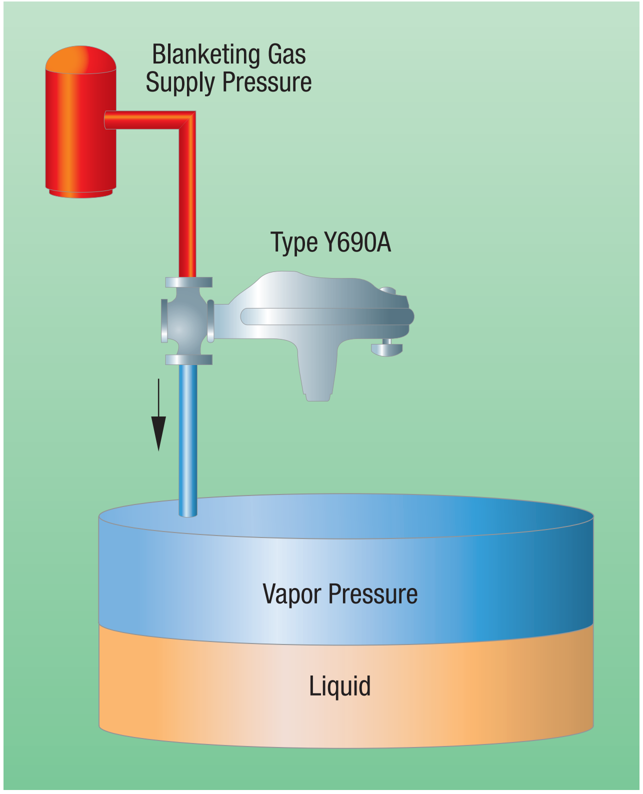


FIGURE 1 *Tank Blanketing (Padding)*
When the vapor pressure in the tank drops below preset limits, the regulator's diaphragm moves the valve disk away from the seat, allowing blanketing gas to flow in.

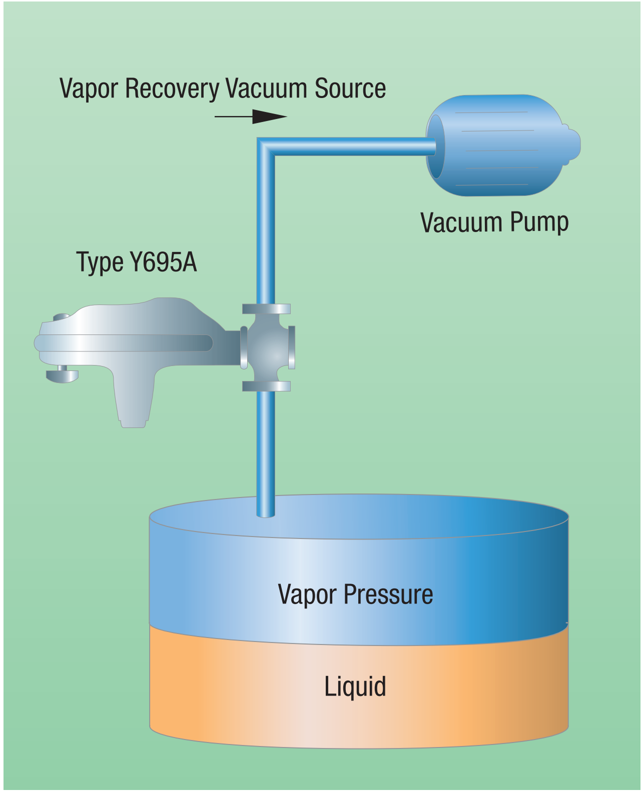


FIGURE 2 *Vapor Recvoery (De-Padding)*
In vapor-recovery applications, the regulator moves the valve disk awy from the seat in response to high vapor pressures, allowing excess vapor to flow out of the tank.

FISHER

EMERSON Process Management

Vapor Recovery (also called De-Pad)

When pressure inside the vessel rises due to thermal heating or "pump-in" of product, the vapor recovery regulator senses an increase in tank pressure and vents excessive tank pressure to an appropriate vapor-recovery disposal or reclamation system.

Vapor recovery systems have several applications, but the most common reason for installing a system is to prevent vapors from escaping into the atmosphere (some vapors can be vented directly to atmosphere).

Setpoints for vapor recovery systems are typically higher than the blanketing system setpoint to minimize consumption of the blanketing gas. Emergency vents are installed to protect the tank from an upset condition, but these function only in the event of regulator failure or other emergency condition.

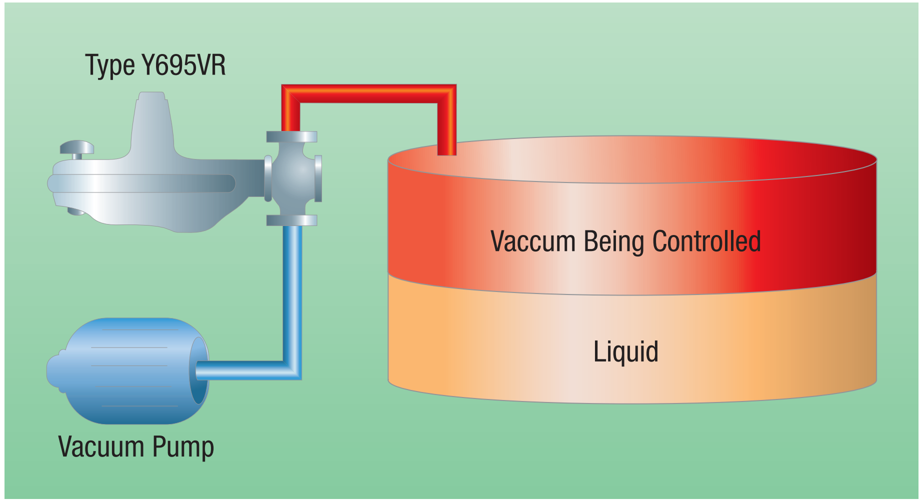


FIGURE 3 *Vacuum Regulator*

Tank Blanketing and Vapor Recovery Valve Types

There are two main types of valves used in positive pressure tank blanketing systems: direct-operated and pilot-operated. Direct-operated valves for blanketing sense the tank's vapor pressure, and this pressure registers directly on the valve's diaphragm. When the tank's vapor pressure decreases below the system's setpoint, the diaphragm moves the valve disk away from its seat, allowing gas to flow into the tank.

The position of the disk relative to the seat regulates the amount of flow. Variable-flow control is called throttling. Here, as vapor pressure in the tank increases, the disk moves closer to the seat and shuts off the flow completely when the pressure rises above the setpoint. Direct-operated systems respond quickly to changes in tank pressure.

In vapor recovery, the action of the direct-operated valve is reversed. When the tank's vapor pressure rises above the setpoint, the valve's disk moves away from the seat, allowing the vapor to flow out of the tank. Thus, the higher the pressure buildup above setpoint, the more the disk moves and the greater the flow. The valve shuts off the flow of escaping gas when the vapor pressure in the tank is reduced below the setpoint.

In pilot-operated valves for blanketing, a pilot valve opens in response to a lower tank pressure, and a loading pressure is loaded or unloaded to the main valve to open it. When downstream demand is satisfied, the outlet pressure increases slightly, thus acting on the diaphragms of the pilot and main valves. Then, the pilot diaphragm moves to close the pilot valve plug, and the loading pressure to the main valve is reduced or increased, allowing it to shut off. Small changes in vapor pressure in the tank are amplified by the pilot valve, resulting in very accurate pressure control of the gas-vapor blanket.

Pilot-operated systems for vapor recovery utilize components similar to those used for blanketing, but the action is reversed. In this case, supply pressure is equalized on both sides of the main valve's diaphragm. When the tank's vapor pressure reaches the pilot setpoint, it begins to open and unload the supply pressure from one side of the main valve diaphragm. The resulting pressure imbalance allows the main valve to then open.

Selecting a System

In general, direct-operated tank blanketing and vapor recovery valves respond faster and are typically less expensive to purchase, install, and maintain. A direct-operated valve should be the first choice if it meets the capacity and accuracy requirements of the system.

Pilot-operated blanketing and vapor-recovery systems may have lower setpoints and greater accuracy than direct-operated systems. Pilot-operated systems are used when the allowable change in controlled pressure is small, or if flow capacities are large. They are also the choice if the body size of the valve is larger than two inches. Pilot-operated systems are the best choice where accuracy and capacity are of prime importance.

TANK BLANKETING IN A VACUUM (NEGATIVE PRESSURE)

When applications arise where the gas blanketing requirements are in vacuum, a combination of a vacuum breaker and a vacuum regulator may be used. Vacuum blanketing is used to prevent vessel leakage to atmosphere when the vapors inside the vessel are harmful. If leakage were to occur, outside air would enter the vessel because of the vacuum in the tank. Therefore, any process vapors in the tank would be contained.

There is a variety of terminology used to describe vacuum, causing confusion when communicating with someone that uses different terminology. Fisher uses the following vacuum terminology.

First determine whether the units are in absolute pressure or gauge pressure (0 psig or 0 bar (g) is atmospheric pressure). For example:

- 5 psig (0,34 bar g) vacuum is 5 psi (0,34 bar) below atmospheric pressure
- -5 psig (-0,34 bar g) is 5 psi (0,34 bar) below atmospheric pressure
- 9.7 psia (0,67 bar a) is 9.7 psi (0,67 bar) above absolute zero or 5 psi (0,34 bar)

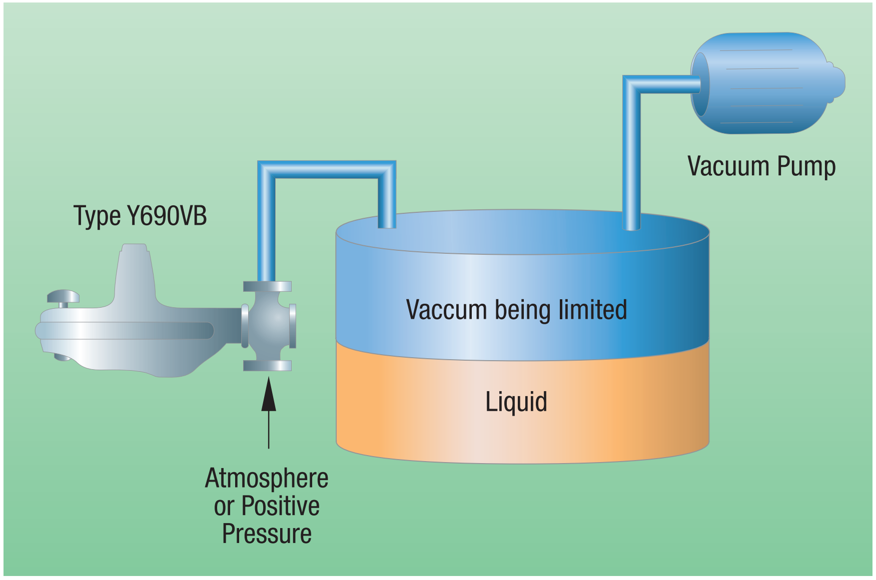


FIGURE 4 *Vacuum Breakers*

below atmospheric pressure (14.7 psia - 5 psi = 9.7 psia or 1,01 bara - 0,34 bar = 0,67 bara).

Just as there are pressure reducing regulators and pressure relief valves for positive pressure service, there are two basic applications for vacuum service. The terms used for each are sometimes confusing. Therefore, it is sometimes necessary to ask further questions to determine the required function of the regulator. Fisher uses the terms vacuum breaker and vacuum regulator to differentiate between the two types.

Vacuum Breakers

Vacuum breakers limit the increase in vacuum. An increase in vacuum (decrease in absolute pressure) beyond the setpoint is sensed on the diaphragm causing the disk to move away from the seat. This permits the higher pressure to enter the system and restore the controlled vacuum to its original pressure setting.

Vacuum Regulators

Vacuum regulators maintain a constant vacuum at the regulator inlet. A decrease in vacuum (increase in pressure) beyond the setpoint registers on the diaphragm causing the disk to move away from the seat, allowing a higher vacuum source to restore the vacuum to its original setting.

Vacuum Applications

Fisher offers several vacuum regulators and vacuum breakers. For specific product information contact your local sales representative for application solutions.

TANK BLANKETING ACCESSORIES

Accessories can be added to a valve. The following is a list of accessories that can be added to a tank blanketing or vapor recovery valve to create a system.

First-Stage Regulator

A first-stage regulator is used to reduce a high inlet pressure to a lower pressure before it enters the blanketing valve.

Pressure Gauge

A permanently installed gauge is placed downstream of the first-stage regulator, on the outlet of the regulator, or on the control line connection. These gauges are used to monitor the system and check performance, monitor start-up, and make adjustments.

Control Line Purge

The purge flowmeter maintains a very small continued flow of blanketing gas through the control line. This eliminates the backflow of tank vapors into the regulator by constantly sweeping them back to the tank. The purge will protect the valve components against potentially corrosive tank vapors and crystallization of the process.

Main Line Purge

The main line purge serves the same purpose as the control line purge, only it purges tank vapors from the main line. Some systems use both control line and main line purges.

Check Valve

A check valve can be piped to the outlet of the tank blanketing valve. This also prevents backflow from the tank to the valve. A check valve should not be applied to valves with internal pressure registration since it inhibits control.

Diagnostics

A diagnostic port provides the capability to analyze the valve's operation in the field, making servicing simpler and more reliable. This is available on the Type ACE95 and Type ACE95Sr.

SAVING NITROGEN

Plant utility managers, tank farm managers and those with storage vessel maintenance responsibilities can easily reduce their gas blanketing expense by using low-setpoint technology.

Fisher low-setpoint tank blanketing valves allow storage vessel operators to maintain a 1/4-inch w.c. (0,62 mbar) setpoint for blanketing gas. Such low blanketing pressures minimize blanketing gas losses by reducing the volume of gas being forced through poorly sealed breather vents and incidental escape paths. The cumulative effect of using Fisher's low-setpoint technology can result in significant savings.

Escape Paths Lead to Loss

In a typical storage vessel, numerous escape paths, pinholes, and seal leaks equal to just 1 inch in diameter will result in up to $8,683 of nitrogen gas loss when tank pressures are maintained at 1-inch w.c.
(2 mbar) versus 1/4-inch w.c. (0,62 mbar).

How Blanketing Gas is Saved

Escape paths, such as slight roof corrosion or poorly seated vents and pressure/vacuum valves also contribute to blanketing gas consumption. Increased vessel blanketing pressures will cause more gas loss. Decreased pressures, such as 1/4-inch w.c. (0,62 mbar), minimize nitrogen loss.

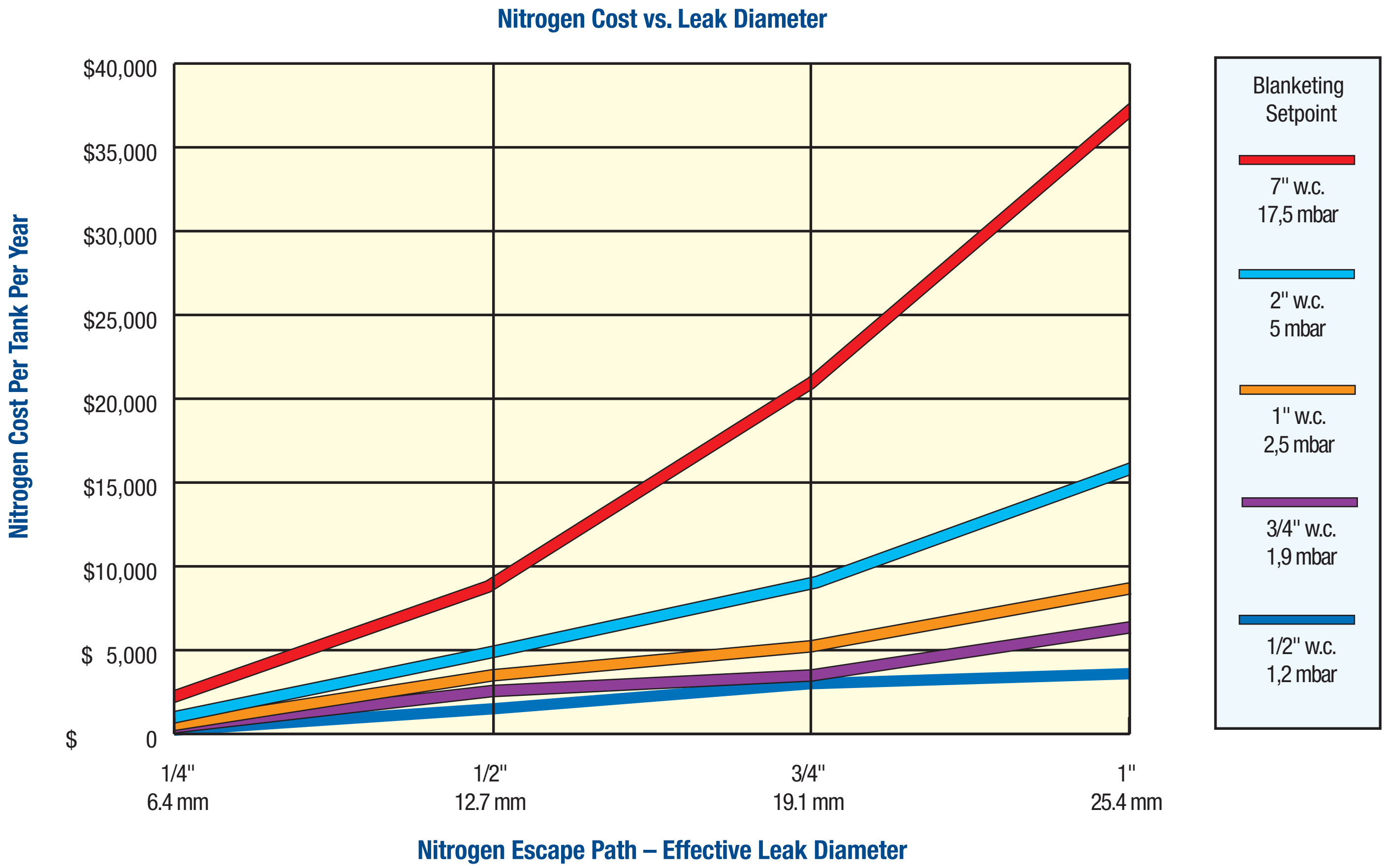


FIGURE 5 *Annual savings from a 1/4-inch w.c. (0,62 mbar) Setpoint Versus Higher Setpoints*
Reduce your gas blanketing expense with low-setpoint technology. This table shows the incremental annual expense of nitrogen where blanketing setpoints are greater than 1/4-inch w.c. (0,62 mbar).

Typical Annual Expenses Calculated

The chart shown in Figure 5 demonstrates the typical incremental annual expense of nitrogen lost when using setpoints above 1/4-inch w.c. (0,62 mbar). To estimate the expense of the annual gas loss, nitrogen was conservatively estimated at $2.00/1000 scfh and validated with a major nitrogen supplier.

SIZING

In order to size a pad or depad application, the user must decide which method is appropriate for the application. Unfortunately, there are few guidelines available. Basically there are two methods in use: direct displacement and API 2000.

The direct displacement method assumes that the volume of product displaced must be replenished by an equal volume of gas. There are no corrections applied for vaporization of product, thermal expansion/contraction or other variables. This method is appropriate for indoor tanks operating at a constant temperature and handling non-flammable product with low vapor pressures. It allows no room for thermal cycling.

The API 2000 method is more complex. It accounts for all of the variables mentioned above. However, it may oversize equipment in many instances. It was developed for tank venting and oversizing was considered to be acceptable.

It is known that some users practice API 2000 sizing, but apply factors to reduce the calculated volumetric requirements. Only the user can decide what is the appropriate method to use for their application.

The blanketing (pad) and venting (depad) valves are system or process operating valves.

Supplemental emergency venting should be considered to protect the tank in case of equipment failure, fire exposure, or other conditions that would cause the tank pressure to exceed operating limits. The pad and depad valves are not meant to substitute for emergency tank vents. These vents protect the tank from excessive pressure/vacuum and provide venting for exposure to fire.

Sizing must also take into account applicable codes and standards as they apply to installation.

The reader is encouraged to contact API and obtain a copy of API 2000. (American Petroleum Institute, 1220L Street NW, Washington, DC 20005. (202) 682-8375)

Terminology

The term "PAD" refers to the make-up or blanketing of tank vapor space contents to maintain pressure. This is to accomodate the effect of removing liquid from the tank, and the effects of ambient cooling of the tank.

The term "DEPAD" refers to venting the tank vapor space contents to limit pressure. This is to accomodate the effect of adding liquid into the tank and the effect of warming the tank contents.

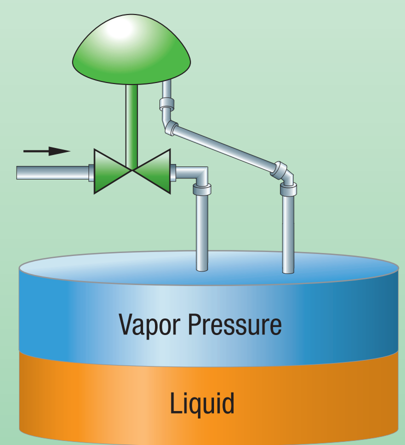
SIZING METHOD

Significant undersizing is undesirable in that it can result in having a higher than desired pressure when depadding (venting). If the pad (blanketing) valve is undersized it can result in the tank pressure dropping too low and the atmospheric vacuum vent opening. This would allow atmospheric air and moisture into the vapor space.
A grossly oversized pad valve could cause overshooting the setpoint, but it is less likely. Pad valves are more tolerant of oversizing than depad valves.

Gross oversizing the depad, however, can result in having the vapor space pressure drop too far below depad setpoint and cause the pad valve to actuate. This is interaction. Oversizing can also increase the cost of the system and result in unnecessary cycling.

When very large tanks are used, the thermal component flow portion of the API methods can be significantly larger than the displacement flow. This means that under conditions of displacement only (no thermal requirement), the valve may be oversized. The depad valve is sized on a differential pressure, which is tank pressure (set pressure + buildup) minus the outlet pressure which is typically a vacuum. Using this information, estimates can be made of the resulting operating pressure of the system, at any flow rate, with any size valve. You can simply look at the capacity tables and determine the differential pressure that would result at a given flow rate. Sizing could maintain a lower pressure under most conditions and a higher pressure under 100% flow conditions. This information could be useful in sizing and could result in a reduced installed cost. *Caution must be excercised to maintain the tank operating pressure within allowable limits under all conditions.*

Oversizing of the depad valve can (but will not always) result in the pressure dropping enough, when the depad opens, to enter the pad pressure region. It is for this reason that we require a *deadband* between the pad and depad operating points. In the case of a displacement flow being significantly less than the thermal portion it may be wise to increase the deadband. Alternately, the depad Cv may be reduced and the tank pressure allowed to rise higher under thermal flow conditions. This modification would require a close examination of the system capabilities including the tank maximum allowable working pressure (MAWP) and the atmospheric vent settings.



Control line should slope downward toward the tank to prevent condenstation buildup.

- Make the control line as short and straight as possible.
- Connect the control line to the point where the pressure is to be controlled.
- Increase 1 pipe size for every 10 feet of control line, with setpoints less than 5-inches w.c. (0,012 bar).

FIGURE 6 *Control Line Installation Tips*