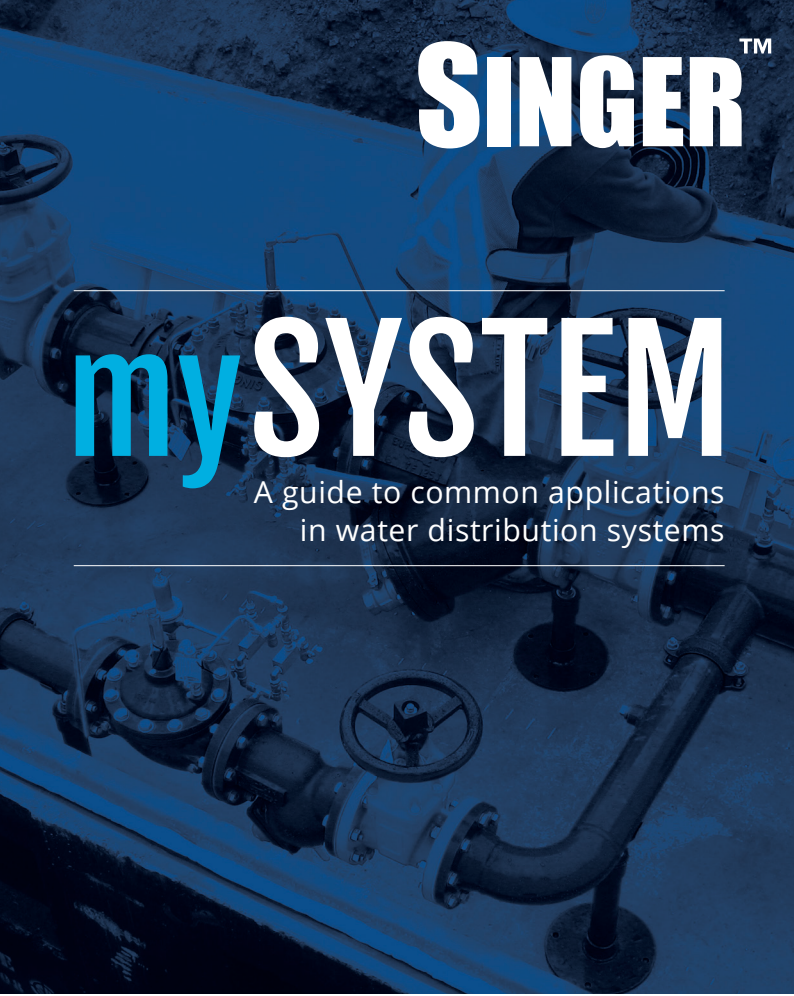

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A guide to common applications
in water distribution systems

Mueller Co.
Reliable Connections™

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This short guide is intended to offer guidance on some of the common problems, applications and questions that arise from using automatic control valves in water systems.

It is not intended to replace a full technical catalogue so you will need to refer to that for complete details, but this will certainly give you some insight into the types of questions a valve manufacturer may ask you and allow you to have a better understanding of some of the more common applications.

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TOPIC ONE

LOWERING THE PRESSURE IN MY SYSTEM

If pressure feeding into a zone needs to be lowered the traditional method employed is to install a pressure reducing valve. This is a valve that will limit the outlet pressure of a valve to a preset pressure regardless of the flow rate and the inlet pressure.

WHAT YOU NEED TO KNOW

The location of this valve needs to be in an accessible area – typically in a valve vault, as they will require occasional maintenance.

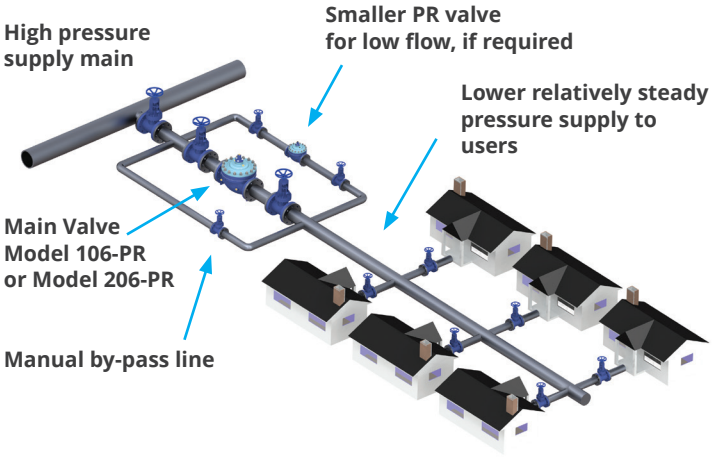
In order to size this valve you will need to know normal inlet pressure, outlet pressure required, and normal flow rates (minimum and maximum).

CAUTIONS

If the inlet pressure to outlet pressure ratio is greater than a 3:1 range there is a real possibility that cavitation will occur. That will require one of two things:

a) Use two control valves in series and lower the pressure gradually over two stages

b) Use a control valve with anti-cavitation trim installed



Note: The smaller PR valve by-passing the main valve helps control low flows and provides service during maintenance. It should be set 3 - 5 psi / 0.2 - 0.35 bar higher than the larger valve.

COMMON QUESTIONS

What if I have two valves feeding into the same zone?

The valves will certainly work but the issue will be ensuring that they both open together. This is something that has to be done during commissioning and will require two people, one at each valve. They will need to communicate with each other to ensure that both valves open together and this will typically involve a slight adjustment to one of the reducing pilots.

Can my valve be installed in a situation where the chamber is underwater occasionally?

While this is not ideal, in a pressure-reducing valve situation the valve will happily continue to operate underwater. If this is a regular occurrence we would suggest using a full stainless steel pilot system.

Why is my valve size smaller than the main line size?

Valves are sized for 20 ft. /s (6m/s) velocity through the seat area for continuous service. We like to see these valves operating in the 20-80% range of their stroke so we can also increase velocity through the very short distance of the control valve than you would normally size your distribution lines for. For this reason it is common to have a control valve maybe one size smaller than the actual line it sits in. (For this reason the reduced port valve is a great option as it has connecting flanges the size of the main line but internals of a smaller valve.)

Will my valve handle the entire flow range?

Typically not, this is why you will frequently see a smaller reducing valve installed in parallel to the larger valve. This is there to handle the low flows that the larger valve cannot handle. If you utilize a control valve with the rolling diaphragm technology this low flow rate will not be an issue as that type of control valve can regulate down to extremely low flows and bypass valves are not required.

Why do I have different pressure set points on larger and smaller reducing valves in a station?

In order for the smaller valve to take control during times of low flow, this valve will be set about 5 psi higher than the larger valve. This ensures that when the pressure downstream starts to drop, this is the first valve that will open. (Remember it is downstream pressure operating on the reducing pilot that keeps it closed so when downstream pressure drops lower than spring setting pressure, the pilot will open, in turn allowing the mail valve to open.) If the small valve cannot maintain the pressure because flow demand increases, the pressure will drop in the small downstream system, thereby allowing the larger main valve pilot system to open allowing main valve to now take flow.

What if the upstream pressure drops below the pressure setting of the pilot?

The pressure-reducing pilot is set by the force of a spring in the top of the reducing pilot. As a normally open pilot, this means the spring is always trying to keep the pilot open. As the reducing pilot senses the downstream pressure, if the pressure is greater than the spring setting, the pilot closes. When this pressure sensed is lower than set point the pilot opens and this releases the pressure from the bonnet of the main valve and the valve will go wide open. Should the upstream pressure rise, the pilot will start to regulate again to maintain the setpoint.

RECOMMENDATIONS

- Installing air release valves ahead of reducing valves is always recommended to eliminate any chance of air in the pilot system. In-line strainers will certainly help to eliminate the items that frequently get flushed down water lines and eventually get trapped in the control valves. It is much easier to remove a strainer lid and clean out debris than it is to remove a pilot system and control valve bonnet.

- If there is the risk of somebody downstream of the reducing valve having the ability to shut off the entire flow quickly (maybe feeding into an industrial complex, line ends with a fire hydrant etc.), then there is the risk that the valve could be in an open position when somebody closes the flow. This results in high pressure passing through the valve and getting trapped downstream. A solution to combat this is to have the reducing valve installed with downstream surge control that assists the valve in closing quickly if the pressure downstream of the valve raises a few psi higher than the normal set point.

- An alternative to the downstream surge control would be to install a pressure relief control valve, but that will depend on the location and the ability to discharge the water safely if the relief valve opens.

- In order to set this valve in the field it would really be advantageous to have at least an isolating valve on the outlet side of the valve.

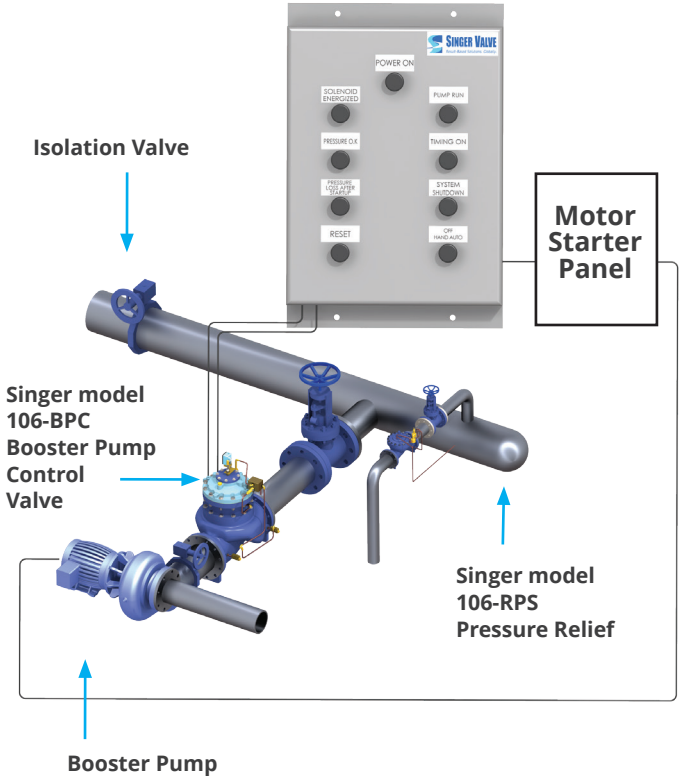
- An outlet pressure gauge will also be required to set the valve.

TOPIC TWO

STARTING A PUMP IN MY SYSTEM

Whenever a pump is started, the sudden increase in flow and pressure can create pressure waves into the system that can cause a lot of noise and damage. As this is not desirable, engineers will frequently utilize methods to slowly ramp up the pump speed either by using something called a “soft start” - where the voltage or current is temporarily reduced in a three-phase motor to give a slow pump start or variable frequency drives – where the pump speed can be adjusted to give a much slower start to the system.

However, both of these options can be expensive and often traditional constant speed pumps are still used. This creates the problem of surges at startup. A common answer to this is to install a pump control valve. This allows the pump to start up against a closed valve that is slowly opening as the pump gains speed. This allows the system to gradually increase in pressure. At the time to shut the pump off, the valve is allowed to start closing before we turn off the pump motor and only when the valve is almost closed does the pump actually turn off. This is what we call an In-Line Pump Control Valve. There is a second type of Pump Control Valve, named a Bypass Pump Control Valve – see explanation of this after this section.



IN-LINE PUMP CONTROL

WHAT YOU NEED TO KNOW

Typically this valve is going to be located very close to the pump so is usually in some kind of pump house. It will require electrical power for the solenoid valve, either AC or DC and will also require wiring back to the pump control panel for a limit switch that gives the position of the valve stem so we know when to turn off the pump just before the valve is closed.

These valves are typically the same size as the main discharge line as even during operation, this valve will be experiencing full flow so we do not want to incur any more pressure loss than is necessary.

You will need to know the pump flow rate and the pressure that the pump will be operating at. This is used to determine the valve rating and the correct solenoid that is used in the pilot system.

You will also need to determine voltage required for the solenoid.

CAUTIONS

Determine ahead of time if you are using this valve just for starting and stopping the pump or if you may require the valve to perform a throttling function also. (This requires two different valve body types.) See Common Question 2 below.

COMMON QUESTIONS

What if I have more than one pump feeding into a header?

You will require a pump control valve for each pump.

Can a pump control valve also be used to control flow rate or pressure?

Yes. However, if you are intending to have this valve throttle we do need to know this ahead of time as the valve is supplied in two options. One utilizes what we call a PG body and this is more like a typical control valve and allows for throttling. The alternate is a PT style body. This is where we use a body style that has two independent chambers in the cover. One to drive valve closed, one to drive it open. This is our preferred pump control body but cannot be used in regulating situations. It does however have a linear operating curve so flow is proportional to the valve lift (e.g., 50% open valve = 50% of flow).

The main valve body is available with an optional internal drop check that will close the main valve in the event of no flow through the valve. This will help to eliminate potential surges.

Is the pump shut off point adjustable?

The pump shut off point can be set by adjusting a small collar on the valve stem that is used to trip the limit switch. This can be field set and changed if required.

RECOMMENDATIONS

- Remember that an in-line pump control valve always sees flow so there will be a small pressure drop across the valve even when it is wide open. Select a valve that gives you the lowest pressure drop. (For this reason this type of valve is usually same size as pipe size.)

BYPASS PUMP CONTROL

The bypass type valve performs the same function as the in-line pump control, in that it allows a slower start to the system but rather than the valve sitting in the main line and opening slowly, the valve sits on a bypass (like a relief valve) and is wide open when the pump is started. As the pump reaches speed the valve is slowly closing so the main pump header reaches pressure slowly before it can overcome the static pressure in the system, holding the check valve closed. Switching off the pump is a reversal of this process. The valve starts to open and the main header slowly drops in pressure, eliminating check valve slam, and just before this valve is wide open, the pump is switched off.

These valves are very useful in eliminating the in-rush of air when a pump starts and also for removing sand/silt that you may get from a traditional bore hole pump on start up.

WHAT YOU NEED TO KNOW

Typically this valve is going to be located very close to the pump so is usually in some kind of pump house. It will require electrical power for the solenoid valve, either AC or DC and will also require wiring back to the pump control panel for a limit switch that gives the position of the valve stem so we know when to turn off the pump just before the valve is open.

Because these valves only operate when the pump is starting and stopping they are sized with much greater velocities than an in-line valve and are therefore typically smaller in size.

You will need to know the pump flow rate and the pressure that the pump will be operating at. We will use this along with the static pressure to determine suitability and the valve rating and also the correct solenoid that is used in the pilot system.

You will also need to determine voltage required for the solenoid.

The static pressure in the system.

CAUTIONS

These valves discharge water during start up and shut down so you will need somewhere to discharge this. Either back into a bore hole or to a drain.

The system will need to have an in-line check valve downstream of the connection for this valve.

COMMON QUESTIONS

Will I need this type of valve if I also have an in-line pump control valve?

No. This valve is used when you do not have another type of pump control valve.

What static pressure do I need in my system for this valve to be able to operate?

We like to see at least 20 psi (138 Kpa).

RECOMMENDATIONS

- These valves will be a less costly alternative to an in-line pump control valve, but if you have nowhere to discharge the water then it is an issue. This can be a problem in areas where freezing occurs as outside drains will freeze.
- A very good alternative if you do not need to add additional functions to a pump control valve as this valve is only open during starting and stopping of pump so does not create a pressure drop when the system is running.

TOPIC THREE

COMBATTING SURGE IN MY SYSTEM

Surge in pipelines can be catastrophic and can be caused in several ways. Before determining a suitable method to eliminate or mitigate surging there are a few things we need to know.

When does the surge occur? Is this when a pump starts and stops under normal operation? Or does this occur because the flow is being suddenly shut off – like in the fire hydrant situation? Is it due to a power loss?

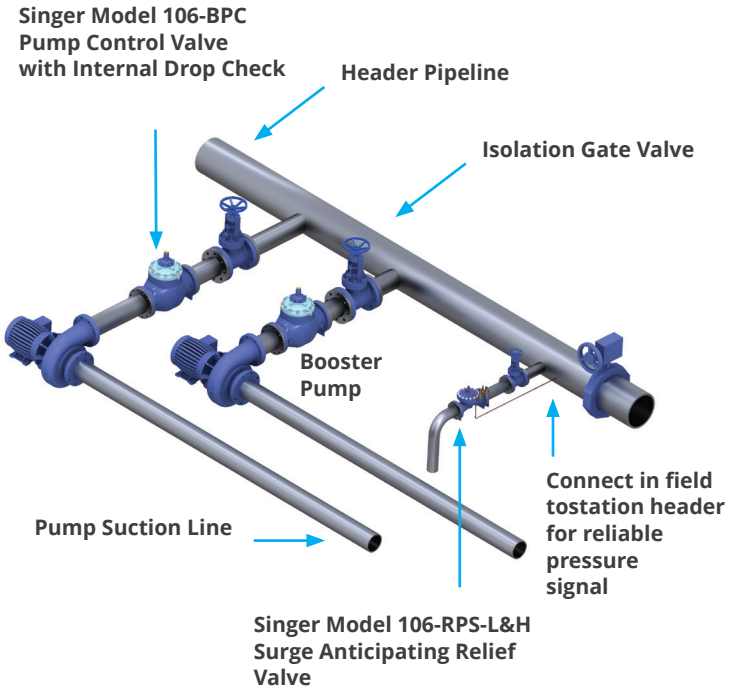
All of these situations can create surging and there are valves that can take care of the problem.

WHAT YOU NEED TO KNOW

First, you will need to know what your flow rates are and what your pressure is during normal operation. What is the system static pressure?

Secondly, what is the pipe material (yes, it does make a difference)? How long is the pipeline? What is the pipe size? What is the topography of the pipe?

TYPICAL APPLICATION



CAUTIONS

If a surge anticipating valve is recommended then you will require a discharge for the water that will be released if a surge occurs.

Traditional surge anticipating valves do require a minimum system static pressure of 92 ft (28m). If you do not have this pressure then all is not lost – we do have a surge solution that will work for you.

COMMON QUESTIONS

I have three pumps feeding into a header. Do I need a surge valve on each pump?

No, you do not. If anything, having a valve too large or having too many will actually create more problems for you. One surge valve on the combined header from the pumps would be sufficient.

Won't a relief valve take care of surges?

Sadly, a pilot-operated relief valve will not open fast enough to take care of a surge scenario, because a relief pilot only opens when it senses the higher pressure, when the pressure surge wave arrives at the valve which is just too late. That is why you do need a true surge anticipating valve that will already be opening before the surge wave reaches the valve.

Will a surge tank system eliminate the need for these valves?

Yes, but at a much larger capital cost and the added expense of on-going maintenance.

RECOMMENDATIONS

- First, no valve company is ever going to do a complete surge analysis for you. At best we calculate what the maximum surge you could expect to see over the longest distance of the pipeline, but that does not take into account other lines feeding into it or size changes, etc., so if you really want to know the surges you could see we recommend having an engineering company conduct a real surge analysis on your system.

- If ever you see surge valve sizes that are close to the size of the main line, be cautious. Oversizing of these valves can be as much of a headache as under sizing.

- This surge anticipating valve is mounted in a tee, downstream of the pump check valve(s) and a sensing line has to be provided that is connected from the valve to a connection on the main pump header.

- If the static pressure is under 40 Psi (275 kpa) we would recommend a Surge Anticipating on Rate of Rise Control Valve. This is a very unique valve that actually measures the rapid rate of pressure rise in a surge event and opens the valve to handle the surge wave. This valve cannot be oversized and is guaranteed to always close after a surge event.

TOPIC FOUR

CONTROLLING TANK LEVELS IN MY SYSTEM

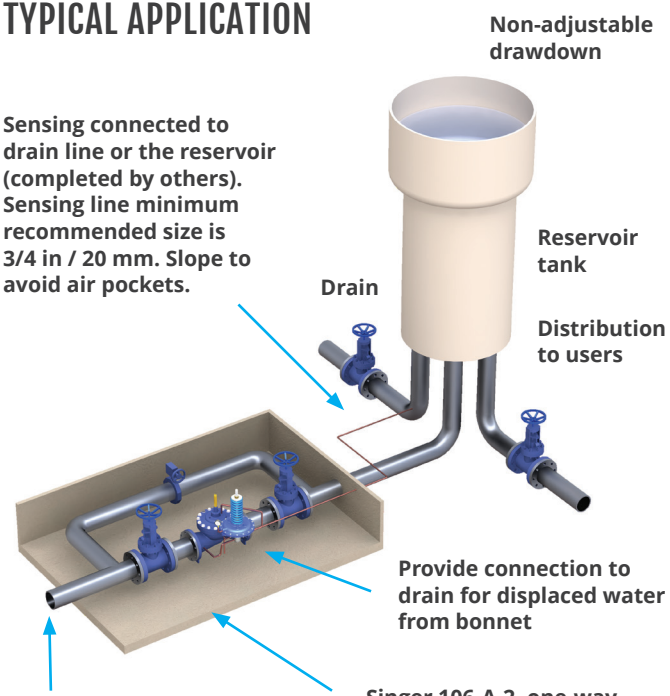
There are several solutions to maintaining the level in a tank. It really depends on whether you want the tank to maintain a set level or if you can allow the tank level to drop before the tank refills. Control valves to maintain levels fall into three categories:

1) Altitude valves – traditionally used on larger storage tanks and in areas where freezing can occur so you cannot have exposed pilot tubing or a float in the tank.

2) Float valves – smaller tanks, up to 4 m (13 ft) and areas where there will be no freezing. Typically used on tanks inside buildings.

3) Electrically operated valves. These valves rely on a signal from the top of the tank (level probe or ultrasonic), to actuate a solenoid on the control valve to open and close the valve.

TYPICAL APPLICATION



WHAT YOU NEED TO KNOW

What is the pipe size, inlet operating pressure and flow rate required?

What is the height of the high water level in the tank above the centerline of the inlet pipe?

Where will the valve be located? Ground level?

Is this in a location that will see freezing?

Will the same valve fill the tank and also let water out of the tank?

Do you want to maintain a set level in the tank at all times or can you allow the tank to empty and then refill? If so, how many feet (meters) can the water level drop before you want the valve to refill the tank?

CAUTIONS

If an altitude valve is being used remember that it will need a sensing point. This should be at least ¾ inches (20 mm) and ideally situated on a static line connected to the bottom of the tank or drain of reservoir. If there is no static line then the next best situation would be the outlet line from the tank. The connection should also be at the same elevation as the altitude pilot.

If electronic valves are used there has to be a signal to the valve controller from the tank. This can either be from a pressure transmitter, conductance probes, or a non-contacting system like ultrasonic or radar. Remember, if the tank is in a location that experiences freezing, ice will form on the top and will give a false reading. The electronic version also requires power on site.

COMMON QUESTIONS

When my tank is filling it draws the pressure in the system down. How can I stop this?

This is very common and a simple solution is to add a sustaining feature to the level control valve. This ensures that the tank will fill but will always ensure that there is a preset minimum pressure maintained in the supply system. The tank will not fill as quickly when the valve is throttling but at least you will still have pressure in the system.

Is there a maximum tank height that I can use a float valve on?

If the valve is mounted within 13 ft (4 m) of height difference between the float and the valve it will be fine. However, on really high tanks that would mean the float valve could be mounted very high above the ground, which may not be ideal for maintenance and operation. That is where an altitude valve or electrically operated valve has the advantage.

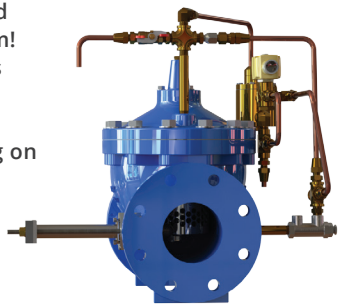
RECOMMENDATIONS

- The choice to use float valves versus altitude valves or electronic valves can be broken down this way:
  - If it is in a freezing location, the pilot lines will freeze so a float valve is not practical and ice forming on the surface will impede top down measurements so an altitude valve is the best choice.
  - If the tank is less than 13 ft (4 m) in non-freezing climates, then a float valve is a good choice. Above that height, then an altitude valve.
  - If the tank is located in a non-freezing environment, and the location has power then the solenoid option is a good choice as it also gives the ability to control the fill rate of the tank.
  - If there is a chance that the inlet to the altitude valve will have a lower pressure than the head of water in the tank produces, we recommend adding a check feature to the altitude valve to prevent flow reversal.

TOPIC FIVE

MEASURING FLOW WITH A VALVE IN MY SYSTEM

Control valves can actually be used to measure the flow in your system! However, traditionally flow meters would be used and commonly in municipal systems these are electromagnetic types. Depending on the manufacturer and installation these can be very accurate and cost effective. But, what happens if you have to retrofit a flow meter and do not have the straight run space that these flow meters require? This is where adding a flow meter into a control valve can start to make good sense.



WHAT YOU NEED TO KNOW

What are the minimum and maximum flows that you are likely to see?

What is the pressure in the line?

What is the pipe material?

What are the installation details? Conventional magnetic flow meters require five pipe diameters upstream and two downstream.

Singer Valve recently introduced a control valve with a built in, single point insertion, magnetic flowmeter. This has proven to be a very cost effective method of having a flow signal from a control valve that may also be controlling another variable, i.e., pressure, level, etc.

CAUTIONS

Magnetic flow meters are prone to “noise.” That is electrical interference due to poor grounding or motors that may be close by. You cannot always do too much about the motors but you can take care of grounding. It is always advisable to install grounding rings (stainless steel plates that sit between flanges that you attach a ground wire to). These will ensure that the flow meter is well grounded.

Also try and keep wiring between the flow meter and the convertor to a minimum.

SPECIAL NOTE: Don’t try and shorten this wire yourself as adding joints into this cable just makes matters worse as far as noise is concerned.

Not all flow meters are created equal. Unless you are only ever going to see maximum flow rate, make sure you specify a meter that lists a percentage of rate or reading for accuracy, not full scale.

COMMON QUESTIONS

How many straight runs do I need ahead of my valve with an insertion flow meter?

Ideally three pipe diameters. However, it depends on what is upstream. If it is a wide open gate valve, this can be installed right up to the control valve. An open butterfly valve with the stem vertical will require one pipe diameter, but if the stem is horizontal, three pipe diameters.

Can I install a valve directly to the outlet of my control valve?

This is not ideal but a wide open gate valve will be OK. Butterfly valves have to be checked to ensure the disc will open into the valve without binding.

How accurate will this flow meter be?

2% of reading is what the flow meter manufacturer will guarantee based on their lab testing. It typically is much better than this but that is the figure that we use.

Remember, all magnetic flow meters are actually reading velocity and then calculating volume flow, so they all have a low velocity cut off point where the water is just moving too slowly to accurately measure. This is 0.3 ft./s or 0.09 m/s.

RECOMMENDATIONS

- A full line size magnetic flow meter is always going to provide the best accuracy, but will require more space for install. An insertion magnetic flow meter is a useful recommendation where space is not available.
- Always install grounding rings. This really ensures we get a good signal from the flow meter sensor to the convertor.
- Maximum distance between the insertion probe and convertor is 200 ft. (61m). Order the correct length at time of ordering and only get as much as you need. Avoid running this cable near electric motors or any other electrical interference. (It is better to mount the convertor close to the probe and run the 4-20 mA signal wire if any distance has to be reached.)

TOPIC SIX

CONTROLLING FLOW IN MY SYSTEM

Control valves make excellent flow limiting valves. What we mean is that they will allow flow up to a preset value and then if the demand tries to exceed that flow rate the valve will throttle down to ensure that the flow rate remains at the set point. Very useful in applications where you can only accept a certain flow, or you want to restrict a user to a set flow or where you possibly want to guarantee you never over pump and risk penalties!

WHAT YOU NEED TO KNOW

What is the pipe size and maximum flow rate required?

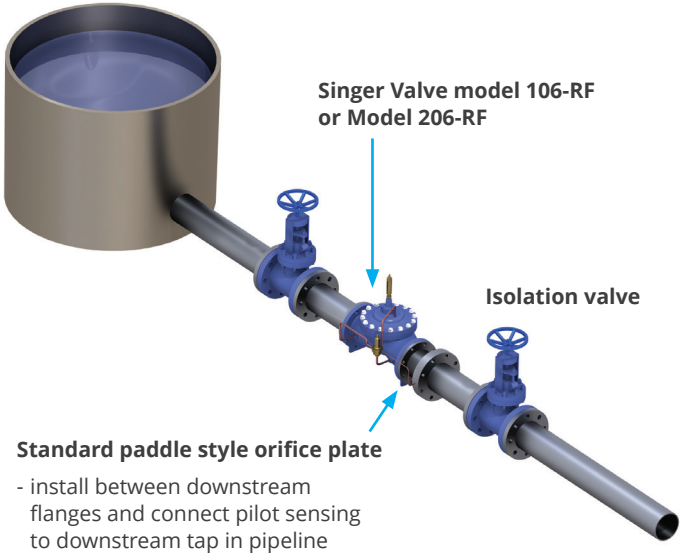
What is the minimum and maximum pressure in the pipeline?

CAUTIONS

This valve does use an orifice plate to give the control pilot the differential pressure that is calculated to control the flow. Because of that it is important to have your flow requirements sorted out beforehand. (Typically the orifices are sized to give a low pressure drop close to the low end of the spring range of the pilot.) Because the differential pressure is proportional to the square of the flow, requiring flow adjustments will require pressure setting adjustments and that may be a problem (depending on the pilot range). The alternative would be to get a new orifice plate.

Turndown (or range-ability) is typically 2:1.

STORAGE TANK



Standard paddle style orifice plate

- install between downstream flanges and connect pilot sensing to downstream tap in pipeline
- completed in field by others

COMMON QUESTIONS

Do I need any straight runs before this control valve?

No. This valve can be installed with other valves, strainers, elbows, tees, etc., upstream.

Can I install the orifice plate against the outlet of the control valve?

Yes, however, ideally you are better to install this downstream to get a more accurate reading. Tests have shown that five pipe diameters downstream are ideal but this is not always practical.

RECOMMENDATIONS

- If full flow control is required (as opposed to flow limiting) then a dual solenoid control valve should be used instead of this valve. This will allow for full flow range adjustments automatically without the need for an orifice plate.

TOPIC SEVEN

CONTROLLING BACK PRESSURE IN MY SYSTEM

Back pressure or sustaining valves are used in systems to protect the upstream of the valve from experiencing low pressure due to high demand downstream of the valve. A pilot is set to the lowest pressure you require upstream of the valve, so as long as pressure is greater than this setting the valve remains wide open. As soon as inlet pressure drops down to the pilot setting the main valve starts to throttle to ensure that the upstream pressure never falls below that set point, regardless of downstream demand. This is a common valve for such applications as protection of a sensitive user upstream, reservoir filling and for keeping pumps on their pump curve.

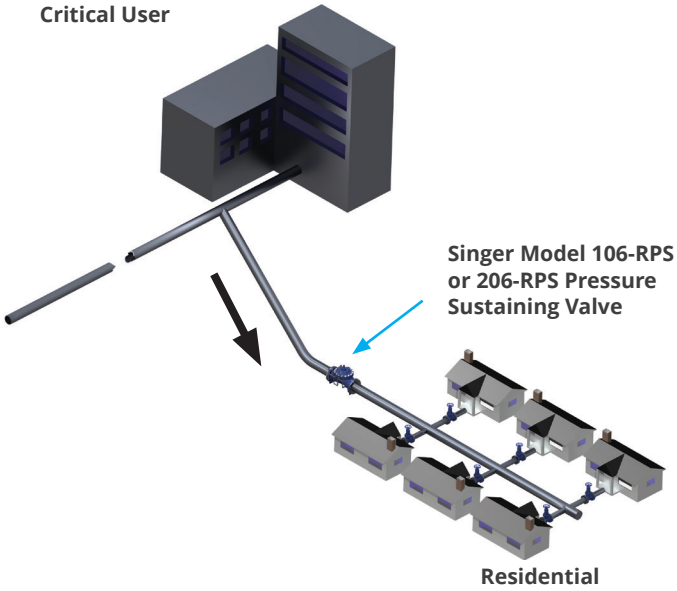
WHAT YOU NEED TO KNOW

What is the pipeline size, flow rates and operating pressure?

What is the sustaining pressure you want to maintain?

CAUTIONS

Because this valve is only concerned with valve inlet pressure, it has no concern for what is happening downstream. It will even close fully to protect the upstream pressure so caution must be used to ensure that this situation would not be dangerous for the downstream users.



COMMON QUESTIONS

Can I combine this valve with another hydraulic function?

Yes, certainly. It is very common to see this valve pilot system paired with a pressure reducing valve so you have a sustaining valve that as long as the inlet pressure is high above the sustaining setting will act as a reducing valve, but should inlet pressure drop, the sustaining feature takes control. It is also common to see this function installed on altitude valves for reservoir filling.

RECOMMENDATIONS

- In order to set this valve in the field it would really be advantageous to have at least an isolating valve on the inlet side of the valve.
- An inlet pressure gauge will also be required to set the valve.

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AUTHORS: **MARK GIMSON & ALEJANDRO DUQUE**

ABOUT SINGER

Singer designs and manufactures automatic control valves for the global water industry. Since 1957, its pilot operated diaphragm control valves have been installed on virtually every continent around the world. Whether it is water loss management in Southeast Asia, water conservation concerns in Saudi Arabia or urban distribution demands in the United States, Singer provides water management solutions to governments, cities, companies and contractors around the world.

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