Process Steam:

Cascade Regulation

Get finer control using pressure regulators

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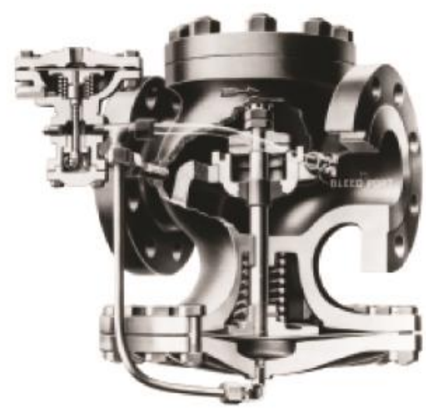
Cascade

Although control valves do have a place in process, the most economical and best-kept secret in the industry today is using a pneumatic pilot operated regulator with an air controller which gives you excellent control at a tremendous saving. This regulator will replace the expensive control valve and still maintain the high level of control which is required in processes without the need of installing a separate pressure reducing valve to maintain the constant pressure that the control valve needs for its fine control.

Watson McDaniel offers a pneumatically loaded, steam-piloted regulator that can cut valve costs by 65% and yet offer better process control than the conventional system. In fact, to achieve this improved control, it is often advantageous to incorporate this regulator into an existing system.



Let's assume we are using a high-pressure steam distribution main and local steam pressure reducing stations. If you normally employ a central pressure reducing station and transport the steam at a lower pressure to the process areas, then your savings may be even greater than what we show here.

In a conventional system, at the point of use, steam enters the process equipment through automatic control valves. These valves are positioned by the various process control instruments that measure temperature, pressure, flow rate or other variables. The process units are thereby maintained at the desired level.

The concept is shown in fig.1. This valve is cascaded with a master controller. The regulator can make immediate changes in the rate of steam flow when the pressure varies, and follow up with finer adjustments based on changes in the process characteristics.

Since this device is actually a high speed, cascaded pressure-control loop, expect improved process control. The 3 to 15 psi pneumatic signal from the primary control instrument is translated directly into pounds per square inch of steam pressure so that the varying requirements of the process can be met quickly and accurately. Any variation in the steam pressure is compensated automatically.

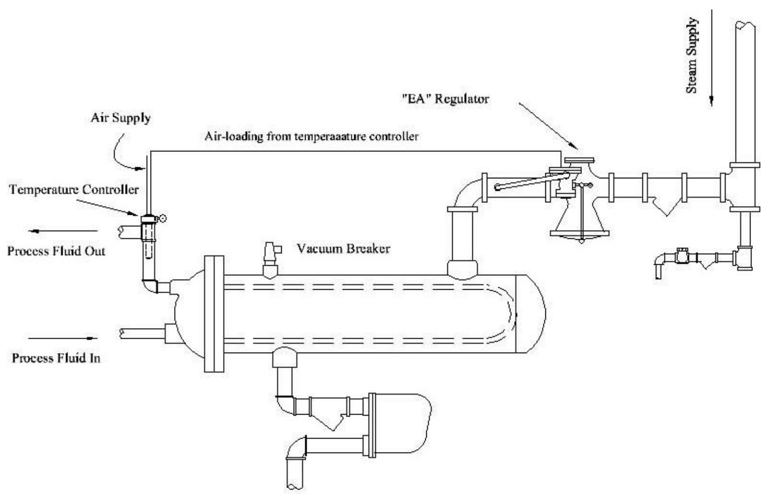


Fig. 1
How the system works

Let's assume the load on the heat exchanger increases, causing a drop in steam pressure. The lower pressure in the control line allows the diaphragm in the pilot to be deflected downward. This triggers a reset of the main valve, which is positioned by high-pressure steam; increasing the steam flow until the pressure in the control line again equals the preset opposing pressure in the pilot. A final adjustment is made if the thermostat in the heated process-fluid feeds a new temperature signal into the recorder-controller, causing it to change the air loading on the pilot.

Several money-saving features of this concept should come to mind immediately:

1. The pressure reducing station can be eliminated because the same valve can serve both to reduce the pressure and to modulate it for process control purposes.

2. More pressure drop will now be available at the control valve, which means that the valve can be smaller.

3. If a central pressure reducing station is normally used, then this system allows you to supply steam at high pressure, using smaller diameter piping. Savings here would be considerable.

STUDY SHOWS 65% SAVINGS ON CONTROL VALVE COSTS

For ease, we have prepared this cost study on a hypothetical plant with only four users. Fig. 2 shows the piping detail of a conventional system and that of the regulator concept. Table 1 “Size Comparison” gives flow rates and sizes of valves.

We assume that all process units require low-pressure 15-psi steam. If other pressures were required to perform the job function, this is attained by simply selecting a different pilot.

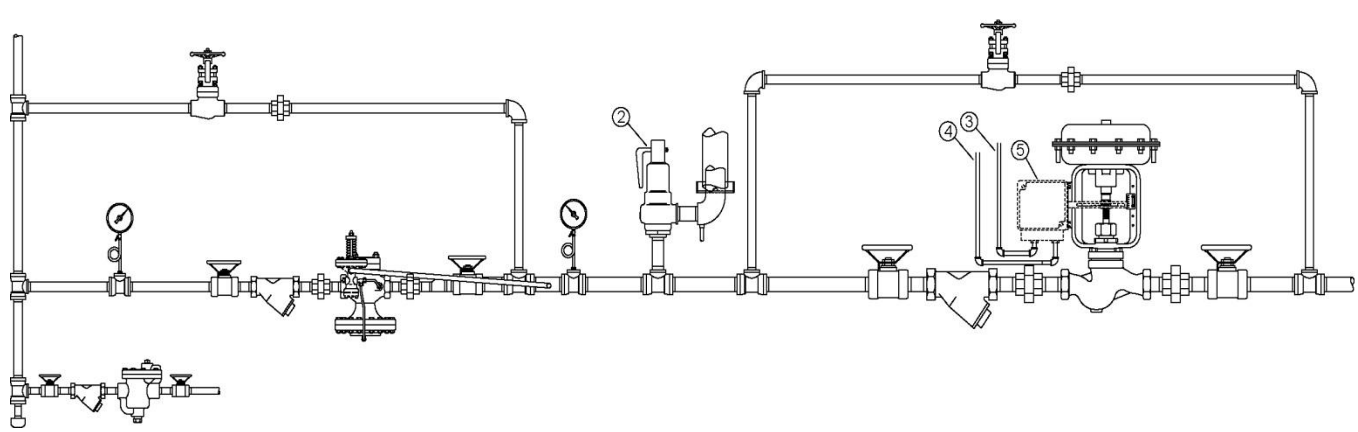


Fig. 2

Details of piping around typical diaphragm control valve a conventional system.

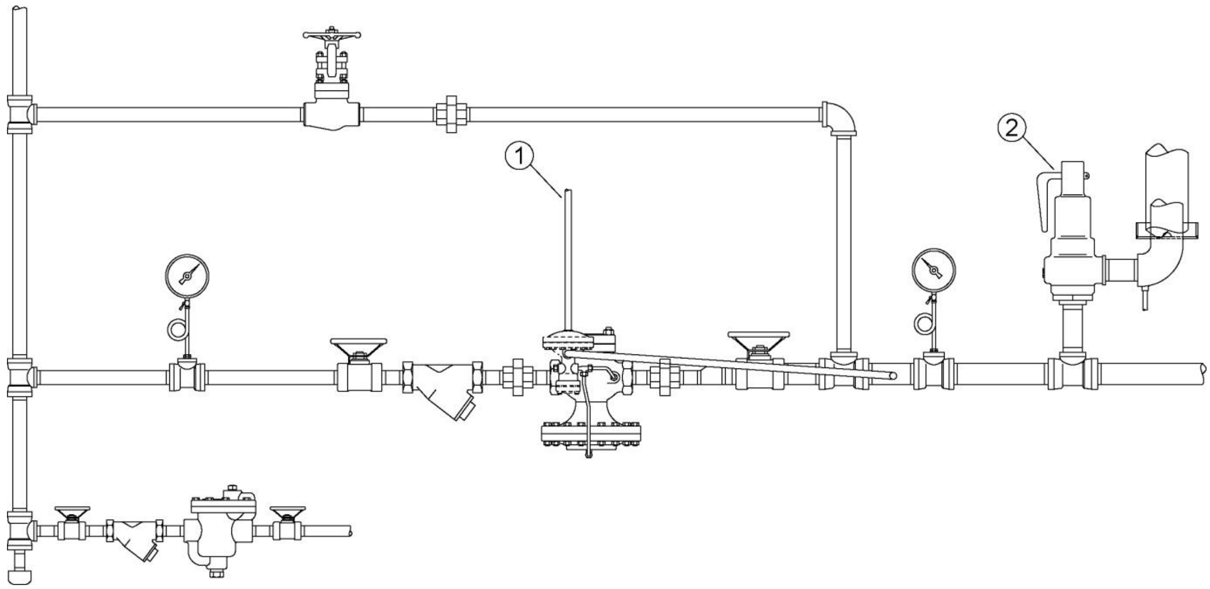


Fig. 3

Details of piping around air-controlled, steam-piloted regulator (new system).

1- Air-loading from temperature controller

2- Safety valve

3- Air Supply

4- Air signal from temperature controller

5- Valve positioner

PERFORMANCE COMPARISION

While the conventional control valve package usually needs little maintenance, the air-controlled regulator needs even less. The regulator is of packless construction, eliminating all of the problems associated with stuffing boxes friction, leakage, adjustments, and exposed stems. Since no positioner is required, and since all the moving parts are unexposed, maintenance is minimized.

The steam-piloted regulator has several design features that contribute to fast response. No stuffing box means that friction is negligible. The power available is large and the control and signal lines are short. Random load fluctuations are rapidly corrected. The result is a true cascade control system, offering finer control at less expense.

Instrumentation and other items that are common to both systems are not included. Only costs of the valves are considered.

Table No. 1 Size Comparison

	User 1	User 2	User 3	User 4
Steam Flow rate lbs/hr	3000	2000	5500	3500
Case 1 Conventional system				
Pressure reducing valve	1-1/4”	1”	2”	1-1/2”
Control valve	3	2-1/2”	4”	3”
Globe valve	1-1/4”,3”	1”,2-1/2”	2”,4”	1-1/2”,3”
Isolation valve	1-1/4”,3”	1”,2-1/2”	2”,4”	1-1/2”,3”
Strainer size	1-1/4”,3”	1”,2-1/2”	2”,4”	1-1/2”,3”
Case 2 Regulator system				
Regulator (replacing control valve)	1-1/4”	1”	2”	1-1/2”
Globe valve	1-1/4”	1”	2”	1-1/2”
Isolation valve	1-1/4”	1”	2”	1-1/2”
Strainer size	1-1/4”	1”	2”	1-1/2”

Scenario 1 represents the conventional system where 150 psi steam is supplied to each local pressure reducing station. As a convenient rule of thumb, the pressure drop allowed for the sizing of each control valve is 3 psi.
Scenario 2 represents the pneumatically loaded steam piloted regulator

Table 2 Cost Comparisons

	Scenario 1 Conventional	Scenario 2 Regulator
Pressure reducing valve	$2,232.00	$ ---
Control valve –positioner not included	$3,792.00	$2,720.00
Globe valves	$682.00	$57.00
Isolation valves	$1,203.00	$95.00
Strainers	$382.00	$54.00
Total cost	$8,291.00	$2,926.00

Note: care has been taken to keep these figures as conservative as possible. Under normal circumstances, the savings would be greater.
Not considered in this cost analysis is the labour and piping saved by not installing the extra station. In this instance that would have amounted to at least $1,100.00

EXISTING INSTALLATIONS

The foregoing text has probably suggested applications in which many of the favorable features of the regulator concept can be exploited even though a system is already in use. The following examples further demonstrate such applications.

1. If fluctuation of your supply pressure causes unacceptable quality of control, replacement of a conventional control valve with an air-loaded regulator will remove these disturbances. The cost will be less than an independent steam pressure regulator installed ahead of the control valve. We should always be suspicious of an installation featuring two or more valves in series. There are few cases where multiple duties cannot be performed by a single valve. Changing load conditions can also be remedied by utilizing the cascade control.

2. There are times when a valve positioner must be added to a control valve. If the valve is relatively small, it may be more economical to replace it with a pilot operated regulator.

3. If the duty on a process unit using low pressure steam has to be increased possibly larger equipment by operating at higher steam pressures. This may be accomplished by introducing higher-pressure steam through an air-loaded regulator;

4. Sometimes, due to expanded plant capacity or sudden load surges, the steam plant cannot always keep up with the demand and consequently, steam pressure drops. (Sometimes even causing boiler syphonage.) By adding a back-pressure pilot to the air loaded SPENCE regulator on non critical processes, they can be made to cut back, and if supply pressure continues to fall, even shut off completely.

LIMITATIONS?

The regulator concept is suitable to most process applications, but not all. The following is a review of its limitations:

1. There are times that cascade control is undesirable. Some processes require an independently regulated steam flow, regardless of load changes or other disturbances.

2. At the present time valves are limited to supply pressure of 600 psi and 500°F.