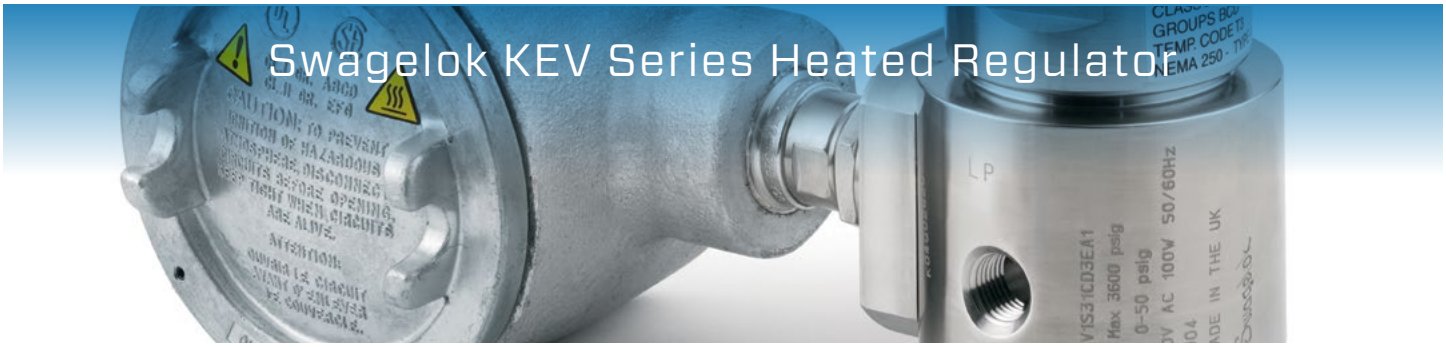
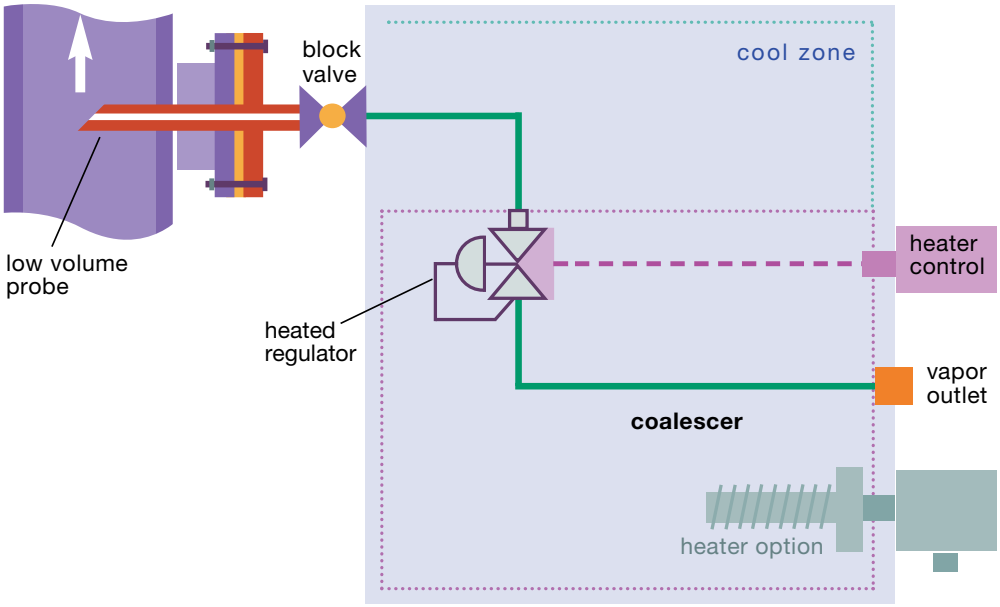


Maximizing uptime with Swagelok KEV Series Regulators

Sometimes it is necessary to transition from a liquid process stream to a vaporized sample stream so that the sample can be analyzed by a gas chromatograph. If the analyzer in an analytical system requires gas but the sample is liquid, the liquid must be converted to gas. This process is called vaporization.

Vaporizing samples can be difficult because the liquid sample must be converted to a vapor without changing the sample's composition. Vaporizing systems must be designed to avoid incomplete vaporization, fractionation and excessive time delay. Additionally, vaporizing equipment must remain reliable, even as differences in pressures along the flow path, ambient conditions, or operator inputs change.

The diagram (below) shows a typical system in which a vaporizing regulator is used. A regulator allows for introduction of heat into the system media. Heating is generally required as part of vaporizing a liquid sample or replacing heat lost after a drop in pressure for gas systems. Often vaporizing regulators are used within hazardous locations and must comply with strict safety requirements. If a regulator cannot adjust its outputs in line with system, ambient, or operator changes, there is risk that it will either malfunction or trip a thermal safety fuse, rendering the unit inoperable. Swagelok has recently updated our KEV Series Heated Regulator design to improve reliability and responsiveness by allowing for thermal feedback and adjustment to changing conditions.



Swagelok

Overshoot Following Flow Change

Vaporizing regulators are designed to work with the thermal load of the material they are vaporizing. Thermal load is a measure of how difficult it is to change the temperature of a material. A high thermal load is a very cold, high density, high flow rate liquid, requiring a large amount of energy to increase the fluid temperature. This can often lead to problems when the thermal load changes significantly during use. If the load drops dramatically (for example, if an upstream valve is closed), there may be excess heat within the body as the heater reacts to the change in demand. This excess heat may cause the thermal safety fuse to trip, permanently cutting off all power to the heater element. If the load increases (for example, if a flow control valve inadvertently opened too far), the heater controller reacts to avoid undershoot by quickly delivering more power to the heater. Often, this quick reaction will lead to a temperature overshoot which could, like the excessive heat due to a drop in the thermal load, lead to a thermal safety fuse trip. In both cases, the regulator will require maintenance or replacement before the system can be restarted.

The amount of power delivered to the Swagelok KEV Series Heated Regulator is proportional to how far the temperature is from the regulator setpoint, the amount of time spent above or below the setpoint, and the rate of change of the temperature. The KEV Series Regulator uses a Proportional Integral Derivative (PID) controller to manage the power level of the heater. PID controllers must be properly tuned to reach and hold the setpoint accurately, without a problematic temperature over/undershoot. To accomplish this, a functional model of the PID feedback loop was created. The model was refined and tested by simulating its response under a variety of thermal load conditions. The simulation results were then correlated with actual data. The result? The Swagelok KEV Series Regulator's well-tuned PID control loop reacts quickly to changes in thermal load without problematic over- or undershoots.

Ambient Temperature Effects

Often, a vaporizing regulator is not the only form of temperature control within an analytical system. It is common to see vaporizing regulators installed within heated enclosures. When designed correctly, vaporizing regulators will function well within their rated range in elevated temperature environments. However, enclosure heaters and vaporizing regulators are often installed close together within the enclosure. In the worst case, the regulator is installed directly above the heater. Since the energy from the heater will rise, the local temperature surrounding the regulator will be elevated. In steady state conditions, this may be acceptable, but if the regulator must react to a change in flow or thermal load, it will be difficult to shed any excess heat through the diminished temperature gradient. This can lead to overheating of regulators and blown thermal safety fuses, requiring maintenance or replacement before the system can be restarted.

The KEV Series Regulator adapts to these challenging environmental conditions. An automatically resettable, embedded thermal switch notifies the heater controller when an overtemperature condition is imminent. The controller responds to this signal by interrupting power to the heater. Once the thermal switch resets, the controller automatically adjusts power output to match system conditions and resumes normal PID control.

Operator Adjustment

Like all fluid systems, analytical sample systems which include vaporizing regulators must be initially adjusted and maintained on a regular basis for optimal performance. When a system is commissioned or restarted following maintenance, it is possible that operators may set vaporizing regulator power levels too high. While this will ensure that no liquid reaches the analyzer, it may cause sample fractionation and puts the regulator at risk of overheating. This problem is compounded by higher wattage heaters (greater than 150W). These higher wattage heaters leave less room for setpoint errors because the higher wattage can quickly overheat a regulator. This can result in thermal safety fuse trips, permanently cutting off all power to the heater element and requiring maintenance or replacement before the system can be restarted.

The ability of the KEV Series Heated regulator to control temperature depends on many factors. The quality of the temperature sensor feedback signal is a critical input. If the temperature difference between the sensor and heat source is too great, even the most sophisticated controller cannot provide an accurate output to the heater. This could result in a thermal safety fuse tripping. The KEV Series Regulator temperature sensor is embedded inside the heat source, which ensures the controller is receiving a high-quality feedback signal.

Conclusion

The improved design of the Swagelok KEV Series Heated Regulator can react to changing thermal loads, adjust power output to match system conditions, and can compensate for power levels. This keeps sample systems running well, maximizes your system's effectiveness, and minimizes costly downtime.

Learn more about how to add vaporization to a sample system, or view more Technical Resources.

For more information about the Swagelok KEV Series Regulator
contact your local sales and service center.