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Tech Notes
Product Development

Eliminating Need For Gas Preheat In Pressure Regulation

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Universal Vortex, Inc. offers proprietary technology that provides non-freeze pressure regulation of non-preheated gas. This substantially reduces or even eliminates energy consumption that is routinely required to preheat the high-pressure gas upstream of its pressure regulation. The UVI technology allows increasing the pressure regulated gas temperature-also without applying any external source of energy. The technique is based on using the proprietary self-heating vortex tube as a primary pressure regulator that follows with the energy redistribution in the pressure regulated gas.

The Vortex Tube (VT) is a specially designed cylindrical device with no moving parts. It takes high-pressure gas and, in the course of its depressurizing, converts (vortex phenomenon) the inlet gas flow energy into two low pressure streams — cold and hot — which exit the VT separately. The generated hot gas, prior to exiting the VT, is used to warm the unit's inlet orifice (spot heating) thus eliminating the likelihood of depressurized gas freezing (self-heating provision). Intensity of the vortex energy division depends on the ratio of the VT inlet and outlet pressures and is not affected by the gas flow rate through the unit.

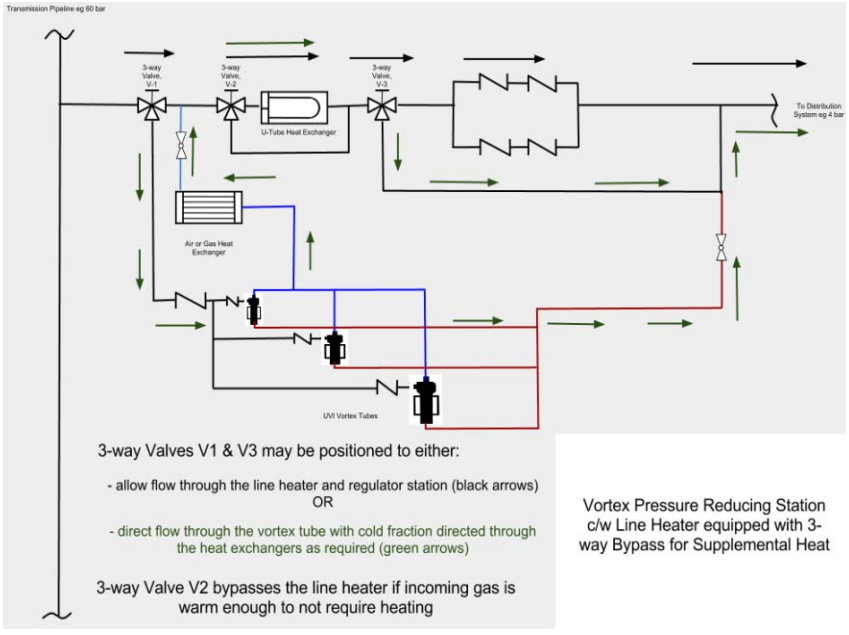
The concept design of the Vortex Pressure Regulation Station (VPRS) that retains the existing PRS is shown in Fig 1.

The VPRS consists of a number of identical VT set up in parallel. Since each VT has an inlet orifice of a fixed diameter ('no moving parts'), plurality of the VT provides for operations in a broad range of fluctuations of the VPRS inlet flow. Each VT has an upstream control valve (CV) that senses the delivery pressure downstream of the VT. Each CV has a distinct set pressure within the station MAOP, such that each VT begins to supply sequentially as demand increases. Similarly, as demand decreases each VT stops supply sequentially.

The pressure regulated gas temperature increase at the VPRS is achieved by removing (generally, dissipating into ambient air) the generated cooling duty from the VT cold outlet and then by combining the now warmed cold gas with the original VT hot outlet.

Two ambient air heat exchangers are required. They are in parallel and only one is operational at any time. When one becomes iced over due to condensation from the air, an automatic run switcher allows it to sit idle to let the ambient air melt the ice away.

The following example quantifies the benefits of the Vortex PRS



Vortex Pressure Reducing Station c/w Line Heater equipped with 3-way Bypass for Supplemental Heat

Conventional PRS

The gas inlet pressure and temperature are 850 psi (58 bar) and 45ºF (7ºC).

The required gas delivery pressure and temperature are 150 psi (10 bar) and 45ºF. A gas fired or electrical gas heater is required here to compensate the 45ºF (25ºC) Joule-Thomson temperature drop in the expanded gas. The energy consumed to preheat the gas at a PRS with capacity of 35MMscf/d is 2,487,700 Btu/hr. Assuming the market value of this energy $5 for 1MM Btu, the revenue a gas distribution company loses annually will amount to $109,000.

The amount of gas burned in gas fired Line Heater to generate 2,487,700 Btu/hr emits CO-2 at a rate of some 135 kg/hr i.e. almost 1,200 t/year.

Vortex PRS

The above station is converted to the Vortex PRS by adding single or multiple vortex run and a heat exchanger to dissipate the vortex cooling load. The self-heating vortex tube (vortex tubes) sized to take the whole station flow is set to discharge 60% of its inlet flow as the cold outlet and 40% as the hot outlet. The vortex cold outlet is heated by ambient air with seasonal average temperatures of 30ºF (-1ºC) winter, 50ºF (10ºC) spring/fall and 80ºC (26.7ºC) summer. A design thermal approach of the heat exchanger is 10ºF (5.5ºC).

Performance Data

The vortex cold and the vortex hot outlet actual temperature is -64ºF (-53.3ºC) and 80ºF (26.7ºC). The warmed vortex cold outlet seasonal temperatures are 20ºF (-6.7ºC) winter, 40ºF (4.4ºC) spring/fall and 70ºF (21.1ºC) summer. The weighted temperature of the combined warmed vortex cold outlet and the vortex hot outlet at the VPRS discharge is:

20ºF x 0.6 + 80ºF x 0.4 = 47ºF winter, 56ºF spring/fall and 74ºF summer. Accordingly: 8ºC, 13ºC and 23ºC.

Therefore, no upstream gas preheat is needed at the Vortex PRS, neither to maintain the gas pressure reduction non-freeze, nor to keep 45ºF (7ºC) or more at the Station discharge.

At the location with more severe ambient temperatures the vortex retrofit into existing PRS is secured by the available gas heater that will take over if the delivery gas temperature falls below a requested value. With this exception, the Vortex PRS will continue reducing the station operational cost and protecting the atmosphere. ***P&GJ***