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Improvement of gas pumping unit anti-surge protection system

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Abstract

The article discusses the issue of increasing the efficiency of the anti-surge protection by replacing the control seat valve with an axial valve to improve the reliability of the blowers, safe operation and increase the productivity of the compressor station.

Keywords: surging effect, anti-surge control system, centrifugal air blower, actuator valve, compressor station.

Аннотация

В статье рассматривается вопрос о повышении эффективности работы антипомпажной защиты, путём замены регулирующего седельного клапана на клапан осевого типа для улучшения надежности нагнетателей, безопасной работы и увеличения производительности компрессорной станции.

Ключевые слова: помпаж, антипомпажное регулирование, центробежный нагнетатель, регулирующий клапан, компрессорная станция.

Reliable and efficient operation of pipeline gas transmission systems is determined by ensuring the gas-dynamic stability of centrifugal blowers of gas-pumping units. A loss for various reasons of gas-dynamic stability, the centrifugal supercharger leads to a surge mode, which is characterized by intense fluctuations in the gas flow rate and pressure in the "supercharger-mains" system, which, in turn, often leads to accidents with major breakdowns of the centrifugal supercharger, the drive engine of the gas pumping unit and other equipment. To eliminate these phenomena and ensure reliable operation of centrifugal blowers of gas-pumping units, a design is considered with the help of which it is possible to regulate the gas supply and eliminate pulsations during the operation of gas transmission systems.

To protect the centrifugal blower from surging, gas bypass from the compressor outlet to its inlet is used in the amount required to avoid surging.

The compressor has a gas return line with an anti-surge valve, which returns the cooled gas to the receiving tank after the cooler at the compressor discharge.

The side stream from the discharge chiller of the pipeline booster is connected to the gas from the inlet separator in the dew point control module. In winter, this line maintains zero flow under normal conditions, but in summer this line is constantly used.

The recirculation flow to the inline booster compressor is controlled by an anti-surge control, capacity and speed controllers. This system operate the line pressure valve from the chiller of the pipeline booster compressor into a separator at the inlet of this compressor to prevent surge.

The suction pressure of the pipeline booster compressor is monitored by a pressure gauge that sends a signal to the anti-surge controller. [3]

The discharge pressure of a pipeline booster compressor also is monitored by a pressure gauge which sends a signal to the anti-surge control, capacity and speed control.

When compressors are running in parallel, the load sharing controller monitors the common suction manifold pressure by adjusting the load controller setpoints. The flow controllers provide signals to the anti-surge control system and to control the capacity and speed of the booster compressors. Flow controllers balance the compressors by equalizing the flow of each compressor. [6]

The anti-surge protection controller, based on the pressure and temperature parameters, flow rate on the suction line, pressure and temperature on the discharge line, as well as the temperature after installing the coolers of the air cooler, adjusts the degree of opening of the anti-surge valve thereby bypassing the gas into the receiving tank.

In a centrifugal compressor of a gas compressor unit, in addition to the main operating modes, unacceptable and unstable modes are also observed.

The compressor mode is called unstable if after any disturbance of the equilibrium state there is no recovery into working mode. And, conversely, if, after the disappearance of the disturbance, the initial regime is restored. [4]

The unstable operation of the compressor manifests itself in the form of a significant non-stationary gas flow in the compressor elements. The forces on the impellers, housing elements, bearings, couplings, etc. increase. which leads to serious breakdowns and sometimes complete equipment failure. Due to the uneven supply of gas to the consumer and the high probability of equipment breakdown, operation in such modes is unacceptable.

Surge is the stalling of the gas flow in the compressor with a loss of dynamic stability. The resulting fluctuations in gas flow and pressure can lead to equipment destruction. The surge phenomenon occurs when the pressure at the outlet of the supercharger is high and the gas flow through it is low.

Surge is a systemic phenomenon that can form in vane blowers in which the continuous flow of the supplied gas is disrupted and becomes irregular or pulsating. In the process, not only the compressor itself is under load, but also all other components of the system, namely: pipes, fittings, containers, tanks, couplings, etc. The phenomenon is usually accompanied by high radial and axial vibration, and large fluctuations in pressure and temperature at the inlet and outlet of the compressor. Strong claps and blows are also a sign of this phenomenon. Surge is typical only for axial and centrifugal compressors. [2]

Due to their design, axial flow control valves have a significantly higher flow capacity than conventional globe valves, allowing smaller valves to be used. Large flow rates can also be used to minimize pressure drop on a valve or for other purposes, such as special control characteristics, noise reduction, cavitation control, or expanding the control range to accommodate future process changes. [1]

The axial valve has a very rigid design, which, combined with the relatively small dimensions of the actuators, results in a low weight and compactness. These benefits increase with valve size and pressure class, which is of particular interest for offshore installations. The valve requires a small footprint to install, which reduces not only the risks associated with transportation, but also the installation and maintenance costs.

In a conventional globe valve, turbulence and high outlet speeds increase the risk of vibration-related failures. Multiple flow paths reduce trim performance and result in unbalanced trim forces.

The axial flow control valve body has a high pressure build-up rate so that energy conversion occurs only in trim. This favorably distinguishes such a valve from a conventional seated valve, in which part of the energy is converted in an uncontrolled manner in the body itself. The even distribution of the flow through the separator ensures effective noise reduction.

The noise level from the flow of the medium through the body is low, since by its very nature the design of the axial-type control valve helps to reduce turbulence to a minimum. The supporting ribs of the inner shell are streamlined and do not cause turbulence and associated noise. [5].

Compared to a seat-type valve, an axial-type valve has several advantages, namely:

- low noise during operation;
- small overall dimensions (light weight and compactness);

- high throughput;
- minimal possibility of leaks (all-metal body);
- reduction of flow turbulence due to the symmetrical flow of the gas flow.

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