

Study on Noise Source Analysis and Control Method of Gas Station

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Abstract: With the rapid development of economy, environmental issues have attracted more and more attention from all walks of life. As a new type of efficient energy, urban gas plays a vital role in promoting the healthy development of cities and mitigating urban air pollution. As the hub of urban gas, gas stations play the role of gas distribution, peak regulation and pressure regulation, and are necessary facilities for the safe and stable operation of urban gas pipeline network. With the increase of the number of urban gas stations, the noise problem generated by the stations is becoming increasingly prominent, which seriously affects the quality of people's life and social environment. Based on the analysis of the causes of gas station noise, this paper analyzes the noise control strategy of gas station.

1. Introduction

Gas stations are mainly used for gas transmission and distribution as well as peak and pressure regulation. Generally speaking, the gas station shall not be arranged too far away from the user, and the pressure regulating station in the gas station shall be arranged in the center of the load in principle. In view of this, gas stations are easily arranged in mixed areas of industry, commerce and residence. At the same time, with the rapid development of urban construction, many gas stations originally located at the edge of the city gradually migrate to the urban area, which makes the noise problem of urban gas stations increasingly serious.

In order to improve the environmental quality of the city and provide a comfortable living environment for residents, noise should be considered in the design of gas stations. Generally speaking, in the design of gas stations, the noise level at the place 1m away from the equipment is required to be less than 80dB-85Db. According to the analysis of the noise sources of gas stations, the noise control of gas stations can mainly start from the internal noise control and the external environment noise control.

2. Noise hazard

The gas station is mainly used for gas transmission and distribution as well as peak shaving and pressure regulation, so the location of the gas station shall not be too far away from the user, and the pressure regulating station in the gas station shall be arranged in the load center in principle. In view of this, gas stations are easily arranged in mixed areas of industry, commerce and residence. At the same time, with the rapid development of urban construction, many gas stations arranged at the edge of the city have gradually moved to the urban area,

which makes the noise problem of gas stations increasingly serious. In general, the noise hazards of gas stations are as follows:

- 1) The noise of gas production station exceeds the standard, and the complaint rate of surrounding residents is too high;
- 2) Being in a high decibel noise environment for a short time will have a serious impact on the central nervous system, hearing, memory and other aspects of the staff;
- 3) High decibel environment has a serious impact on the life and work of surrounding residents, especially for children. Sudden high decibel noise will cause irreversible damage to children's hearing;
- 4) The noise reduction of gas stations is generally carried out by burying or wrapping noise reduction materials, and the purchase, operation and maintenance costs of wrapping materials are too high;
- 5) High frequency noise will cause mechanical vibration in the station, damage the mechanical equipment in the station, and cause potential safety hazards, especially serious consequences after causing ground resonance.

3. Noise source

The noise of gas station is especially prominent in the high pressure station. The main equipment generating noise includes manifold, pressure regulator, pipeline, etc.

3.1 Noise generated by manifold

The manifold is a facility to connect valves and pipelines, and its main function is to distribute air flow. Therefore, in the complex air flow direction of the guild hall, severe turbulence will occur, and the gas entering the manifold from the branch pipe will scour the pipe wall violently.

Therefore, the manifold of the pressure regulating station is one of the main reasons for noise.

The cylinder and branch pipe form a header. The noise generated by the manifold is directly related to the diameter of the cylinder. The manifold is generally arranged in four ways, as shown in the figure below.

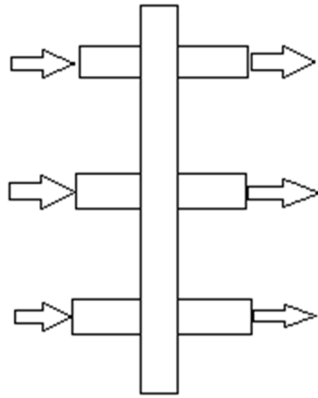


Figure 1 Layout Mode I

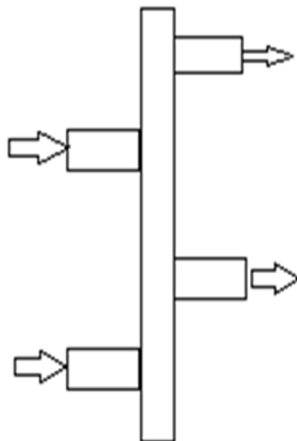


Figure 2 Layout Mode II

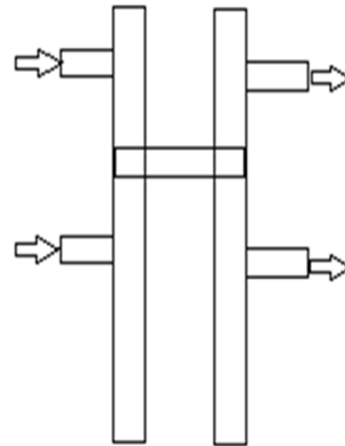


Figure 3 Layout Mode III

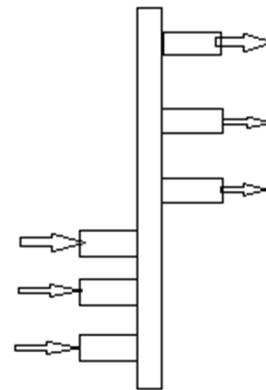


Figure 4 Layout Mode IV

3.2 Noise generated by voltage regulator

The pressure regulator can throttle and depressurize, which is mainly achieved by throttling. Therefore, the pressure regulator will generate a lot of noise, which is mainly composed of three parts, including hydrodynamic noise, aerodynamic noise and mechanical vibration noise.

1) Hydrodynamic noise

Hydrodynamic noise is mainly generated by the turbulence and eddy current after the fluid passes through the valve door of the pressure regulator. In short, the noise is generated by the interaction and friction between the fluid and the pressure regulator or the inner surface of the pipe.

2) Aerodynamic noise

Aerodynamic noise is generated when the natural gas passes through the pressure reducing part in the pressure regulator and the outlet expanding part of the pressure regulator, and the mechanical energy of the fluid is converted into sound energy. This noise accounts for a large part of the regulator noise. Aerodynamic noise can be reduced by taking certain measures, but it cannot be completely eliminated.

3) Mechanical vibration noise

Mechanical vibration noise refers to the noise generated by mechanical vibration, natural frequency vibration and fluid pressure fluctuation caused by oscillating displacement of valve core. The cause of this kind of noise is related to the design of the voltage regulator, parts and materials, processing technology and assembly quality.

3.3 Noise generated by pipeline

The pipeline is the most common equipment in the pressure regulating station. The main noise of the pipeline is caused by the friction and collision between the high-speed flowing gas in the pipeline and the inner wall of the pipeline. The faster the gas flow rate, the greater the noise. On the contrary, the slower the gas flow rate, the lower the noise.

4. Noise control

The noise control of gas stations can be divided into two ways: one is internal noise reduction, which is mainly to improve the materials and processes of facilities in the stations; The second is external noise reduction, mainly by burying pipes and wrapping noise reduction materials.

4.1 Internal noise reduction

The internal noise reduction of gas station mainly includes the noise control of outlet pipeline and equipment body.

1) Noise control inside the pipeline

In order to reduce the noise generated by the interaction between the inner surface layer of the pipeline and the air flow, noise reduction equipment can be set inside the pipeline to reduce the noise inside the pipeline.

2) Noise reduction in voltage regulator

The internal noise reduction of the pressure regulator generally adopts the method of installing a built-in muffler at the valve port. This kind of muffler belongs to the small hole injection muffler. The main principle is to use the gas from the high-pressure container to spray out through the small orifice plate on the base layer to reduce the noise.

The peak frequency of jet noise reduction is inversely proportional to the nozzle diameter, that is, the smaller the nozzle diameter, the higher the frequency of jet noise. On the contrary, the higher the nozzle diameter, the lower the frequency of noise energy radiated by the nozzle. Therefore, when the orifice is small to a certain range, the jet noise will also move to the frequency range that is insensitive to the human ear.

4.2 External noise control

The external noise of the pipeline is reduced by wrapping the noise reduction materials and burying the pipeline.

1) Noise reduction by applying sound absorbing materials outside the pipeline

Sound absorbing material is a kind of non-metallic material. Its sound absorption effect is very good, generally speaking, it is porous fiber. There are a lot of micropores and gaps in the material, and these small gaps form air channels. With the introduction of sound wave,

the sound wave vibration velocity between the inner wall of the pipe and the middle of the pipe is different. The internal friction caused by the velocity difference between the media converts the sound wave vibration energy into heat energy and is absorbed.

The laid sound absorbing material is about 5cm, which can solve the problem of noise absorption in a wide frequency range. Porous sound absorbing materials have a sound absorption characteristic, that is, high frequency sound absorption is better than low frequency sound absorption. In order to improve the sound absorption characteristics at low frequencies, the thickness of the material can be increased.

2) Noise reduction in station construction

The noise is transmitted by air and travels farther in the downwind environment. Therefore, the pressure regulating station shall be located at the downwind side of the residential area as far as possible to minimize the impact of noise on residents.

Another effective way to control noise is to bury the pipeline and place pressure regulating box in closed buildings or underground.

5. Summary

The noise of gas stations is generated in many ways. In order to reduce the noise effectively, a combination of various ways is required. According to local conditions and the actual situation, noise reduction measures combined with various methods are selected.

References

1. DAI, Jian-hong. Study about the problem of the factory boundary noise monitoring[J], Environmental monitoring in China, 2006 (2) : 34-36
2. WU Ren-yu. Discussion on noise monitoring inside boundary limitation of industrial area[J]. Environmental Protection in petrochemical Industry, 2006(3):33-35
3. MEN Juan-ning, DONG Shao-mou. Environmental noise pollution prevention and control law[J]. Shanxi Environment, 1996(4):12-13
4. Feifei Zhang, Xu Jian. Noise source and noise reduction measures of gas pressure regulating station [J]. Gas and heat, 2016, 36 (11) : B23-B25.
5. Ming Wang. Noise Reduction Engineering Practice of Natural Gas Pressure Regulating Box [J]. Gas and Heat, 2013, 33 (12) : A39-A42.
6. Qu Lei. Main Sources of Noise in Gas Transmission Station and Countermeasures [J]. Neijiang Technology, 2015, 36 (3) : 41-42.
7. LiZheng Yao, Analysis of Dangerous and Harmful Factors in Compressed Natural Gas Filling Station and Control and Prevention Measures [J], Jilin Labor Protection. 2010, 02; 49-50.

8. Chang Sun, Engineering Design of a Natural Gas Filling Station in a City [J], South China University of Technology.2013,11:1-68
9. Xia Ran Wang,Research on system configuration and operation energy saving of compressed natural gas filling station [J], Shandong Jianzhu University, 2013, 04:1-78