Feasibility Analysis of Distributed Variable Frequency Heating System

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Abstract. With the continuous improvement of people's economy and the development of urbanization, the energy consumption has also increased sharply. According to the data of annual research report on building energy conservation in China, the urbanization construction in China develops rapidly, the building area increases day by day, and the building energy consumption increases day by day. Therefore, the study of building energy conservation is particularly important, and the focus of building energy conservation is also on heating energy consumption. The application of distributed variable frequency pump in central heating system solves this problem well. Distributed frequency conversion system is also an excess of traditional heating and intelligent heating network. Whether the system can run economically plays an important role in the future development of intelligent heat network. It is also very important for the energy-saving operation of the present pipeline network. Therefore, this paper will analyze the feasibility of distributed variable frequency heating system.

1. Operation principle of distributed variable frequency heating system
Distributed variable frequency regulating system, that is, in addition to the main pump set in the branch, in other users installed variable frequency pumps, instead of balance valve or regulating valve, to meet the branch users of the resource pressure head at the same time can avoid the energy waste brought by the regulating valve. This not only solves the waste of resources caused by the most unfavorable loop in the traditional heating system, but also solves the problem of short heating radius in the traditional heating system. Compared with the traditional heating system, which USES the most unfavorable loop to configure the water pump, the distributed frequency conversion system makes each pump responsible for its own area. The design head of the boiler circulation pump is only responsible for the water circulation in the boiler, and each branch circulation pump is responsible for each branch. In this way, the regulating mode of heating system is changed from quality regulation to quantity regulation, and the heating quality is improved according to the demand, that is, the distributed variable frequency heating system.

2. Theoretical feasibility analysis of distributed frequency conversion system
As early as ten years ago, some people put forward the distributed variable frequency heating system, and some people implemented the scheme in these years. Compared with the traditional heating system,
the distributed variable frequency heating system has a slightly higher investment, such as energy saving, safety, economy and so on, which is superior to the traditional heating system.

On the basis of the traditional heating system, the distributed frequency conversion system replaces the original regulating valve with the frequency conversion pump. At the same time, heat source pumps and heat network pumps are installed in heat source, primary network and secondary network respectively. The heat source pump is responsible for the water circulation in the boiler room. At the same time, the heat network circulating pump will be set on the side of the primary and secondary network of each heat exchange station. Thus, the frequency conversion pump has formed a relatively new heating system and distributed frequency conversion heating system.

Although the number of distributed variable frequency system pumps is large, the early investment is high, but compared with the traditional heating system; its energy saving effect is very significant. The energy consumption of traditional heating system mainly includes one. The heat loss inside the boiler room; two. The heat loss of primary and secondary networks and each heat exchange station; three. Invalid heat caused by uneven heating and cooling of the thermal user and system. 4. The amount of invalid electric energy in the heat media transmission of the pipe network. According to the statistical calculation, these invalid electricity consumption as well as the invalid heat supply total energy in the proportion is very big. Compared with the traditional heating system, the distributed frequency conversion system can save about 40% energy in the aspects of water pump electricity and hydraulic balance

3. Economic analysis of the feasibility of distributed frequency conversion heating system

Undoubtedly, the above introduction of distributed variable frequency heating system is more energy saving than the traditional central heating system. Therefore, some enterprises have carried out the analysis of the economic benefits of the annual cost method and the payback period method. They have set up six heating schemes, the first is the traditional heating mode, the other five are the distributed variable frequency heating system, and the difference of the five heating modes lies in the selection of various pumps and the installation location of pumps.

3.1. Year Cost Method and Investment Recovery Period Method

Among them, the annual cost method is adopted in engineering economics.

\[ M = \frac{C}{N} + T \]

Formula M: Annual calculation cost of a project, yuan/a
C: Initial investment of a project, RMB;
T: Annual operating cost of a project, RMB/a

Investment payback period method: investment payback period = initial investment amount / first-period cash flow

3.2. Conclusion

The results show that the initial investment of the distributed frequency conversion system is almost the same as that of the traditional mode, but the operation cost will reduce a lot, and the annual calculation cost will also decrease a lot. Unlike traditional methods, the annual net income of distributed frequency conversion system is relatively low, and the corresponding profit recovery period will be extended. At the same time, the energy consumption of the distributed frequency conversion system will be reduced by almost 70% compared with the traditional heating system. At the same time, the larger the scale of the pipeline network, the larger the range of energy saving.
4. Technical feasibility analysis of distributed frequency conversion system and improvement analysis of traditional heating system

4.1. Technical Reform

At present, in our country, the heating forms and the layout of the heating network in all heating areas have taken shape. In order to quickly realize the application of distributed variable frequency pump in central heating system, it is necessary to reform the original heating system. Compared with the traditional heating system, the advantages of distributed variable frequency heating system are more prominent, such as good operation economy, high efficiency, easy to control and so on. However, distributed frequency conversion system is a flow system. In order to ensure the stable and energy-saving operation of the system, it is necessary to establish a relatively mature heat network monitoring system at the same time of transformation. Realize the monitoring, control, unified management of the heating system, as well as the diagnosis and treatment after the failure.

Taking Urumqi Xinxiang thermal power co., ltd. located in Urumqi new urban economic development zone as an example, in order to save energy and reduce emissions, and at the same time to improve the company's efficiency, the company has carried out distributed frequency conversion transformation for the heating system. The main reformation contents include: 1. Relevant reformation of boiler room, one furnace and one pump mode replacing the original parallel mode of main circulation pump, the working range of circulation pump only stays in the whole boiler room, and equipped with pressure equalizing pipe. 2. According to the calculation results of hydraulic conditions, frequency conversion pumps are installed on the backside water of primary network of all heat exchangers. 3. In order to monitor the data of the whole heat network in real time, it is necessary to establish a complete heat network monitoring system. The company has adjusted the monitoring system, system operation strategy and system safety strategy of the heating system, which can run stably. However, there are many problems in the operation of the system. Firstly, when the main circulating pump of the boiler suddenly stops running, the boiler is very easy to vaporize, resulting in extremely serious safety accidents; and if there is a large area blackout in the outer network, the flow of the outer network will be reduced quickly, so there are new requirements for the burning of the passage. Therefore, in order to ensure the safe operation of the system, some security strategies must be set up in the transformation of distributed frequency conversion. For example, a fault alarm system will be set up in the central control room of the monitoring system and a standby water pump during power outage.

The company's economic benefits after transformation are considerable, saving about 20% of coal and electricity every year. The problem of hydraulic imbalance in primary network has been solved, the complaint rate of users has been significantly reduced, and the heat balance rate has been improved. The transformation of distributed frequency conversion system has been successful.

4.2. Development of Modern Frequency Conversion and Science and Technology

Nowadays, some people begin to construct the intelligent heat network. To this end, we must understand what is intelligent and what intelligent heat network is. The so-called intelligent heating network, intelligent heating system should be composed of heating system, intelligent management system and intelligent control system of heating enterprises. Distributed variable frequency heating system is an important step to realize the transition from traditional heating to intelligent heating. It solves the problems of excessive usage of pressure head of traditional water pump, uneven cold and heat phenomena and low energy efficiency of heating system. Distributed transmission and distribution heating system of the whole network has remarkable effect of energy saving and energy saving, because of its remarkable active hydraulic balance, remarkable improvement of heat balance rate and prominent effect of energy saving and heat saving. Therefore, the application of distributed frequency conversion heating system is the inevitable trend of building energy saving in the future, and an important means of energy saving.
4.3. Application of Distributed Frequency Conversion Technology in Unmanned Thermal Station

Frequency conversion technology has developed rapidly, and now it has been applied to unattended thermal stations. In order to operate 24 hours a day and operate efficiently, economically and safely, distributed frequency conversion pumps can be installed in unattended systems controlled by intelligent heat networks. According to terminal calculation and previous experience, the optimal water supply temperature is obtained. Finally, the flow rate of primary pipe network is adjusted by frequency conversion pump, which makes the water supply temperature of secondary network side close to the calculated optimal water supply temperature. While satisfying the heating demand of users, it also ensures the heating quality, economic operation and optimal working conditions. Therefore, the system can maintain a high heating quality while saving human resources, save a huge expense for their company. So the application of distributed frequency conversion technology can improve the heating efficiency of the system, improve the quality of heating, improve the safety performance of the system, heating on demand, energy saving and emission reduction, which is of great significance.

5. Feasibility analysis on security of distributed frequency conversion system

With the acceleration of urbanization construction in China, large-scale heating pipe network or super-large heating pipe network is gradually taking shape. Because the pipeline network of central heating is buried underground for a long time, there will be many pipeline parts in the whole pipeline network. In the long-term use process, pipelines and equipment will certainly have more or less problems, so the safety of pipeline network operation cannot be ignored. Distributed frequency conversion heating network can take the point of zero pressure difference as the control variable, and the control system can control the speed of frequency conversion pump to adjust the zero pressure difference, so the operation adjustment is simpler and more convenient. It has good controllability, thus improving the safety of the whole pipeline network.

5.1. Distributed Frequency Conversion Applied to Stability Analysis of Central Heating System.

When the required flow rate decreases, the traditional system adopts valve throttling, the total impedance of the network increases, the total flow rate decreases, and the characteristic curve of the pipeline network becomes steeper, and the operating point changes. When the main flow rate decreases, the backpressure at the zero pressure point in the distributed system increases, the frequency modulation of the main circulation pump reduces the speed, and the characteristic curve of the pump changes accordingly. The variable speed regulation of the pump cannot only reduce the pressure. The loss of pressure head can also expand the efficient working area of the pump to ensure that the pump still has high efficiency when the flow rate changes greatly. The hydraulic stability of each user has been greatly improved by using the distributed frequency conversion system. Therefore, if the design of the pipeline network system is reasonable, the hydraulic stability of the system can be effectively improved by using the frequency conversion pump instead of the original control valve. Because of the complexity of the pipeline network, it is often necessary to use valves to regulate the frequency conversion pump in practical engineering. The frequency conversion pump cannot completely replace the control valve.

Compared with the traditional valve regulation mode, the hydraulic stability of the pipeline network has obvious advantages in the distributed frequency conversion regulation. In actual operation, the combined use of control valve and frequency conversion pump can solve the problem of hydraulic imbalance in the pipeline network to the greatest extent and enhance the stability of the pipeline network.

6. Application and future prospects

The building types of central heating system services include public facilities, commercial buildings and industrial buildings. For some buildings, such as school dormitories and other buildings, which are inseparable from human life, they can be divided into continuous heating buildings. There are also some buildings, such as office buildings, but in a certain period of time there will be people inside the building can be divided into intermittent heating buildings. For continuous heating buildings, the frequency conversion heating system can adjust macroscopically according to the different needs of each heat user,
and then improve the heat balance. At the same time, thermal users can also adjust the flow rate of the pump according to their actual needs. Intermittent heating building can set a time period through the background of the system. In this specific time period, the building enters a low flow and low temperature state, thus avoiding waste of resources and saving energy. Therefore, how to adjust the flow rate and flow rate of hot water is very important, and it is the key to heat distribution in the future.

Since the 11th Five-Year Plan, the Ministry of Housing and Construction has begun to implement the reform of heating metering and charging, and the remote data acquisition and management platform of heat meters has been widely used. Thermal users can control hot water flow and room temperature according to their actual needs. At the same time, the heat meter is set in the heat user pump, and the hot water usage of each heat user is counted and charged according to the quantity. In this way, the system can not only carry out heat balance analysis, accurate statistics, and improve the enterprise's charging rate. It can also constrain hot users to further conserve resources.

7. Conclusions and suggestions
For the distributed variable frequency pump heating system, it is the key to connect the intelligent heating network with the traditional heating system. From its operation principle analysis, it is on the original traditional heating system that the frequency conversion pump replaces the control valve, distributes the flow reasonably, and saves the excess energy consumption brought by the control valve and other facilities. It can solve the problem of thermal and cold imbalance, thus saying goodbye to the energy waste phenomenon of large flow and small temperature difference similar to the big horse trolley. From the economic point of view, distributed variable frequency heating system needs to arrange a large number of variable frequency pumps, whether it is supply and return water pressure pump or user-side pressure pump, which are indispensable in the system. At this time, the design of the system will require high requirements for hydraulic calculation, installation location, head selection and operation efficiency of the frequency conversion pump. Moreover, the investment in the early stage will be very large, and the investment life will be relatively long. In order to realize intelligent heating as early as possible, it is necessary for heating enterprises to exchange and adjust data, complete large data calculation, and make frequency conversion heating more effective and economical energy-saving operation. From the point of view of safety, compared with the traditional central heating mode, the distributed variable frequency pump system replaces the control valve or adjusts with the control valve at the same time. Therefore, it is very important to timely overhaul the various pressurized frequency converter pumps. At the same time, the simultaneous operation of frequency conversion pump and control valve will solve the problem of hydraulic imbalance in the pipeline network and enhance the stability of the system. For the future development of distributed frequency conversion system, this paper mentions that the main breakthroughs are how to accurately regulate the flow rate, to maximize the energy utilization of hot water, and charging by volume.

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