Problems Existing in the Operation Energy Saving of Central Heating Pipe Network and Solutions

Xue Lv, Junfeng Qi and Lingyue Zhang
College of municipal and environmental engineering, Jilin Jianzhu university, Jilin, Changchun 130000, China
Corresponding author: 820640560@qq.com

Abstract: In recent years, in the country vigorously advocate energy conservation and environmental protection call, all industries have made a positive response. As the largest part of the building energy consumption of the largest consumer of social energy, central heating energy saving operation will be a difficult task facing us at present, and the energy saving of heating pipe network is just an important link that cannot be ignored in the energy saving of heating system. Therefore, this paper will mainly discuss and analyze the energy consumption links existing in the pipe network of central heating system, and put forward the corresponding optimization and transformation measures.

1. Introduction
As an essential part of winter life in northern cities and towns, central heating system provides comfortable and comfortable thermal environment quality for people to live in and brings many benefits to people's life. However, as a bridge in the transportation process of the whole heating system, the pipe network is not only large in scale, but also complex in network and each transmission and distribution link has serious heat loss, serious energy waste in operation, low heat transfer efficiency, and a wide range of influence. Therefore, in the context of the era of equal emphasis on conservation and development, this requires us to make full use of energy, reduce the loss of energy, and achieve the strategy of sustainable development of our country.

2. Problems and analysis of central heating pipe network system in China
With the acceleration of urbanization, the central heating industry is developing vigorously, but there is still great room for improvement in China's heating industry. According to the data, the efficiency of outdoor pipe network in foreign countries can reach 92-95%, while that in China is only 70%. Compared with foreign countries, the heat loss of outdoor pipe network in China has not only heat preservation loss, but also serious unbalanced loss and leakage loss. All the time, the phenomenon of system water loss and hydraulic maladjustment has not been well solved. The heat transfer efficiency of heating pipe network is low, and the energy consumption remains high.

2.1 Analysis of unbalanced loss of heating pipe network
(1) Reasons for design and construction. Firstly, the design of heating pipe network system should strictly follow the requirements of hydraulics, thermodynamics and relevant specifications, and then select reasonable pipe materials and application equipment. However, in the design process, designers are often used to use a certain "safe" coefficient, which is easy to lead to unreasonable pipe diameter design, circulation pump, flow control valve selection, and so on, hydraulic changes will produce large
fluctuations, causing unbalanced phenomenon. Secondly, in the process of construction, it is easy for the construction personnel to arbitrarily change the construction path and system connection mode based on their own work experience, which increases the resistance of the system and leads to hydraulic maladjustment.

2) Reasons for operation and maintenance. At present, the management mode of each heating unit is more extensive management of equipment. It seldom takes into account the increase or decrease of the number of users in the system and the change of the heat used by users. Often, these small changes will lead to the change of pipe network flow rate and the change of pipe network flow resistance characteristics, thus leading to hydraulic maladjustment. Secondly, in the operation of the pipe network system, some pipe networks may suffer from corrosion, damage, wear and tear of accessories, or even failure. However, due to negligence, timely maintenance is unlikely to occur, which leads to the increase of resistance coefficient of the pipe network and damages to the original balance.

2.2 Leakage loss analysis of heat grid

1) Poor construction quality. In the process of construction, the heating network cannot meet the minimum laying depth in accordance with the standard provisions when it adopts the straight buried pipe without compensation, improper welding occurs at the pipe joints, or the pipe trench or directly buried with substandard inferior pipe materials and accessories, and the treatment method of overhead is adopted, and the drainage is serious after operation.

2) Insufficient supervision of heat supply. In the process of pipe network operation, secondary network leakage is more serious. In order to maintain the pressure required by the pipe network, some workers tend to directly refill the water in the secondary network with serious water loss according to their own work experience without authorization according to the rules and regulations. Secondly, due to the wide range of pipeline laying and easy corrosion and aging, failure to timely maintenance and management can easily lead to the occurrence of running, running, dripping and leakage, which brings losses to energy.

3) Users have vague knowledge of heating. During winter heating, each user's home often appears the phenomenon of uneven heat and cold. Low-temperature users will use the valve to drain water in their homes, resulting in increased water consumption of the system. Come so, not only won't change indoor temperature to bring bigger burden to heating pipe network system instead.

4) Water theft by users. Some hot users secretly put hot water in radiator for economic convenience or connect a pipe directly from the top of radiator to use for washing clothes and mopping the floor in daily life. Even some bathrooms, car shops and restaurants directly use hot water for bathing, washing cars and plates, resulting in increased water consumption of heating system.

2.3 Analysis of pipe insulation loss

1) Defects of insulation materials. At present, rock wool is the main material of insulation layer of outer network in China. It is soft and light, but the process is complex, its permeability is poor. After a long time of accumulation, water is easy to accumulate in the rock wool board, causing insulation layer to fall off, resulting in a lot of heat waste.

2) Improper selection of insulation thickness. Generally speaking, as the thickness of insulation layer increases, the thermal resistance increases, the heat loss decreases, and the heat preservation effect increases. However, the thicker the insulation layer, the higher the initial investment, so it is necessary to determine the reasonable thickness of insulation layer.

3) Backward pipeline laying mode. At present, the main laying way of central heating pipeline in China is trench laying. It can protect the pipeline not only from external force and water erosion, but also meet the requirements of environmental protection and beautiful, but its corrosion and insulation performance is poor, the phenomenon of water accumulation in the pipeline is often occur, serious heat loss, thereby increasing the heating load. In addition, there are some difficulties in the maintenance and management of pipe trench laying mode. Once the problem is found, a large amount of manpower and material resources need to be wasted, and the operation cost is relatively high.
2.4 Analysis of power consumption loss of pipe network

(1) Power waste caused by power consumption equipment in the heating system. Some data show that central heating or central air conditioning in the total energy consumption of large energy consumption is the pump or fan, accounting for about 40%. It can be seen that the power consumption equipment is a significant part of the power consumption loss, which brings about a large loss of energy.

(2) The operation mode of large flow rate and small temperature difference causes the waste of electric energy. In order to ensure that the indoor temperature of each hot user in winter can reach the optimal heating temperature, most heating units will adopt the method of improving the circulating pump power and increasing the circulating flow of pipe network to ensure the heating effect. In this way, not only increased the power consumption of the circulation pump and indoor temperature high user home will open the window heat dissipation, heat will be lost with the window, for us to bring a great waste of energy.

(3) Power waste caused by unreasonable design. Due to the conservative principle of most designers, it is easy to lead to the phenomenon of large circulation pump type selection and unreasonable number of sets. At the same time, the operation condition of multiple devices in parallel is not clear, and the control scheme is not ideal, which will lead to reduced operation efficiency and increased energy consumption.

(4) Power waste caused by increased resistance of equipment. In the long running pipe network system, the equipment is easy to wear out, rust, flow resistance increases, water pump power consumption increases.

3. Optimization and improvement measures for the existing problems of heating pipe network

3.1 Measures to solve hydraulic maladjustment of the system

(1) Each unit shall design the pipe network in strict accordance with the standards, and it shall not estimate the pressure head resistance of each loop, especially the resistance balance of the spur line, due to the heavy workload and tedious process of calculation. In order to ensure the accuracy of hydraulic calculation, the pipe diameter should be constantly adjusted to keep the unbalanced rate within the specified range.

(2) Self-supporting flow control valve, self-supporting pressure balancing valve and balancing valve are set at each heat user, heat exchange station or branch of pipe network, so as to timely adjust in case of hydraulic imbalance, and make initial adjustment to eliminate the remaining pressure heads existing in each loop before the system is put into operation.

(3) Each terminal device is equipped with a temperature control valve, and users can fine-tune the pipe network according to their comfort. In this way, it avoids the fuzzy adjustment of management personnel according to their own work experience and saves the loss of excess heat in the user's home.

(4) Use the computer monitoring system to set up special wires, auxiliary spare parts and networking equipment in the insulation layer of the directly buried pipeline. Operators can understand the running state of the heating system in real time according to the monitoring system, grasp the main operating parameters, timely and effectively adjust the system in case of problems, and improve the level and quality of heating.

3.2 Feasible measures to reduce system water loss

(1) Strengthen construction supervision. The selection of pipe materials and fittings as well as the minimum soil depth of non-preheating and non-compensation directly buried pipeline must comply with the relevant national standards. It is strictly prohibited to use inferior products and unqualified technology for construction.

(2) Strengthen the inspection work in the early stage of heating. Before the operation of central heating system, professionals should be regularly assigned to double-check the heating pipe network. The joints of reserved pipe sections must be welded to death with blind plates. Timely maintenance
and management should be carried out for pipes and accessories with running, rising, dripping and leakage phenomena to avoid water leakage and leakage during operation.

3) Set up personnel training system. Some heating company employees may have a strong sense of responsibility, low level of operation, technical quality cannot meet the requirements of the phenomenon. All heating companies should regularly carry out personnel training, enhance the sense of responsibility and practical ability of employees, improve their understanding of heating theory, can quickly find the cause of the problem and put forward effective measures to solve it.

4) Increase publicity. All heating departments should make full use of various media to publicize education, enhance users' heating common sense and moral education, and let users understand the harm of water loss. System water loss will not only affect the quality of heating, heating effect is not ideal, but also after the treatment of the heating water will cause harm to the human body, fundamentally prevent the occurrence of water theft by users.

5) Add additives to the pipe network system. Additives require color or special smell, do not cause harm to the human body. Or join the scale inhibitor that has weak alkaline color, can protect conduit already, can prevent a user from stealing water from the source again, when necessary still can take certain penalty measure.

3.3 Solutions to improve insulation problems
(1) Choose high-quality insulation materials. Using polyurethane instead of rock wool as insulation material, not only is the construction simple, will not cause harm to the construction personnel, but also polyurethane water absorption rate is low, low thermal conductivity, heat loss is only 1/4 of the traditional pipe material, insulation effect is better than rock wool.

(2) Reasonably determine the thickness of insulation layer. Insulation layer thickness of heating pipe should be calculated according to national standards, and economic thickness should be chosen as the priority. For pipes with special technical requirements, the thickness of insulation layer should be determined clearly according to the process conditions.

(3) Adopt correct pipe laying method. At present, prefabricated direct burial technology has been widely used in China. Adopting modified polyester as insulation material and high-density polyethylene as protective shell, it is not only easy to operate, occupies a small area, but also has good tightness, good insulation performance, and reduces certain heat loss of pipes. Long-term operation can greatly reduce costs and save a lot of energy.

3.4 Measures to solve power consumption problems
(1) Adopt distributed frequency conversion system. Most of the electricity is due to the user's home water flow and flow requirements are not consistent, resulting in a great imbalance caused by the loss. At present, we use distributed frequency conversion system to improve this kind of problem, that is, the transmission to adjust the speed of the pump, control the output flow, reduce the power loss of the main circulation pump, so that it can work normally under low pressure, to ensure the safety and reliability of pipe network operation, improve the quality of power supply.

(2) Correct selection of pump capacity and operation mode. The calculation of circulating pump capacity should take into account the heat load of all users in the pipe network, so it cannot be estimated. When multiple parallel pumps are in operation, the operating point of the pump should be drawn and whether it meets the operation requirements should be considered. Because each parallel on a device, the flow increase is smaller, the worse the effect, so should try to choose a single pump operation, one standby.

4. Summary
As a people's livelihood project, central heating optimization design is of great significance to us. Therefore, we should reduce the energy consumption in the operation of the pipe network, improve the heating efficiency of the pipe network and ensure the heating effect of residential areas under the requirements of the national energy-saving development strategy of central heating. Protect the living
environment around us and promote the development of China's green economy.

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Reference
[1] Jikai Han.(2016) Analysis on energy-saving and consumption reduction measures of urban central heating operation management. Urban planning.80.8phase.
[2] Zhanggang Liu.(2011) Energy-saving transformation and heat transfer analysis of heating pipe network. Master's thesis. Qingdao university of technology.
[3] Xiaoyan Liu.(2016) Problems and solutions of heat preservation in central heating pipe network. Science, technology and engineering. Volume 10, issue 18.
[4] Tao Ming.(2010) Analysis on energy saving of central heating network system. Wind of science and technology. 20.
[5] Chunying Zhu.(2010)Research on energy-saving technology of a central heating system and analysis of improvement measures. Master's thesis. School of environmental science and engineering, Tianjin university.