CHAPTER «ENGINEERING SCIENCES»

ANALYSIS OF ENERGY-EFFICIENT AND ENVIRONMENTAL TECHNOLOGIES IN THE FIELD OF HEAT SUPPLY

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Abstract. This paper takes the rational introduction of energy-saving and environmental protection technology in the field of heating as the theme. **The purpose** of the paper is to aiming to improve the ecological security of urbanized areas. The monograph makes a comprehensive analysis of energy-saving and environmental protection technologies in the field of heating, and analyzes in detail the pollutants produced by urban energy facilities in the heating process and their impact on the environment; discuss the latest research progress of central heating, and how to promote the sustainable development of central heating system through technological innovation; at the same time, the current situation of pollutant emission of central heating boilers is analyzed, the existing pollutant control technology is evaluated, and its improvement space is discussed. The technical progress of heating boilers in energy conservation and environmental protection is evaluated, and its contribution to urban ecological security is discussed. The negative impact of public energy system on the environment is discussed, and the corresponding environmental technology solutions are put forward. Finally, the development status of low-carbon heating

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industry at home and abroad is summarized. **Results** of the analysis can be used for the actual implementation and effectiveness evaluation of various environmental protection and energy saving technologies, and provide industry background for many researchers. **Practical implications.** Through the comparative study of domestic and foreign heating industry, it provides certain help and reference for improving energy conservation and environmental protection in the field of heating in various countries. **Value/originality.** In this paper, the advantages and disadvantages of common heating methods and their economy are compared.

1. Introduction

In today's world, climate change, environmental deterioration, resource shortage, rapid economic growth in recent years, all aspects of people's life have been promoted and improved to a certain extent, but followed by some environmental and energy-related problems are becoming increasingly serious, we need to strengthen the attention to energy shortage and environmental pollution, how to save and make full use of energy has become the first issue to be considered.

In some cold northern areas, the heating method is mainly the traditional burning boiler heating method, but the heating method in the heating boiler has a large degree of pollution to the ecological environment, and often produces a lot of waste gas and smoke when it is applied. Although these waste gas and smoke spread slowly in the winter when the temperature is low, the pollution degree is still relatively large. The flue gas pollution of heating boiler has become an important part of treatment at present. In addition, although the collective heating method of heating boiler has certain economy in application, it often needs to consume a lot of resources, and may cause serious damage to the environment. Coal combustion in heating boilers will produce flue gas, in which there are usually many pollutants, such as nitrogen oxides, sulfur oxides, etc., which not only destroys the urban environment, but also threatens people's health, which is contrary to the construction of ecological civilization at the present stage.

With the large use of clean energy natural gas, natural gas cogeneration and gas boiler heating have become an important heating method in cities. The heat released by the combustion of natural gas in the boiler will not be fully used, so some loss will inevitably occur. The smoke exhaust loss is

the biggest one among the heat loss. If the heat in the flue gas emission is recycled, the thermal efficiency of the boiler can be improved, which is of great significance for energy saving and emission reduction. In addition, the gas boiler NO_X emission problem has aroused people's high attention, how to control NO_x emission is imminent, through the deep utilization of flue gas waste heat and denitrification integrated technology application research and analysis, get the technology and conventional scheme in energy saving and environmental benefits. Finally, it is concluded that how to reform and apply the technology of flue gas waste heat utilization in heating gas boiler.

2. Analysis of urban pollution by energy facilities

Human beings are inseparable from the environment. The environment provides renewable energy and non-renewable energy to supply various activities of human beings. The corresponding activities of human beings have caused a certain amount of energy waste and consumption, destroyed the natural environment to a certain extent, and caused a certain amount of pollution. While using energy, the environment and pollution control have been changed to some extent. All these constitute the dynamic model between environment, energy and pollution control.

Nowadays, the environmental problems are mainly manifested in urbanization. It is necessary and urgent to have a reasonable urban environmental management mode. The social phenomenon caused by environmental problems is common, the most important is water pollution, there are many enterprises regardless of the cost of the environment, in the case of not conforming to the national standards and norms, the production of all kinds of unqualified products, pollution production, pollution discharge is far beyond the standard and so on, which leads to the current situation of energy and pollution. For the present enterprise sector, enterprises should pay attention to their own clean production, abandon the traditional terminal governance model, the whole process of enterprise clean production control product life cycle process, relatively stable, significantly reduce the amount of pollution production, pollution discharge is also significantly reduced, resource utilization rate increases, resource consumption decreases, product output increases, product cost decreases, There has been a marked increase in economic returns and almost no transfer of pollution. Cleaner production by enterprises is beneficial to the whole society and to people's housing.

And we know that the end of the treatment, the amount of pollution production, pollution discharge is also more, the utilization rate of resources is low, the increase of resource consumption, the decrease of product output, the increase of product cost, these are not comparable to clean production.

3. Research status and development of district heating

The overall goal of district heating is comprehensive satisfaction of economic benefits, environmental benefits and social benefits. Economic, environmental and management factors determine the development mode of district heating [1]. Due to the different geographical location, energy structure and economic conditions, each country takes different heating methods according to the actual situation of the country, in order to meet the heat needs of different users. This section introduces the development and current situation of heat supply in the United States, Russia, Denmark, China, Japan and South Korea from the aspects of energy structure and heating methods.

3.1 Development status of European and American countries

European and American countries started earlier and experienced the stage of simple management, infrastructure, comprehensive development and automatic control [2]. After the 1970s, Denmark, Norway, Russia, Poland, Germany and other countries began to develop multi-energy heating, natural gas, fuel oil, waste, biological energy, heat pump technology and other applications in urban central heating, has achieved significant economic, social and environmental benefits. European and American developed countries pay attention to the development and application of intelligent control technology of district heating, leading the industry [3; 4].

The United States is the first country in the world to use district heating, but because of its vast land and sparse population, American families have the characteristics of scattered, so the family heating mode is basically distributed. American residential and villa buildings basically use individual heating devices, and apartments generally set up boilers in front of the building to heat the whole apartment. According to the 2015 residential energy consumption survey data released by the U.S. Energy Information Administration, the vast majority of households in the United States use gas furnaces, electric furnaces or heat pumps as winter heat sources. At present, the United States mainly uses natural gas, electricity and

petroleum as heating fuel. The winter heating fuel consumption (2015) calculated by the United States Energy Information Administration shows that natural gas accounts for 47% of heating, electricity for 40%, oil for 5%, propane for 5%, wood fuel for 2%, and other energy sources l %. According to the U.S. energy and climate strategy, renewable energy heating will also be a necessary part of the U.S. fuel diversification strategy in the future [5; 6].

Russia is affected by geographical factors, most areas of the climate is cold, the heating period as long as 7 months, also relatively perfect. Therefore, Russia's heating industry is relatively developed (Russia attaches great importance to the development of heating technology). The district heating technology of Russia (including the former Soviet Union) was born in 1903, and it is one of the earliest countries to develop district heating. The former Soviet Union has been taking thermal power plant heating as the main technology development policy, 70% of the national industrial and civil annual total heat supply by thermal power plant and regional boiler room central heating, among which Moscow's central heating system is the world's largest central heating system, the city's heat supply penetration rate is close to 100%, there are a lot of experience in heating intelligent control technology worth learning. At present, the Russian city to central heating, thermal power plant as the heat source, has a relatively perfect heating network. The main district heating in Russia is in the city, while the proportion of rural district heating system is small. According to the statistics Bureau of Russia, in 2016, the central heat supply rate of urban Russia was 84.3%, and the central heat supply rate of rural Russia was 17.7%. The heating fuel is mainly natural gas, with a smaller proportion of coal.

The technology of district heating in Ukrainian cities has developed rapidly, from artificial steam and lime water heating to heat from gas combustion. With the development of technology, Ukrainian cities are now also beginning to introduce new energy technologies, such as solar energy, geothermal energy, biomass energy, etc., in order to promote more sustainable urban heating facilities. In addition, Ukrainian cities are investing in the development of infrastructure to improve the quality and reliability of heating while reducing energy consumption. In general, the development of district heating technology in Ukrainian cities is in good shape, and it is now beginning to introduce new energy technologies and invest in infrastructure

development to gradually promote the transformation of the energy mix. The future development will also be in a more sustainable direction to provide reliable heating services for the local people.

Germany's heating technology is relatively advanced. In 1972, it began to study heat metering technology and heat meter detection technology. The establishment of intercity heating system and heat metering has entered a mature period of private participation in services. Nordic countries started heating supply early, with large investment, excellent equipment, mature technology, perfect control means, stable operation of heating system and good effect.

Denmark is a country lacking in natural resources, with few minerals other than oil and gas, and has been suffering from climate problems since the 1990s. Therefore, in order to reduce the dependence on fossil fuels, improve energy efficiency, and reduce CO_2 and other pollutant emissions, regional energy systems have great potential. The Danish government is also vigorously supporting the development of regional district heating system, and vigorously developing renewable energy [7, 8]. Currently, nearly 50% of Denmark's heating needs are provided by district heating systems [9]. According to Statistics Denmark, district heating in Denmark accounts for 53.2%; Central heating accounts for 36.58% of the total, and most of the thermal energy is provided by thermal power plants, forming a renewable energy situation dominated by cogeneration and combined with wind energy, bio-energy, tidal energy, solar energy and a small amount of fossil fuels. Denmark is one of the world's earliest and most remarkable countries in the development of renewable energy. The integration of renewable energy in district heating systems is the most important objective still to be achieved.

From the perspective of the development of the district heating system in these countries, except Russia (Russia has a vast area and small population, and even if the city size is the same as that of China, the urban buildings and population density are not as good as China's, and the volume of China's district heating system is larger than that of Russia), the UK (if the energy supply in the UK reaches the goal of decarbonizing, District heating should be adopted more widely in the UK) [10–12] and a few other countries have developed similar heating development to China, but other countries have developed decentralized district heating or household heating. In addition,

the heat source of the heating system in European and American countries is mostly natural gas, various oil products and renewable energy.

3.2 Development status of Asian countries

In recent years, China's district heating has developed rapidly. Both the heating capacity and the scale of the heat network have increased greatly. The popularity of district heating and its application areas are becoming more and more extensive. But behind the rapid development of district heating, there are also some problems, among which the most prominent problem is the high energy consumption of heating system in China is 2 ~ 4 times that of Europe at the same latitude. There are three main reasons: first, the insulation of the enclosure structure is poor; Second, the operation efficiency of the heating system is not high, the transmission energy consumption is high, the heat user regulation mode is not good, leading to the problem of overheating and underheat exists at the same time, the heat waste phenomenon is more; Third, the efficiency of heat source is generally low, the heat source heating capacity does not match the demand of heat users, the operation scheduling needs to be improved, and the heat supply planning and decision-making lack theoretical guidance and support. Another problem that cannot be ignored is the increasingly serious environmental pollution caused by central heating. In China, coal-fired thermal power plants and regional coal-fired boiler houses are used as central heating sources, and the emission of various pollutants caused by coal burning accounts for a high proportion of the total emission, as shown in Figure 1.

Pollutant monitoring data also show that a large amount of coal burning in the heating period poses a great threat to the urban ecological environment. Not only is the content of SO_2, NO_x and Total Suspended Particle (TSP) in the atmosphere significantly related to a large amount of seasonal coal burning, but also the health status of urban residents is affected by this. Heavily polluted cities have seen an increase in the prevalence and mortality of respiratory diseases. According to the monitoring data of environmental monitoring station in Urumqi, Xinjiang, China, the concentration of SO_2 in the atmosphere in the city's heating period once reached 15 times of that in non-heating period, and the concentration of NO_x was nearly 2 times of that in non-heating period. In addition, the greenhouse gas CO_2 has become the focus of the world. At present, China's annual CO_2 emissions

exceed 6 billion tons, surpassing the United States. As can be seen from Figure 1, CO_2 emissions from coal burning account for about 85% of the total emissions. Therefore, how to reduce CO_2 emissions from heating system has become one of the keys to successfully achieve greenhouse gas emission reduction in China.

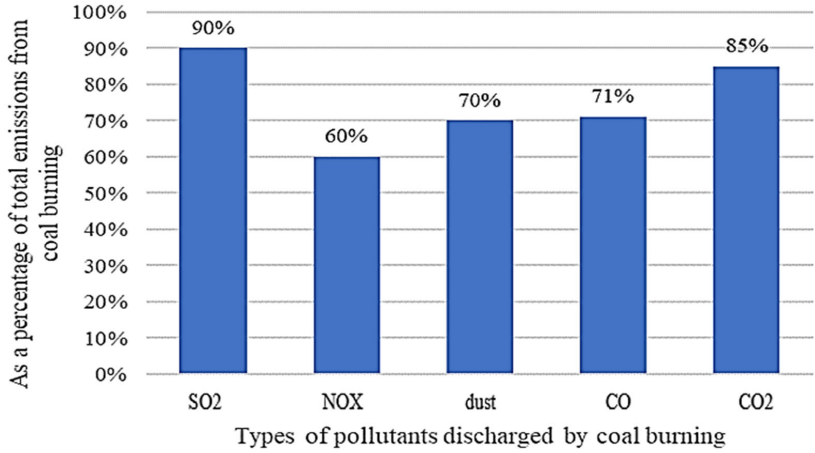

Figure 1. Major pollutants from coal combustion and their percentages in total emissions of China

The heating system is huge, and the intermediate heat exchange stations are scattered and numerous. It is difficult to achieve pipe network balance solely depending on human adjustment. Meanwhile, due to the complex system, pipe network aging causes frequent accidents [13]. Between the stations, between the buildings are easy to appear near the hot far cold phenomenon, so there is a "competition for food", especially the long haul pipeline, in the middle of a level or two relay pumping station, supply and demand do not match, the operation condition is not ideal, in order to ensure that the end of the heat, will increase the temperature or increase the flow at the cost of greater energy waste. This requires real-time dynamic data and improves the monitoring ability of the central control room [14]. With the development of heat network monitoring system, heat supply management has risen from manual meter reading, station management and passive

maintenance to station room automatic monitoring and unattended, and the rudiment of intelligent heat supply pipe network has initially taken shape.

With the development of technological progress, heating technology is constantly updated. Many heat enterprises try to improve the heating temperature, increase the circulation water to ensure the most unfavorable heating for users, to solve the problem of hot and cold imbalance, hydraulic imbalance, so there is a "large flow and small temperature difference; In terms of the adjustment mode, the simple quantity or quality regulation is replaced by the combination of quality and quantity regulation. For the long-distance pipeline network, the branch network is supplemented by more complicated ring pipe network, and in order to improve the reliability of heat supply, the heating system is even operated by double or multiple heat sources [15], which makes the heating system more complicated. Simply relying on human adjustment can no longer meet the needs of heat supply. Heat enterprises adopt computer technology in heat source production and heat network transmission and distribution to realize remote monitoring, which is the preliminary stage of management informatization and intelligent construction.

At present, China's heating industry has its own industry standards. Most of the newly built thermal stations are equipped with advanced digital instruments, sensors and control devices, basically realizing the automatic control of a single heat exchange station and the remote monitoring of data of multiple stations. Some cities have even realized the unattended heat exchange stations. The dynamic data collected continuously during the heating season by the modern instruments deployed in a large scale in the heating system are uploaded to the monitoring center of the heating enterprise through the network. The operation management staff can know the operation status of the system at any time on the computer screen and set control objectives for the equipment in the station according to the daily dispatch instructions. At the same time, the automatic control system of the heat exchange station can adjust itself and optimize the operation according to the change of outdoor meteorological temperature without intervention, which saves a lot of manpower and financial resources for the enterprise. However, there is no unified standard for intelligent heat network, and all enterprises are still in the exploration stage. Although some heat exchange stations have installed control devices, due to the lack of unified standard,

the design level of control system is uneven, and most of them lack linkage with monitoring center, so they can only upload data instead of remote control and cannot be considered as automatic control in real sense [16].

There is still a lack of unified understanding of intelligent heating in China, and technical research has just started [17]. In recent years, with the increasing awareness of energy conservation and environmental protection, the development of communication technology, learning from foreign advanced countries in terms of real-time monitoring, design and construction, equipment quality, technical content and other achievements, explore the construction of intelligent heat network suitable for China.

Japan mainly develops district heating [18,19], which has a small scale of development. The largest heating area is 3.386 million m^2, located in northeast Japan. Natural gas, electricity, oil, gas and biomass energy are the main heat sources for heating. Japan attaches great importance to the utilization of industrial waste heat, garbage incineration heat, domestic sewage waste heat, air energy and other energy sources [20], and reduces or even does not use coal for heating. According to statistics, coal has been no longer used as a heat source in Japan since 2009.

According to the climate conditions, South Korea implements heating in all parts of the country, but the heating time varies slightly between the south and the north. The heating period in the south is from November to March of the next year, while the heating period in the north is from early November to mid-April of the next year. South Korea is a country relatively short of energy. In order to reduce energy consumption and greenhouse gas emissions, South Korea actively develops central heating. The heating energy is mainly natural gas and various oil products, and basically does not use coal [21]. Different houses in South Korea have different heating methods. South Korean houses include high-rise houses, collective houses and single houses. As Koreans have a "sit-down" living habit, so the basic residential use of kang-style heating, that is, floor heating. In South Korea, the heat source of single heating comes from natural gas and kerosene. In addition, South Korea is developing district heating using waste energy as fuel. It is estimated that 8% of the heating demand in South Korea is provided by waste energy, which helps South Korea gradually get rid of its dependence on fossil fuels [22]. South Korea generally uses regional boiler rooms and cogeneration as heat sources to provide heat for buildings in the region.

3.3 Problems in central heating

In the new period, with the continuous economic development of various countries, the acceleration of urbanization and the improvement of people's living standards, urban heating has developed rapidly, especially the demand for urban central heating has gradually increased. With the acceleration of urbanization and the gradual deepening of people's understanding of resources and environmental protection, the scope and scale of urban cogeneration central heating, as a form of heat supply strongly supported by countries around the world, is expanding constantly, with broad prospects for development. However, compared with developed heating countries, cogeneration central heating in China still has many problems, such as complex heat network problems, thermal stations fail to play their due roles, and the comprehensive utilization efficiency of central heating energy is still low [23]. Therefore, on the premise of full analysis and research, how to take practical measures to improve the central heat supply rate, reduce resource waste and environmental pollution, has important theoretical and practical significance for the sustainable development of urban district heating in China.

(1) Poor overall planning: The level of overall planning and design is not enough, so that the energy reduction can not be implemented in place. At present, the design standard of indoor heating does not systematically specify the specific technical requirements of heating devices, and does not reflect the real level of current energy saving technology. At the same time, in the process of central heating for thermal users, the design department and planning department still use the old design concepts, which makes it impossible to implement the energy saving in place. Cause natural deficiency [24].

At present, with the continuous improvement of people's living standard, the living environment comfort requirements are also higher and higher. Take China as an example. In the past, many urban buildings south of the Yellow River did not use heating measures, but in the new era, more and more cities are providing central heating for urban buildings. Especially in recent years, cities south of the Yangtze River have begun to provide central heating in winter. Whether it is the reconstruction of old cities or the construction of new cities, many cities lack overall planning in the process

of heating from non-heating, resulting in the situation of more small boilers, more chimneys and less heating range.

(2) There are many problems in the design of heat network: in the process of urban reconstruction and construction, the continuous popularity of central heating makes the coverage of urban heat supply network more and more large. However, due to the unscientific problems existing in the design of heat network, the phenomenon of poor heating effect in major cities often occurs. They are mostly unscientific and closely related. The most common phenomenon is that the heating is too hot for the local user and not too hot for the remote user. Pipe network management layout is of great significance to the efficiency of central heating [25]. Only scientific and reasonable design, to ensure the quality of heat supply, reduce energy consumption, save construction costs, to meet the needs of users. At present, many details are not considered in the design of heating networks. For example, condensate recovery will lead to water shortage due to heating temperature, material selection, construction technology and quality, etc. If it is taken into account in the design, heating consumption will be reduced, heating quality will be improved and the service life of the pipeline will be enhanced. Another example is the thermal insulation of heating pipeline. Strengthening the thermal insulation design of heating pipeline can reduce the heat of heat network pipeline and reduce energy consumption.

(3) Heat charging is not scientific: the lack of reasonable calculation of heat, resulting in the difficulty of charging. At present, the charging method of urban district heating in China is still focused on charging by heating area, which leads to some problems, such as inaccurate measurement of heat consumption of heat users. Because the heat energy consumed by thermal users cannot be calculated as accurately as that of water, electricity and gas, etc., the charge of heat consumption by users cannot be carried out according to the actual situation, which limits the enthusiasm of thermal users for energy saving and timely payment, making the operation of each unit of heat supply difficult to continue. For users with high heating temperature, there is no awareness of energy saving; For low heating temperature users, there is a loss, customer opinion is larger. At present, the state advocates urban central heating, but also emphasizes the importance of energy conservation and emission reduction. Therefore, if the scientific heat charging method

can be adopted, more users can choose heat consumption according to their own needs, so as to achieve the purpose of energy conservation and emission reduction. With this charging method, it can also reflect the actual situation of users.

Heat supply production is heavy in workload, heavy in task and complex in content, often involving many units and users. Therefore, how to effectively manage the heat supply system, the project process, cost control and enterprise resources needs to strengthen the reform of environmental protection and energy saving technology, and needs a powerful intelligent information management platform to provide support. This is to explore the application of advanced management ideas represented by information technology to promote the establishment of a new management system, make full use of information technology to improve the technical level of enterprises, management level, improve the quality of heat supply, sincere service, environmental protection, energy saving, harmonious heat supply purposes, promote the traditional industry from extensive to intensive transformation.

3.4 Necessity of intelligent heat network

(1) The necessity of overall energy control

China is a major coal energy consumer, with prominent contradiction between energy supply and demand, prominent energy security problems, low energy utilization efficiency and serious environmental pollution. Therefore, with the increasing requirements for urban air environment protection and the adjustment of urban energy structure, sustainable development faces great pressure. It also puts forward the strategy of sustainable energy development, which is "energy saving priority, security of supply, optimization of structure and environmental friendliness".

Since the buildings were all non-energy-saving buildings before 2007, the users could not use heat independently, and the heating facilities are aging, resulting in the overall efficiency of the heating system is not high; The operation efficiency of small cogeneration boilers is low, and the development of heating is too fast, so that the pipe diameter is getting bigger and bigger, the pipeline is getting longer and longer, and the heating system is getting more and more complex, forming the operation mode of "large flow and small temperature difference", which affects the energy saving level of the system. According to statistical

calculation, the average coal consumption of urban central heating in each heating season is about 25~35 kg/m^2. If 50% and 65% energy saving is achieved, the coal consumption of heating can be reduced to 15~18 kg/m^2, that is, 10~17 kg/m^2 can be saved. The national heating area reaches 10 billion square meters [27; 28]. It can be seen that the amount of energy saving reaches 1.0~1.7 million tons of standard coal. Urban heat supply has become an important part of energy conservation and emission reduction.

(2) The necessity of saving energy and reducing consumption

For heating enterprises, the basis of energy saving is a clear understanding of energy consumption at all levels of the heat source, station and user, combined with whether the operating parameters inside the outdoor temperature checkpoint match, whether the indoor temperature of the user meets the standards, etc. That is to say, effective energy consumption analysis can provide reliable basis for efficient and energy-saving operation of the company, so as to save the company's operation costs and improve economic benefits. The establishment of production scheduling system can comprehensively and systematically analyze and calculate the production and operation cost of heating season. Through analysis and accounting, the heating cost can be effectively controlled, and the purpose of rational allocation of resources, balanced heating, energy saving and consumption reduction and expansion and development can be achieved. Saving energy and reducing consumption is the eternal theme of building a conservation-oriented society and promoting sustainable development.

3.5 Development trend of urban district heating

(1) The scale is getting bigger and bigger

In the future, with the gradual improvement of people's living quality, the demand for winter heating is more and more extensive. More and more cities will be heated, and the scale of urban central heating will be larger and larger.

(2) Enhanced overall planning

As the country gradually enhances the planning of urban construction, the heating supply planning mode which was designed only when needed will be improved in the past, and the heating supply planning mode which focuses on the overall planning and development of the city will gradually rise and help urban development.

(3) The design of heat network is gradually optimized

The design of heating network is very important for heating effect and energy saving. More and more design units, in practice, have accumulated more heat network design experience. In the new urban planning, more scientific heat network design scheme can be provided. At the same time, the existing heat network is gradually optimized to improve its heating efficiency.

Scheme 1. Reasonable design of pipe network layout and pipeline direction. Pipeline and pipeline setting are the core content of the whole pipe network system. Whether the pipeline layout and pipeline direction are reasonable directly affects the heating effect. In the design of pipe network system, careful investigation and scientific design must be carried out, drawing analysis should be done, design intention should be fully understood, pipeline direction should be rationally arranged, and reasonable optimization and arrangement should be considered from the perspective of the whole heating system to ensure the rationality of the whole central heating network, so that users from near and far can enjoy standard heating services [29].

Plan two, strengthen the solution of the condensate problem. Condensate water is a prominent problem in the central heating pipe network system. In order to avoid the effect of condensate water on the central heating pipe network effectively. It is necessary to strengthen the selection and inspection of thermal insulation materials, use new pipes to avoid condensate, and carry out experiments and tests on the pipes and thermal insulation materials used. Secondly, in the construction process involved in the part of the pipeline through the wall should be added insulation protective sleeve, to ensure the continuity and tightness of the pipeline.

Scheme three, the use of polyurethane as insulation material. Compared with rock wool, polyurethane is more suitable as insulation material. Polyurethane not only makes up for the shortage of rock wool, but also has better insulation performance than rock wool.

Scheme four, ensure smooth pipeline. If there is foreign body in the central heating pipe network, it will affect the water circulation system of the heating pipe network and seriously affect the heating quality. Therefore, during the design of pipeline installation, it is necessary to carefully check to ensure that there is no foreign body in the pipeline, descale and rust on

the pipe wall, and ensure that the inner wall of the pipeline is clean before closing for installation. It must be taken into account in the optimization design of central heating network.

(4) The concept of green energy saving will be widely used

At present, the whole world attaches great importance to the concept of green energy saving. Urban district heating is a concentrated energy consumption carried out in a specific season. If we can integrate the concept of green energy saving into it, we can save resources and promote environmental protection. For example, in the choice of heating energy, coal combustion is the main heating energy at present. In the future, there will be a serious shortage of human resources, and it may become a new trend to use nuclear power as the main energy source for heating [30].

(5) Reliability is gradually improved

In urban central heating, the most important problem that users complain about is stopping heat. In the future, the reliability of heating can be improved by designing multi-heat source heating network. That is, more than one heat source is connected at the same time. When the main heat source fails, other heat sources can immediately supplement heat supply. So as to avoid the decrease of user experience caused by personnel failure, or the occurrence of major accidents, to ensure the maximum reliability of heat supply.

(6) The concept of intelligence is advancing gradually

The future is the era of intelligence, all walks of life will penetrate the idea of intelligence. In urban heat supply, intelligent means such as intelligent temperature control and intelligent billing will be gradually promoted. Intelligent control equipment can be installed at the client end to realize the need of indoor temperature control by the customer, that is, the indoor temperature can be adjusted by remote control. In addition, more scientific and rational intelligent billing can be carried out according to customers' heat usage and usage period [31]. For example, you can set a lower temperature when the user is not at home during the day. The indoor temperature is automatically adjusted half an hour before the user returns home, so that the user returns home with a suitable temperature. This can greatly reduce the consumption of heat sources, in line with the national strategy of energy conservation and emission reduction. For heat supply enterprises, data mining with big data technology and intelligent decision

support system will become the main trend in the future. In the design of the full consideration of new technology, new products, so that the management and control of heating enterprises tend to be intelligent. So that the heating system not only meets the needs of energy saving and emission reduction, but also can run in the best state.

In a word, from the perspective of energy saving development, urban central heating is bound to develop in a large range. In the future, with the gradual advancement of information level, designers of urban heating system must actively explore and accept new things, new methods, new equipment and new software, and quickly apply them to the design of urban central heating system.

4. Pollutant discharge status and control technology of central heating boilers

Boiler in the process of operation will inevitably discharge air pollutants, directly affect the quality of air environment. It is very important to strengthen environmental control of boiler air pollutants and reduce emissions. Boiler is a facility that converts chemical energy of fuel (solid, liquid and gas fuel) into heat energy by combustion, which is widely used in power, petroleum, metallurgy, chemical industry, heating and other production and life fields [32]. In the process of boiler operation, fuel combustion generates a lot of combustion heat, but also produces a variety of combustion products, mainly including carbon dioxide, sulfur dioxide, nitrogen oxide and particulate matter. Among them, carbon dioxide is a greenhouse gas, sulfur dioxide and nitrogen oxide can form acid rain under certain conditions, and particulate matter can form dust in the atmosphere or be inhaled into human lungs and cause disease. Large capacity boilers generally process the combustion products through the dust removal, desulfurization and denitrification device after the tail heating surface, and then discharge them into the atmosphere, becoming atmospheric pollutants. And many small capacity boilers will all combustion products directly discharged into the atmosphere, to the quality of the atmosphere and people's living environment quality caused serious damage.

The operation mode of heating boiler is through the heat energy generated by the combustion of materials to supply the normal operation

of the boiler. Usually, coal is the main raw material used, but in the process of burning coal there will be excessive consumption and emissions, and a series of chemical reactions will occur. For example, insufficient combustion, excessive combustion and other phenomena, these phenomena will not only cause serious pollution to the environment, but also reduce the normal service life of the boiler to a certain extent. Boiler in the process of operation will inevitably discharge air pollutants, directly affect the quality of air environment. It is very important to strengthen environmental control of boiler air pollutants and reduce emissions.

4.1 Pollutants contained in boiler flue gas pollution

Nowadays, the air pollution problem has been put in front of people, we should effectively control the source of pollutant emission, so as to realize the protection of the ecological environment. Heating boiler in the process of operation mainly through the burning of coal, often produce a lot of pollutants, should take effective control measures for heating boiler. The generation of heating boiler smoke is mainly because some chemical substances are not fully burned, resulting in a large number of small black particulate matter, due to the increasing and condensation of these substances, and floating in the air, thus causing serious damage to the environment. If these smoke substances into the human body, then it is very likely to appear infection and toxic effects, mainly because the smoke is likely to combine some metal elements. Secondly, sulfur dioxide pollution is a serious gaseous pollutant, which is also an important gaseous pollutant under control in China. There are often many sulfur-containing components in coal and other raw materials, and sulfur dioxide may be produced if the combustion is not sufficient, which is very likely to form acid rain in the atmosphere and cause serious damage to our ecological environment [33]. In addition, nitrogen oxide pollution, if this pollutant enters the human body is very likely to cause methemoglobinemia disease problems, if combined with other pollutants under certain conditions, may even cause photochemical smog pollution problems. Finally, carbon dioxide pollution, global warming today is mainly caused by increasing levels of carbon dioxide.

4.2 Causes of boiler flue gas pollution

(1) Unreasonable control of secondary wind pressure

In the process of boiler operation, if we want to further improve the economic value and use efficiency of boiler fuel, we must make reasonable

adjustment and improvement according to the actual situation. Therefore, secondary air pressure can be controlled to ensure the combustion in the furnace, so as to effectively avoid fuel waste and serious pollution [34]. In the actual use process, the vast majority of boilers will produce different degrees of pollution and other problems, which is mainly because the control of secondary air pressure is unreasonable and unscientific, and the pollution inside the furnace is mostly caused by the air coefficient, as well as a series of problems caused by the rise of smoke exhaust temperature.

(2) Coal material moisture is too high

In the actual operation of the boiler, if the water content of the fuel is too high, it will lead to insufficient fuel combustion. Especially, when the water content of one part of the boiler is too high, high temperature steam will be generated, and then the water vapor and flue gas will mix and react, resulting in the occurrence of smoke exhaust pollution inside the furnace [35]. At the same time, fuel moisture will also have a direct impact on the internal exhaust temperature, and even form acidic substances, which has fatal damage and corrosion to the boiler itself, and will directly affect the normal service life of the boiler.

(3) The quality of coal

The boiler should be inspected in the process of use, but also the quality of the coal itself should be regularly controlled and spot checked to ensure that the fuel used in the boiler is of high quality.

4.3 Energy saving and environmental protection measures for boiler flue gas pollution

There will be flue gas pollution and other phenomena during the actual operation of heating boilers, which will directly affect the normal use efficiency of boilers and reduce the use value of fuel. The related research shows that there are many reasons for boiler flue gas pollution, but it is mainly because the flame inside the furnace is not enough, and the excess air coefficient leads to the scaling of the heating surface. Therefore, during the reduction of boiler temperature, we must consider various influencing factors, but also pay attention to the overall design of the boiler and fuel quality and other related issues, so as to effectively improve the actual use of heating boilers and comprehensive economic value.

5. Analysis of energy saving and environmental protection technology for heating boilers

With the acceleration of urbanization and people's increasingly high requirements for heating quality, the heating industry has an increasing demand for resources and energy. However, the utilization rate of traditional heat sources is not high enough, which leads to serious waste of resources and energy, and also seriously affects the improvement of urban environment. Therefore, it is imperative to apply energy-saving and environmental protection measures and technologies in heating boilers, which is also an effective way to improve economic and social benefits.

5.1 Necessity of implementing energy-saving and environmental protection technology for heating boilers

On the one hand, the application of new energy-saving and environmental protection technology can not only improve the efficiency of fuel combustion, but also maximize the comprehensive utilization of natural resources. On the other hand, energy conservation and environmental protection technology is applied to heating boiler, and the trend of China's social development, not only at the same time also can effectively push [36] to continue development strategy in China.

5.2 Factors affecting energy conservation and environmental protection of heating boilers

(1) The exhaust volume and temperature of the boiler itself

In order to make the heating boiler energy saving and environmental protection, we must find the factors that affect the effect of energy saving and environmental protection of the heating boiler, and improve the heating boiler from these factors, in order to make the heating boiler energy saving and environmental protection. Among the factors affecting energy saving and environmental protection of heating boilers, the first is the exhaust volume and temperature of heating boilers. The smoke emitted by heating boilers is very hot, which contains a lot of heat. It can also be regarded as a very large amount of heat contained in the heating boiler. Therefore, if a large amount of smoke is discharged all the time, a considerable part of its own heat will be lost, which greatly reduces the temperature of the heating boiler, and a large number of raw materials have to be consumed to raise the temperature back. It can be seen that this process increases the energy consumption of the heating boiler [37].

(2) Carbon content in boiler slag

The carbon content in furnace slag of heating boiler is also an important factor to measure the effect of energy saving and environmental protection of heating boiler. If the staff want to make the heating boiler work energy-saving and environmentally friendly, they can choose to reduce the carbon content in the furnace slag of the heating boiler. The use of some coal with higher moisture content as raw materials for heating boiler operation will make the carbon content in the slag of heating boiler is too high, because the coal with higher moisture content often cannot be fully burned in the heating boiler, there will be a considerable part of residual, which not only greatly increases the carbon content in the slag of heating boiler, but also increases the consumption of coal. Because in order to make the heating boiler reach the target temperature, it must consume more coal, which makes the energy-saving and environmental protection effect of heating boiler greatly reduced. At the same time, the unreasonable setting of working parameters of heating boiler will lead to the increase of carbon content in furnace slag of heating boiler. The preset working parameters of the heating boiler will have an impact on the operation process of the heating boiler. If the working parameters are set unscientifically and reasonably, it is easy to lead to some coal being discharged outside the furnace before it is completely burned, leading to a large amount of waste of coal and increasing the carbon content in the slag of the heating boiler. Figure. 2 shows the coal cinder that is not fully burned. The main reason is that the fuel with high moisture content in the boiler is not fully burned and some of it will remain, which not only greatly increases the carbon content in the slag of the heating boiler, but also increases the fuel consumption, thus reducing the energy-saving and environmental protection effect of the heating boiler to a large extent [38].

In addition, if the boiler does not set scientific and reasonable working parameters, it will increase the carbon content in the furnace slag of heating boiler. In the process of the heating boiler operation is affected by the parameters setting, therefore, working parameters of the heating boiler to set up the science the better as far as possible, so as to ensure that in the case of fuel burn adequately and slag discharge outside the furnace, reduce the carbon content in the heating boiler slag, 迚 and avoid the waste of fuel situation [39].

Figure 2. Inadequately burned cinder

(3) Thermal efficiency of boiler

Heating boiler can be regarded as an energy conversion equipment, which is to convert the energy stored in raw materials such as coal into heat. The standard to measure the energy conversion effect of heating boiler is thermal efficiency, which is also an important factor affecting the energy conservation and environmental protection of heating boiler [40]. Through the analysis of the thermal efficiency of the heating boiler, we can get the combustion of coal and the specific operation of the heating boiler, and can intuitively understand the energy consumption of the heating boiler operation. The staff's operation of the heating boiler is not standardized enough, the design of the furnace of the heating boiler is not reasonable and scientific enough, the overhaul and maintenance of the heating boiler is not carried out in a timely manner and other reasons will lead to the actual thermal efficiency of the heating boiler is low, and the operation energy consumption of the heating boiler is high [41].

5.2 Commonly used new energy heating methods

New energy heating has many advantages, such as less pollution, low energy consumption and stable heating. Therefore, various regions in China have increased the research and development and use of new energy heating. The main new energy heating methods are shown in Table 1.

Table 1

The advantages and disadvantages of common heating methods and economic comparison table

Serial number	Heating mode	Working principle	Advantage	shortcoming	Initial investment (RMB/10 m^2)	Operating costs (RMB/10m^2)
1	Air source heat pump	Air source heat pump	Heating time and temperature can be set freely	Large initial investment, large power consumption, poor comfort	10000	21
2	Wall mounted gas boiler	Household installation of wall-hung boiler	Self-defined heating time, free opening, independent temperature regulation, can simultaneously solve the heating and domestic hot water demand	Heating furnace life of 15 years, antifreeze	6000 (equipment 4000 indoor facilities 2000)	28
3	Carbon crystal plate	Pure carbon particles heat, power that is heating	Easy installation, small initial investment	High operating costs	3000	62
4	Geothermal heat pump / water source heat pump	Buried tube geothermal heat pump	High energy efficiency and low operating costs	Limited by geographical conditions, high initial investment, groundwater recharge	21000	18
5	Sewage source heat pump	Sewage source heat pump compressor system	Relatively low initial investment and low operating costs	Pipe blockage	18000	17
6	Solar-assisted electric heating	Solar heating, electric auxiliary heating in the absence of solar	Simultaneously solve the heating and domestic hot water demand	Larger initial investment	10000	16
7	Regenerative electric heater	Convert electrical energy into heat	Easy installation, small initial investment, the use of peak and valley electricity prices	High operating costs	7000	28

6. Conclusion

To sum up, the continuous development and progress of society make the heating industry gradually increase the consumption of resources, if the application of energy-saving and environmental protection technology in heating boilers, not only can maximize the efficiency of energy utilization, reduce energy consumption, but also can reduce the pollution to the urban environment to a certain extent. Therefore, in the actual application, we should actively adopt energy-saving and environmental protection technology, through these effective energy-saving and environmental protection measures, and then improve the economic and social benefits.

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