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Feasibility analysis of residential building adopts household fireplace instead of centralized heating in Dezhou

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Abstract. Analyzing the heating scheme of residential buildings to use gas as fuel in winter, this paper chooses municipal thermal central heating and household gas-fired boilers to compare energy utilization, initial investment and operating costs. The results show that the advantages of household type gas wall-hanging furnace for independent heating are significantly higher than that of municipal heating. The research can provide reference for the heating of residential buildings in Dezhou in the future.

1. Introduction

Heating energy is an important part of building energy consumption in northern China. At present, in most areas of China is still adopting traditional central heating. With the gradual increase of smog weather, the relevant departments of Dezhou issued the 《Work plan to accelerate winter heating “replacing coal with gas and electricity”》 in 2017, which was clearly required to be completed before the end of October. In other words, the task of six thousand households "gas or electricity to replace coal" transformation should be taken in time. With the implementation of coal-to-gas, the heating of household gas-fired boilers is becoming more popular than ever before. The household gas-fired boilers have powerful central heating functions. For instance, each room not only can be comfortably satisfied according to different demand, but also can be provided with large-flow constant-temperature sanitary hot water to meet the need of bathing and washing. The use of household gas-fired boilers has a significant role in reducing pollutant emissions and improving air quality.

2. The comparison of heating methods in residential buildings

With the continuous adjustment of urban energy structure, heating methods have also entered a diversified era. At present, the heating methods of residential buildings in the northern region mainly include: urban heating network central heating, district central heating (such as the use of regional boiler rooms and heat pumps), separate heating of gas wall furnace, and other heating methods (such as air-conditioning). The layout of the gas boiler line is shown in Figure 1.



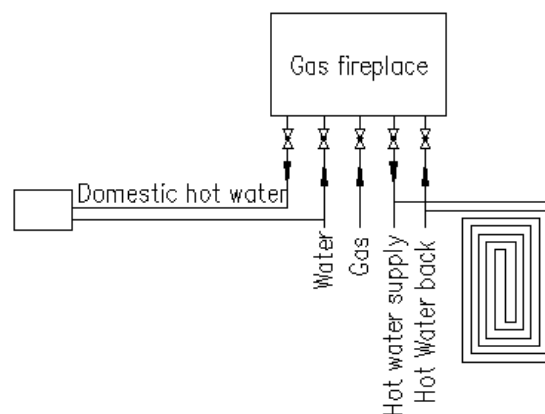


Figure 1 Gas wall boiler layout diagram

The performance and technical characteristics of various heating methods vary greatly^[1]. At present, the heating methods of residential buildings in Dezhou are mainly concentrated in two types: municipal thermal central heating and individual-type gas fireplaces for independent heating. The following is a comparison of the main heating methods.

Table 1 Comparison of heating methods

Heating method	Individual household gas boilers for independent heating	Municipal thermal central heating
Scope of use	Urban and rural use increased year by year	Urban areas are mostly used
safety	The operation is stable, safe and efficient	The boiler is a high pressure container and has high risk
Energy saving	High thermal efficiency	Heat loss problem in outdoor pipelines
Manageability	Humanized design, easy operation, automatic or remote control room temperature	It is difficult to charge for property, and it costs a lot of operation, maintenance, overhaul, management and operation
Environmental protection	The emission of gas concentration is small	Smoke concentration, CO ₂ and NO _x emissions are large
Economic	No charge is incurred when not in use	Need to build a heat exchange station, occupying limited land resources of the community
Comfort	Free to adjust the indoor temperature and heating time	All-day heating, room prone to high or low temperature
Operation and Maintenance	Need to undertake the management and maintenance work	Thermal is responsible for maintenance and management
Applicability	Not suitable for public buildings	Wide application

By comparing two heating methods, we can see that the residential building adopts the separate heating method of the household gas-fired boiler, which is comfortable and convenient, and the management of heating time is more flexible. What is more, it can truly achieve the purpose of the energy saving and the emission reduction. The municipal thermal central heating needs to be equipped with special valves, flow meters, pressure regulating boxes and special security protection devices for the boiler room. Because of the long pipelines and many links, the possibility of problems is relatively

increased, which is prone to cause frequent maintenance. Therefore, the requirements for its equipment, accessories, pipelines and constructions are overwhelmingly high. The gas boiler and the domestic cooking appliance have the same pipelines in terms of gas used for heating. In other words, there is no need to add new equipment and pipelines, the safety and reliability are improved.

3. The program comparison

3.1 Comparison of energy efficiency

Option 1: Using municipal thermal central heating

According to GB24500-2009 "Industrial Boiler Energy Efficiency Limit Value and Energy Efficiency Rating", the thermal efficiency of gas boilers is shown in table 2 below.

Table 2 Thermal efficiency of gas boiler

Energy efficiency rating	Fuel variety	Fuel receives low heat Q kJ/kg (kJ/m ³ Standard state)	Boiler capacity Dt/h(Or kW)	
			D≤2 (Or D≤1.4)	D>2 (Or D>1.4)
			Boiler thermal efficiency %	
I	natural gas	Q≥18800 kJ/m ³ Standard state	92	94
II			90	92
III			88	90

According to the provisions of GB/T50627—2010 "Evaluation Standards for Urban Heating Systems", the efficiency of outdoor heating pipe network transportation should not be less than 90%. According to the 95% (the higher value) efficiency of the new thermal pipe network, the thermal efficiency of the central heating system is as shown in table 3 below^[2].

Table 3 Comprehensive thermal efficiency of heating system

Energy efficiency rating	Fuel variety	Fuel receives low heat Q kJ/kg (kJ/m ³ Standard state)	Boiler capacity Dt/h(Or kW)	
			D≤2 (Or D≤1.4)	D>2 (Or D>1.4)
			Central heating system thermal efficiency %	
I	natural gas	Q≥18800 kJ/m ³ Standard state	87.4	89.3
II			85.5	87.4
III			71.1	85.5

Note: Comprehensive efficiency of heating system=pipe network transmission×heat source efficiency

Option 2: Independent heating with household gas fireplace

According to the provisions of GB20665-2006 "Energy efficiency limit value and energy efficiency rating of domestic gas rapid water heaters and gas heating water heaters", the thermal efficiency of gas heating furnaces used in residential buildings should meet the requirements of table 4.

Table 4 The energy efficiency limit value and energy efficiency grade of domestic gas quick water heater and gas heating water heater

Types		Heat load	Minimum thermal efficiency value %		
			Energy efficiency rating		
			I	II	III
Heating stove (single heating)		Rated heat load	94	88	84
		≤50% Rated heat load	92	84	—
Heating stove (dual type)	Heating	Rated heat load	94	88	84
		≤50% Rated heat load	92	84	—
	Hot water	Rated heat load	96	88	84
		≤50% Rated heat load	94	84	—

According to the above data, the two schemes are uniformly selected according to the value of the first-level energy-efficiency equipment. The integrated thermal efficiency of the central heating boiler and the pipe network is 87.4% when the heat supply is 1.4kW. If the single-heating gas boiler is used, the heating efficiency can be up to 93%; if the heating and hot water dual-purpose gas boilers is used at 70% load (heating and hot water are used at the same time.), the heating efficiency can reach about 94%, which is higher than the use of coal, oil ,electricity and air conditioning etc. Therefore, the use of separate gas-fired boilers for independent heating can save energy.

3.2 Comparison of initial investment

Option 1: Using municipal thermal central heating

If the residential building adopts municipal thermal central heating, the thermal company will charge the matching costs (Cost of building heat exchange station, heating interface, etc). The thermal corporation in Dezhou charges ¥72/m² for supporting expenses, such as residential building area of 50,000 m² (assuming a total of 500 households in a community, each residential area is 100 m²), so the heating company will charge about ¥3.6 million. Moreover, it is generally required to build a heat exchange station on the ground, which not only needs to take possession of the limited land resources of the community, but also needs to set the heat pipes in the community by themselves, which is high, and corresponding costs such as system maintenance may occur later.

Option 2: Independent heating with household gas fireplace

If the residential building is heated by a separate household gas wall furnace, each home only needs to be equipped with a gas fireplace. The price of a gas fireplace in the market ranges from ¥3,000 to ¥7,000. Assuming that the price of a gas fireplace is ¥5,000 and there are 500 households in the community, the cost is about ¥2.5 million. In addition, from the perspective of real estate developers, the use of separate gas-fired boilers for independent heating can also reduce a large amount of property management costs, not to worry about the difficulty of heating charges, uneven housing heat and other issues.

From the initial investment analysis, municipal heating centralized heating one-time investment is high, and it only provide heating, the community needs to build heat exchange station, covers a large area; However, the one-time investment of household gas-fired wall-mounted furnace heating is slightly lower, which can provide hot water and heating at the same time, saving the reinvestment of domestic hot water equipment, eliminating the need to build additional heat exchange stations and saving construction land. Therefore, residential buildings using household gas wall-hanging furnace independent heating is significantly better than municipal heating centralized heating.

3.3 Comparison of operating costs

Option 1: Using municipal thermal central heating

If the residential building adopts municipal thermal central heating, according to the municipal heating charging standards in Dezhou, the residential heating will be charged at ¥22/m², if the building area is 100m², then the winter heating cost will be ¥2200, which only contains heating. If it is necessary to offer hot water for 24 hours, an additional water heater is required, and the cost is generally between ¥500-1000. And the owner can not effectively control the indoor temperature.

Option 2: Independent heating with household gas fireplace

According to the natural gas charging standards in Dezhou, if the residential building is heated by a gas fireplace, the residential users using natural gas independent heating, the annual gas consumption is 1000m³ and below, which natural gas price is ¥2.20/m³. If others, the annual gas consumption is more than 1000 m³, the natural gas price is ¥2.64/m³. Due to the difference in the brand name of the fireplace, the condition of the building, the warmth of the room and the method of using, the gas consumption of the general household is usually 6-8 m³ every day. The heating season is from November 15 to March 15 of each year, which is 120 days. Consequently, it is heated by the

household gas wall furnace and the cost is about ¥1500-2000, including the expense of heating, bathing, cooking and so on. Moreover, the indoor temperature is completely regulated by the owner.

From the analysis of manipulating costs, the operating cost of municipal thermal central heating is slightly higher than that of household gas-fired boilers. Moreover, the use of municipal thermal central heating, the reality is that the temperature felt by residents on different floors is also uneven. Some households will experience a particularly hot room temperature, while some low-level residents do not feel the heat, so the indoor comfort is not good and the resources are wasted. At the same time, if the people is not at home, the central heating will not stop, and heating will continue. The expenses incurred will still be borne by the residents. Relatively speaking, cost-performance ratio is not high. If the separate heating is adopted by the household gas wall furnace, its time management will be flexible and convenient. The opening time and closing time of the household gas wall furnace are determined by the user in order to ensure the comfort of the winter.

4. Conclusion

Through the analysis of heating methods, reasonable selection of efficient and energy-saving heating methods to reduce building energy consumption has become an important part of improving building energy efficiency standards^[3]. This paper compares and analyzes the municipal heating central heating and the independent heating of the household gas-fired boilers in terms of energy utilization, initial investment and operating costs, and obtains the following conclusions:

(1) Assuming the value of first-level energy efficiency equipment, the comprehensive heat efficiency of municipal heating is 87.4%; To adopts a household gas wall-mounted stove for independent heating, and the heating thermal efficiency can reach about 94%.

(2) Assume the residential area is 50,000 m², using municipal thermal central heating, the heating company will charge about ¥3.6 million yuan; the independent heating of the household-type gas wall-mounted boiler, the cost is about ¥2.5 million.

(3) Assume the residential building area of a household is 100m², using municipal thermal central heating, the heating cost in winter needs about ¥2,200; the independent heating of the household gas-fired wall-hung boiler, the heating cost is about ¥1,700.

To sum up, the advantages of household gas wall-mounted independent heating are obviously higher than that of municipal central heating. Household gas-fired wall-mounted furnace is a kind of energy saving and environmental protection product, which conforms to China's energy policy and is the direction of future heating. Some cities in China have already issued policies, and in the future new buildings must adopt household heating. In order to achieve maximum energy conservation and emission reduction, solar energy, geothermal energy and other new energy can be combined with household gas wall-mounted furnace to achieve combined heating.

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