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Thermal Effectiveness of a Wall-Hung Condensing Boiler

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Abstract: *To analyze the impact of the outdoor temperature and humidity on thermal efficiency of the condensing boiler, the experimental platform is set up based on the condensing boiler and low-temperature radiant floor heating system. Using the method of experiment, it's measured that amount of natural gas, the temperature of supply and return water, the outdoor temperature and humidity etc. The thermal efficiency is calculated in different outdoor temperature and humidity. Also it is analyzed that the impact of that the change of the outdoor temperature and humidity on thermal efficiency. The results show that, when the outdoor temperature is 8~15℃and humidity is 30%~70%RH, the impact of the outdoor humidity on thermal efficiency is very poor. But the impact of outdoor temperature on thermal efficiency is more remarkable. Thermal efficiency is the higher when the outdoor temperature is the higher.*

Keywords*: Condensing boiler, outdoor temperature, outdoor humidity, radiant floor heating, thermal efficiency*.

I. INTRODUCTION

With the intension of the global energy and deteriorative environment, natural gas has been applied to the every field as a kind of clean and efficient resource. Compared with other fossil fuel, natural gas has high thermal values, and do not produce dust after burning. It has advantages in efficiency and economy. The natural gas will play an important role in the social and economic development in the future.

As one of the most developed cities, Shanghai is in the forefront in consuming the energy. With the development of transporting the natural gas from the west to the east and other gas source project, the supply of natural gas in Shanghai has been increasing perfect. At present, the gas sources are mainly the natural gas from the west to the east, the East China Sea, Sichuan to the east, and LNG. It is equationted backbone network, providing an important guarantee for a smooth and orderly supply for the city.

With the development of urban natural gas, Gas-fired boilers have been used universally. Chinese scholars have done more research in thermal efficiency of boilers. For example, Wang Jianguo got the reasonable thermal efficiency of the boiler by analyzing the impact of various heat loss of the gas boiler to thermal efficiency, providing a reference for the selection of the configuration of the boiler[1]. Zhang Wensheng, MengJianqiong etc. analyze the relationship among the gas boiler thermal efficiency and smoke temperature and heat loss, and they derive the estimation equation of thermal efficiency[2]. Through the theoretical analysis and calculation, Wang Zhiyong etc. find that lowering flue gas temperature has a major impact to improve thermal efficiency, and flue gas temperature decrease from 195℃to 40℃,thermal efficiency will increase about 8%[3]. Aimed at that the test of thermal efficiency is not easily operated, BaiYufang and Su Xiaoguang design thermal efficiency test system based on the C ++ builder. It has practical and cost-effective in practice[4]. As heat source, condensing boiler has high efficiency and could protect the environmental in the stand-alone residential heating equipment. So it has become the research object currently. Due to the requirement of the temperature of supply and return water, low-temperature floor radiant heating system can more sufficiently improve the efficiency of the condensing boiler[5].

II. Calculation of natural gas heat value and the properties of smoke

In this article, the condensing boiler uses the natural gas from the west to the east. Its components and volume fraction of composition is in the table.1[6].

Table.1 Components of Natural Gas

Component	CH_4	C_2H_6	C_3H_8	iC_4H_{10}	nC_4H_{10}
Volume fraction%	96.207	0.740	0.094	0.011	0.011
Component	iC_5H_{12}	nC_5H_{12}	CO_2	N_2	He
Volume fraction %	0.003	0.003	2.741	0.161	0.029

Analysis of relation between outdoor temperature and thermal efficiency

Outdoor temperature mainly affects gas temperature and air temperature, which has an impact on thermal efficiency. During the experimental period, the outdoor temperature is varied between 8℃and 15℃.When the supply water temperature remains constant, the outdoor temperature has a little change during the experimental measurements. So the number of thermal efficiency is less in different outdoor temperature. They are summarized as shown in Table 4.

Table.4 relationship between outdoor temperature and thermal efficiency

Supply water temperature/℃	Outdoor temperature/℃							
	8	9	10	11	12	13	14	15
50	/	/	/	/	104.16	104.65	104.68	105.09
55	/	103.63	103.62	103.72	104.03	104.67	104.62	104.82
60	102.80	103.22	103.53	/	/	/	/	/
63	102.25	102.46	/	/	/	/	/	/
67	/	101.76	101.9	/	/	/	/	/
71	/	/	100.92	/	/	/	/	/
75	/	/	100.55	100.39	100.33	100.18	/	/

Obviously, efficiency thermal of condensing boiler declines with the increase of supply water temperature in the condition of the same outdoor temperature. When the supply water temperature continue to rise from 60℃, thermal efficiency decline faster. When the supply water temperature remains constant, thermal efficiency increases with the rise of outdoor temperature. There is a certain nonlinear relationship between them. When the supply water temperature rises to 75℃, thermal efficiency hardly changes, and maintains at 100.18%~100.55%. The reason is that the latent heat recovering from water vapor is negligible.

III. Conclusion

Through the experimental analysis of heating system, the factors—the outdoor temperature and humidity affecting thermal efficiency condensing boiler are calculated and analyzed. And the following conclusions can be gotten.

1. The influence that outdoor humidity on thermal efficiency of the condensing boiler is less. When the humidity increases by 60%, thermal efficiency will increase just only 0.15%. So the humidity as the factors affecting thermal efficiency can be negligible.
2. The impact that outdoor temperature on thermal efficiency is more remarkable. Thermal efficiency is the higher when the outdoor temperature is the higher.

Because of the experimental period is short and small changes in outdoor temperature conditions, some data are not fully measured. So thermal efficiency affected by different outdoor temperature is required to have a further detailed analysis. And the experimental parameters in different conditions need to be measured, which will be explored in future experiments.

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