Development of a Computer Heating Monitoring System and Its Applications

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Abstract: This paper develops a computer heating monitoring system, introduces the components and principles of the monitoring system, and provides a study on its application to residential building heating including analysis of indoor and outdoor air temperature, heating index and energy savings. The results show that the current heating system has a great potential for energy conservation.

Key words: heating monitoring system; energy savings; application

1. INTRODUCTION

With the quick development of urban construction and environment protection, urban central heating system is becoming large and large as well as heated area. The operation adjustment and management of heating system is also becoming more and more complicated. Therefore, the use of computer to supervise the heating system is very meaningful and has many advantages including testing of system parameters in time, adjustment of heating network, quantificational management as well as the improvement of system efficiency and heating quality.

2. COMPUTER HEATING MONITORING SYSTEM

2.1 System Components

The computer heating monitoring system is mainly made up of computer, A/D switcher, flow sensor, temperature sensor, and signal line, etc. As shown in Fig. 1, the digital signal of temperature and the frequency signal of flow are input to computer for calculation and analysis.

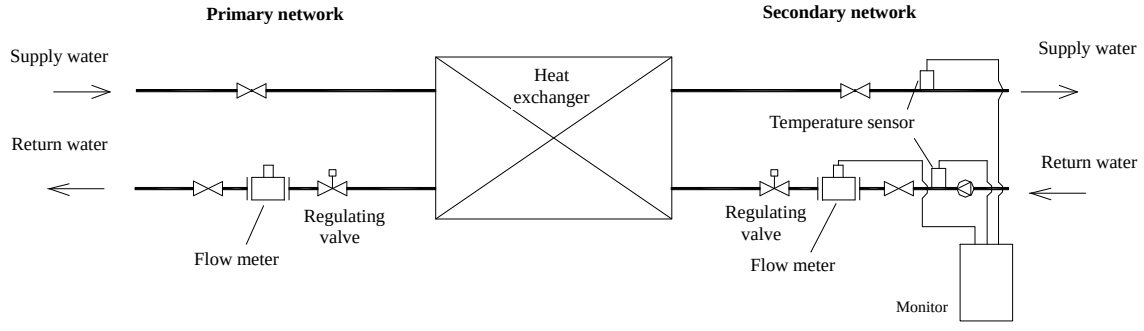

Fig. 1 Computer heating monitoring system

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2.2 Operating Principle

As the flow passes the flow meter, the pulse signal of flow is input to Counter Timer Circuit for frequency counting, and then the frequency signal is transferred to computer and monitor after fluid density modification. Meanwhile, analog temperature signal is transformed into digital signal with “A/D” converter. Digital temperature signal is input to computer and monitor. Calculations of heating load, accumulative heat supply, etc. are carried out by the computer established with professional software programmed by C computer language.

2.3 Functions

The main functions of the heating monitoring system include general layout, thermometer, parameter table, trend figure, backup, file, etc (shown in Fig.2). It can provide a real time monitoring of supply and return water temperature, indoor and outdoor temperature, circulating flow, heating load, and accumulative heat supply. It can save and print the data and figures for checking and study.

3. APPLICATIONS

The application of heating monitoring system is put into effect in Beijing Institute of Civil Engineering and Architecture (substation heating system) and Beijing Yuxin Residential Area (boiler station heating system). The analysis on testing results is as follows.

3.1 Analysis on Indoor and Outdoor Temperature and Heating Load

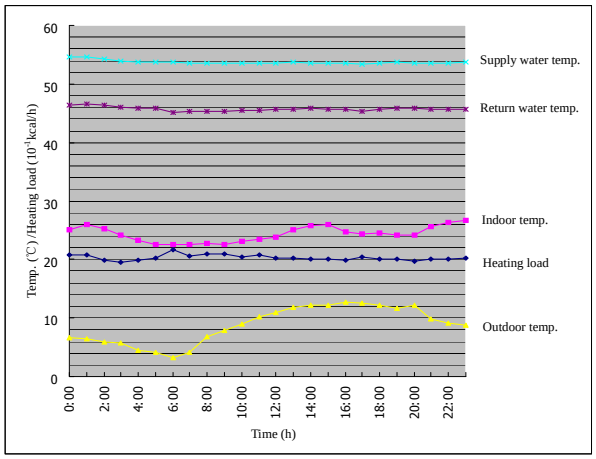

Fig. 2 Changing trends of parameters for substation heating system (Mar. 8, 2000)

From Fig. 2 and 3 we can see that the fluctuation of the supply and return water temperatures of the secondary network is very small, but the fluctuation of indoor air temperature is large, which has the same changing trend as that of outdoor air temperature. The reason includes that the supply water temperature of the primary network is controlled by Beijing District Heating Group, which keeps stable during a period of time, and the flow fluctuation of the primary and secondary network is very small. As for end users, when the outdoor temperature goes down/up, the heating load increases/decreases. If the heat supply keeps stable, the indoor temperature would goes down/up accordingly.

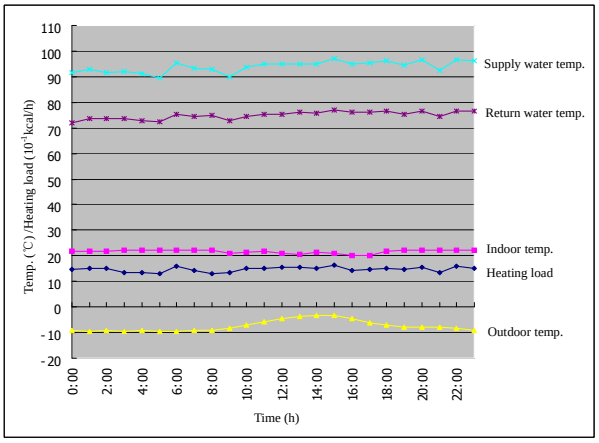

Fig. 3 Changing trends of parameters for boiler station heating system (Jan. 22, 2000)

As for boiler station heating system, the fluctuation of supply and return water temperature is very large, because the operator would adjust the supply temperature of boiler according to outdoor weather conditions. Basically the supply water temperature changes as well as heating load with the change of outdoor air temperature. When outdoor temperature goes down, the heating load increases, and the operator would adjust the boiler burning situation to improve the supply water temperature as well as heat supply. Therefore, the fluctuation of indoor air temperature of boiler station heating system is smaller than that of substation heating system.

3.2 Analysis on Heating Index

From table 1 we can see that the actual average heating indexes (under the outdoor temperature of -9) of substation heating system and boiler station heating system are 72.5W/m^2 and 44.1W/m^2 respectively, the required heating indexes (under the outdoor temperature of -9) are 55.3W/m^2 and 41.1W/m^2. The heating index can be controlled at about 45W/m^2 to save energy and decrease pollution.

3.3 Analysis on Energy Conservation

Table 1 shows that during the whole heating season the actual heat supply of boiler station and

substation heating system is much higher than the required heat. The average indoor air temperatures are 19.3 and 23.45 respectively, which are higher than the design temperature of 18 . In that case, since the indoor temperature is too high, the users always open the window leading to large amounts of heat waste. If indoor air temperature keeps at 18 , the related required heat supply would be 132,502.92GJ and 28,126.68GJ respectively, and the potential of energy conservation is 6.93% and 23.78% respectively. Therefore, the quantificational management of the heating monitoring system can lead to large energy conservation.

Tab. 1 Heat supply analysis for 1999-2000 heating season

	Yuxin District	BICEA（1#）
Average Indoor Temp. t_{np}（ ）	19.3	23.45
Average Outdoor Temp. t_{wp}（ ）	0.53	0.53
Heating Days（days）	138	134
Heated Area（m^2）	418,200	67,943
Total Heat Supply（GJ）	142362.9	36901.17
Heating Index Under t_{wp}	28.6	46.9
Heating Index Under -9	44.1	72.5
Needed Heat Supply Under the t_{np} of 18 （GJ）	132502.92	28126.68
Needed Heat Supply（t_{wp}）	26.6	35.8
Needed Heating Index Under -9	41.1	55.3
Energy Saving Potential	6.93%	23.78%

4. CONCLUSIONS

1) The usage of computer monitoring system in heating system may guide the operation of heating system, decrease indoor temperature fluctuation, and improve comfort.
2) During most of the heating season, actual heating index of heating system is much higher than the needed heating index, especially in the last period of heating system. According to heating index analysis, average heating index of Beijing area may be controlled at about 45w/m^2.
3) The energy saving analysis shows that Yuxin district and BICEA have an energy savings potential of 6.93% and 23.78% respectively. If heating system can operate with the basis of quantificational management, the integrated energy saving potential could be about 15%.

5. ACKNOWLEDGEMENT

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