

Control mode of household heating system

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Abstract: Aiming at the current household heating system, discuss the control principle and character from heat source to the end-user, and analyze the control equipments, measures as well as the advanced regulations and control theories in order to provide the valuable suggestions to reduce the energy consumption of the entire heating system and also to enhance the efficiency of the heat distribution and system circulation.

Keywords: control mode, household heating system, Hydraulic Balance of Heating Network, Energy saving

1. Introduction

The fast development of market economy is pushing the Chinese heating supply from welfare to market activities. By fulfilling the new demands arising from the new household billing and measurement heating system, new equipments and system modes are adopted. Here, some necessary control measurements and devices are discussed and hope those would provide some beneficial suggestions to colleague working in this field.

2. Control of heating source

The basic principle for control of heating source is to keep the dynamic balance between the heat load and heat supply, which means heat generation matches heat consumption, no more no less. Therefore, the parameters, which lead the changing of heat load, should be monitored. For heating system, there are two elements contributing to this, outdoor temperature and indoor free heat such as heat emission of appliances, sunshine and people etc. Among the those elements, the outdoor temperature definitely influences the change of overall heat load, so it is necessary to adjust the heat resource based on outdoor temperature.[1] Compared with outdoor temperature, other elements just have impacts on the individual or part of the residence, and this does not necessarily cause the change of total heat load of a building or a district and was able to be overcome by heat redistribution within system instead of the heat source.

Thus, the outdoor temperature can be used as the basic parameter for controlling the heat supply or

generation at heat source, meanwhile, the return temperature as well as typical room temperature need to be considered as reference. The most simple and common way to do this is to establish a function between outdoor temperature and flow temperature of heating system so that the flow temperature could be automatically adjust with the outdoor temperature. Of course, how to realize this control depends on different type of heat source. Fig.1 and Fig.2 show how a heat exchange substation to achieve this by controlling primary flow through motor valve. By this, the relation between the heat load and heat supply is reasonably set.

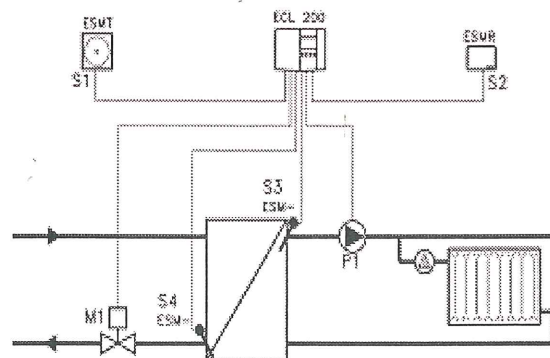


Fig.1. Control of Weather Compensation Substation

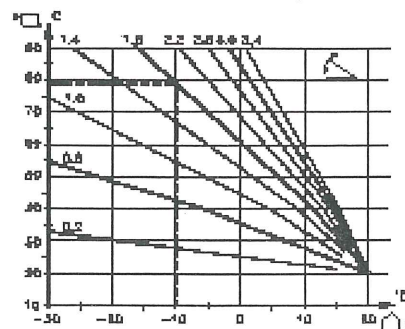


Fig.2. Heating Curve of Outdoor and Flow Temp

Another component, which need to be taken into consideration is circuit pump. Even, the flow temperature changes with the outdoor temperature, heat supply is still more than what really demanded from buildings because we need keep the heat authority more than one for individual room temperature setting, and flow temperature could not be too low considering the efficiency of heat source. In fact, the residents control their room temperature by thermostat, which regulate flow to radiator, fan coil or other terminal units. So, frequency converter should be used to control the circuit pump in order to prevent pump fall into low efficiency zone because of the possible low flow, meanwhile, this dramatically reduce the energy consumption of pump. There are mainly three methods used for pump control: constant differential pressure control; proportional differential pressure control; parallel differential pressure control. (See Fig. 3)

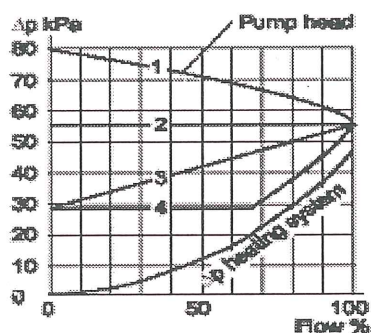


Fig.3 Relation of water head and flow

In Fig.3, Curve No.1 is the pump without any control, Curve No.2 is the pump with constant differential pressure control. Curve No.3 and No.4 separately indicate the pump with proportional and parallel differential pressure control. When the constant differential pressure control is applied, the water head of pump would be constant despite the reducing of flow, but, for the proportional and parallel control, the water head of pump decrease with the drop of flow. However, the minimum value of water head is half of the water head of max. flow. Of course, the last two have better control result, but good knowledge of system resistance characteristics is critical for successful control. Compared with those two, the constant differential pressure control is easy and simple.

3. Hydraulic Balance of Heating Network

The main task of heating network is to reasonably distribute the medium to each end user and maintain the hydraulic and thermal balance among the users. As

it is discussed above, the flow of heating network varies according to the regulation and control. Therefore, how to maintain the balance in this variable flow situation becomes the key point of a successful heating network control. The manual balance valve normally used in traditional constant flow system is not able to keep the balance because they could only guarantee the desire balance at design flow. When the system flow deviates from the design value due to the regulation either from end users or heat source, the balance established by manual valve would disappear immediately since the manual valve is not going to give any response to the new flow conditions [2].

So, what we need is a device which automatically react to the flow change of system and provide the adequate and stable flow supply to each terminals. Self-acting differential pressure controller is one of such equipments. It can automatically adjust its own resistance with the change of available differential pressure from heating network, and always keep constant differential pressure after valve in spite of the flow variation. Because it is a self-acting device, what we need to do is to set the desire differential pressure during the installation by releasing or tightening the setting spring, and this setting would be held during the whole running process. Fig. 4 just shows how the differential controller works, the curve indicate the water head of circuit pump, and the white section is the resistance of differential pressure controller, it automatically adjusts following the available pressure at entrance of end user so that the differential pressure to end user, the grey section, is constant and uniform despite locations and flow change.

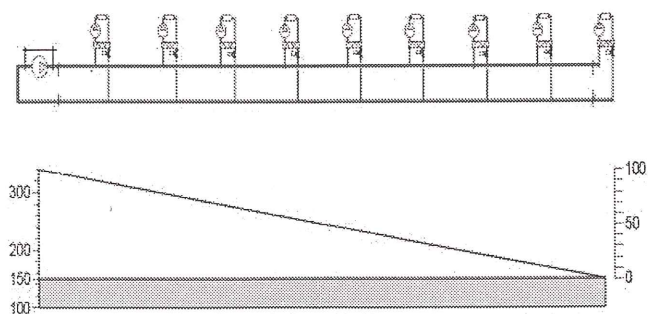


Fig.4 Utilization of DP controller in heating network

4. Room temperature control and heat consumption measurement

Based on current heating system in China, the heating billing and measurement system are mainly in

two categories, one for renovation and one for new building. The renovation is to convert the old one pipe system and two pipe system into a system in which the room temperature control and heat measurement can be done. The systems for new building are quite flexible and have many options. However, the basic two functions of heating system need to be met, one is individual room temperature control, one is heat consumption measurement. Fig.5 indicates such a system. The thermostat radiator valve accomplish the task of auto room temperature control, the heat meter at the heat entrance of the apartment measure the heat consumption. Of course, self-acting balance valve may also be needed to balance each apartment and different risers.

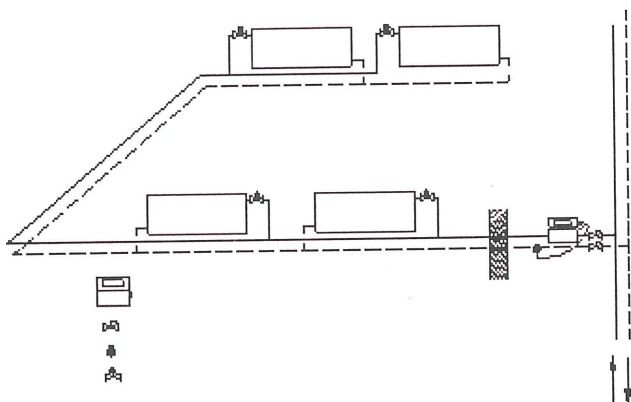


Fig.5. New household heating billing measurement system

Talking about the renovation, the main problem of one pipe system is that the radiator are serially connected from top to bottom floor, the flow through each radiators is unchangeable. The renovation must make the flow through radiator adjustable, and the individual radiator adjustment give minimum influence to other radiators.

Presently, the approach for this problem is to add a bypass, which is one size smaller than the vertical pipe together with a thermostat valve toward radiator. By doing this, 30 % of flow goes through the radiator when the valve is fully open, and other 70 % goes through the bypass pipe directly. Thermostat valve control the 30 % flowing through the radiator in order to maintain the desire room temperature, the bypass pipe let unnecessary water reach to the radiator in next floor with almost the same temperature as original one pipe system. The doubt cast on this solution is weather

the 30 % of original design flow through the radiator can give same amount of heat supply as the original one pipe system. In fact, the heat emission of radiator reduces after adding bypass pipe, however the reduction is less than 10%, and this small reduction is compensated either by original over-size radiator or a slight flow temperature increase. Fig. 6 displays a clear explanation of this. The surface temperature of radiator is the drive force of heat transfer, yet in original one pipe system the flow has reached the section which make slight contribution to the surface temperature of radiator. So, even the flow toward the radiator is cut down to 30% of original valve the heat emission is above 90% original value at same flow temperature[3].

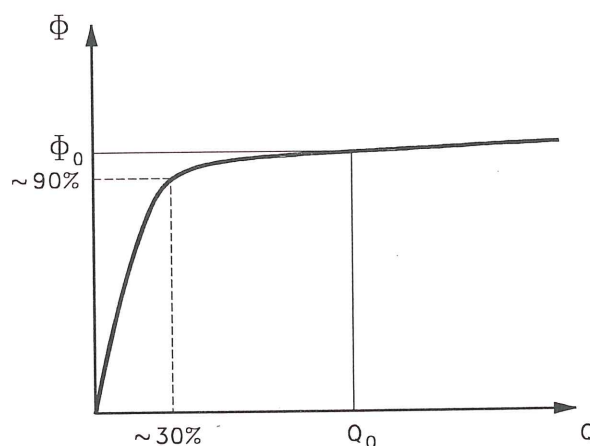


Fig.6. Relation between heat emission and flow volume in convection radiator

The heat measurement for the renovation system could be achieved by heat allocator on each radiator with a general heat meter at the entrance of a building or district. Considering the possible different temperature drop at each riser, a flow limiter normally is needed for the riser. Fig. 7 give a sketch of this sort of renovated system.

5. Conclusion

A successful heating control system is a combination of a variety of regulations and controls from heat source to end user. To introduce new concepts of control theory and new control devices is probably the most important thing. We are used to the traditional constant flow system with pretty limited control or even no control at all, which cause tremendous energy waste, the thermal environment of the building is far below the demand of resident. Therefore, to adopt the

proper control method of heating system is critical for the further development of heating business in china.

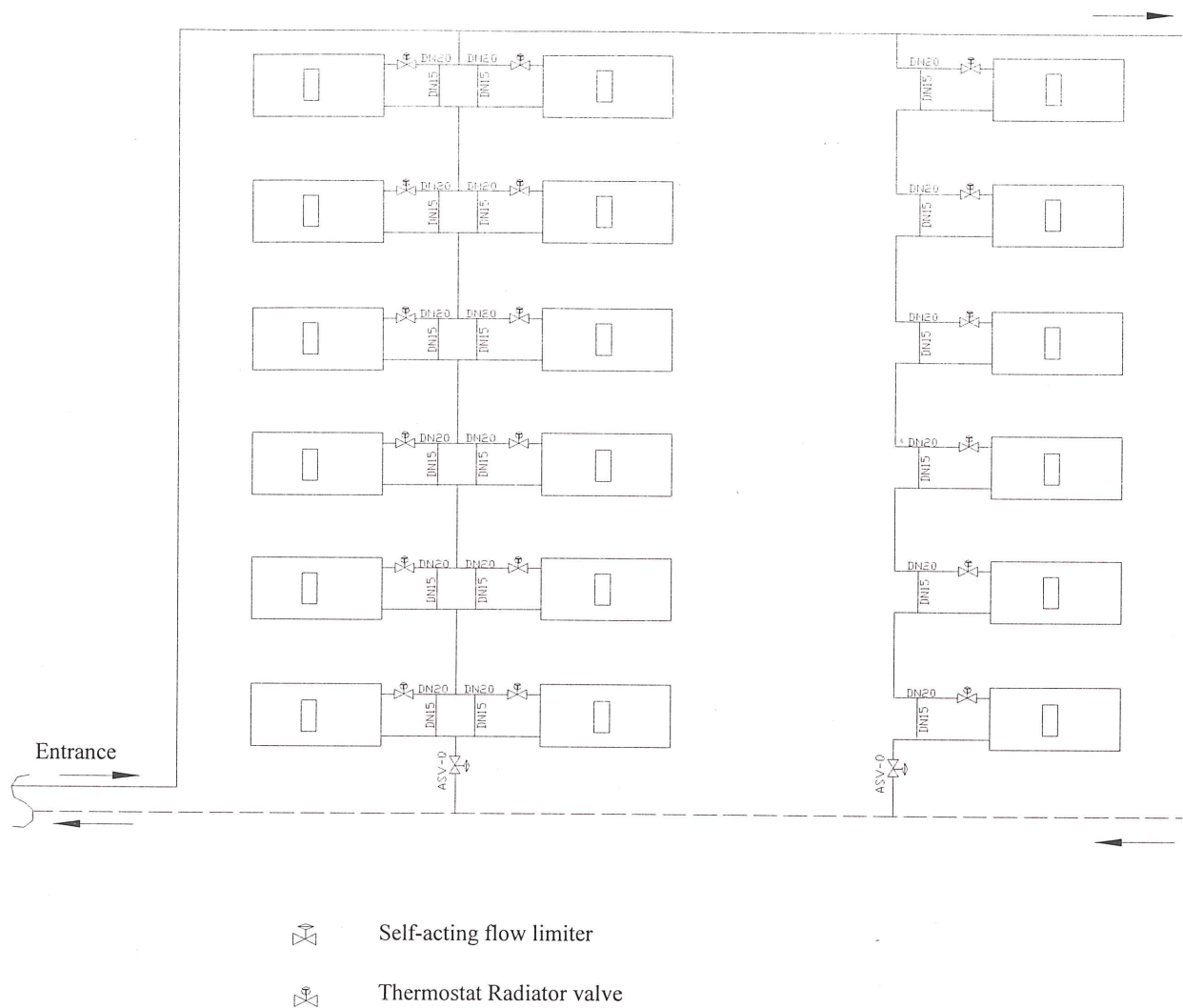


Fig.7. Example of one pipe renovation system

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