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Analysis of the dilatancy technology of district heating system with high-temperature heat pump

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ABSTRACT

The article described the dilatancy technology of district heating system with high-temperature heat pump (HTHP). For the exploitation of low-temperature return network sources, a high-temperature heat pump with a heat exchanger was planned. As the core technology of the dilatancy district heating system, HTHP units and heat exchanging systems had been described detailedly through theoretical and experimental analysis. The model was proved to be in good agreement with the experiment data. It could be used for engineering design. In this paper the district heating system in Datong was taken as a case study. The main characteristics of the dilatancy district heating system had been presented in the form of diagrams. The principal advantage of dilatancy technology in the district heating system lies in increasing the temperature difference, reducing the diameters and the initial investment of primary side network. This paper shows clearly the analysis of the dilatancy technology for characterising and improving the performance of district heating systems.

1. Introduction

Heat supply for residential and commercial sectors consumes a large portion of domestic energy in China. Most of the heat has been supplied by gas-fired, oil-fired or coal-fired combustion boilers. However, owing to the energy crisis and global warming problem, heat pump technology which alternates classical combustion boiler is gathering the focus. Much research has been published regarding the HTHP since 1990s. In the literature many papers had proposed various kinds of high-temperature heat pump [1–3], but the outlet water temperature in these studies was consistently below 70 °C. Such a temperature cannot be directly used by fin-type heating radiators. A high-temperature heat pump can recover the heat and produce high-temperature water up to 85 °C to heat a building using fin-type heating radiators. High-temperature heat pumps usually supply 65–95 °C hot water by using 20–55 °C low grade waste heat resources. And the quantity of heat is released by condensing in the condensers. High-temperature heat pumps can be widely utilized for waste heating as an energy-saving method due to their high condensing temperatures [4].

By changing the model of heat exchanger station system, the high temperature heat pump technology is applied to traditional district heating system. According to the heating network conditions and the needs of heat consumers, a traditional system is transformed by using the dilatancy technology to enhance the capacity of district heating system. Fig. 1 presents schematic diagram of dilatancy in a district heating system. Through a heat exchanger, HTHP is connected to a secondary side-local heating network. The import and export temperature of a heat exchanger is 65/40 °C. The import and export temperature of a evaporator is 50/30 °C. The import and export temperature of a condenser is 65/85 °C. HTHP just likes a use of low temperature system.

2. The basic principle

2.1. Traditional water–water heat exchanger station

A traditional water–water heat exchanger station connects primary pipe network and secondary pipe network by using one or more heat exchangers. A heat exchanger unit is planned to supply heat to the heat consumer. In this way, the district heating network is decoupled from the building appliances and systems installed. They are not directly determined by the mass flow rates and temperature drops in the building systems. All houses are connected in parallel to the local distribution network (secondary side of the heat supply). Table 1 shows the parameters of a traditional water–water heat exchanger station.

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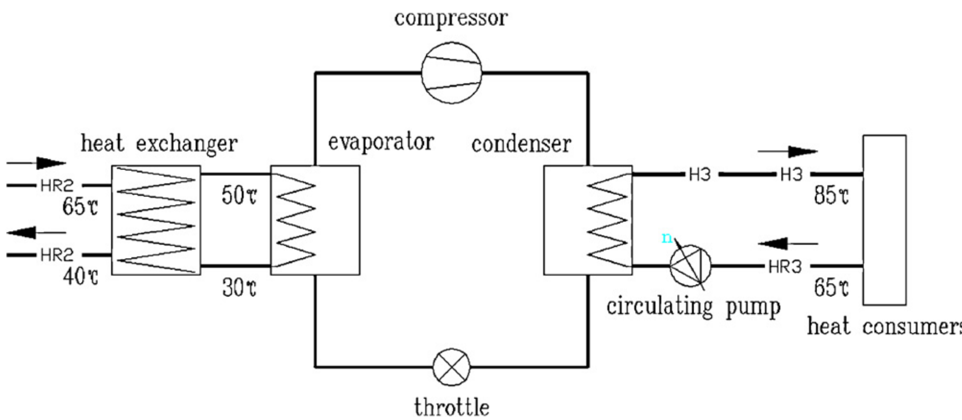

Fig. 1. A schematic of the dilatancy in district heating system.

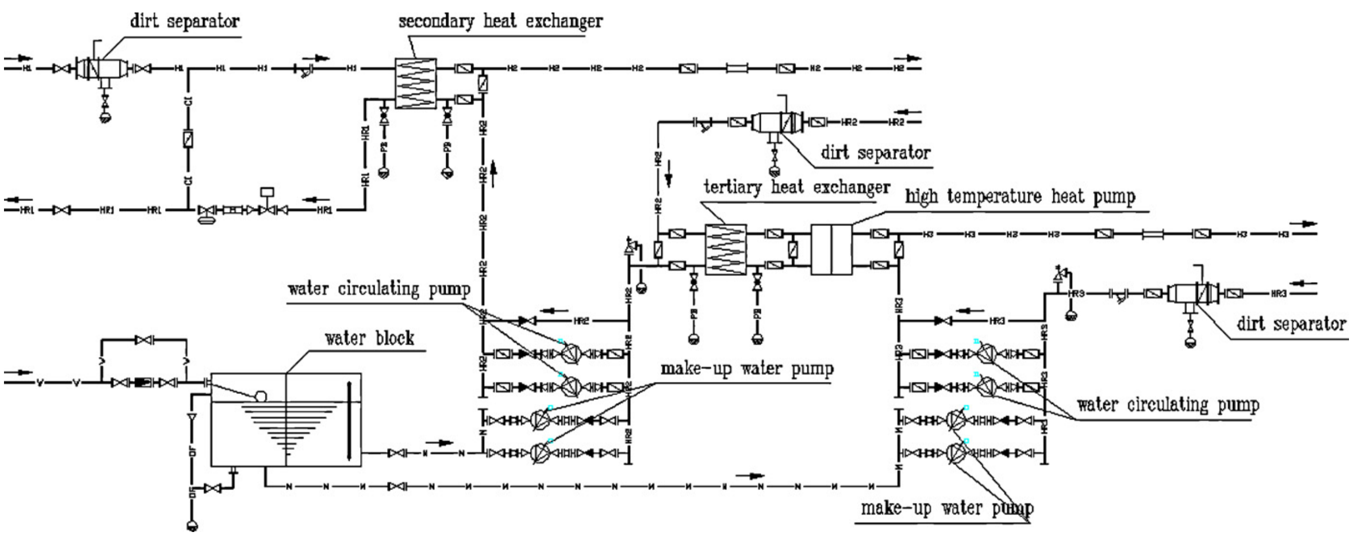

Fig. 2. A schematic of the dilatancy water–water heat exchanger station.

2.2. The dilatancy technology of district heating system with HTHP

On the one hand, the new heat exchanger station which makes use of the dilatancy technology connects primary pipe network and secondary pipe network to transfer heat. On the other hand, it can extend the heat capacity of a district heating system with HTHP. Fig. 2 shows a schematic of the dilatancy water–water heat exchanger station. A new heat exchanger station consists of three parts:

1. The secondary exchanger transfers the quantity of heat from the primary side-district heating network to the secondary side-local heating network to supply heat to the heat consumers.
2. The tertiary exchanger transfers the low-temperature heat from the secondary return pipe to HTHP.
3. HTHP recovers the heat from low-temperature water and produce high-temperature water up to 85 °C to heat building using fin-type heating radiators.

Table 1
Parameters of a traditional water–water heat exchanger station.

Component	Temperature (°C)
Primary side-district heating network	120/70
Secondary side-local heating network	85/65

The dilatancy technology of district heating system can reduce the primary return water temperature and enlarge temperature difference to extend the heat capacity of a district heating system. Table 2 shows the parameters of the dilatancy technology of district heating system.

3. Simulation analysis of energy consumption

Fig. 3 shows the flowchart for operational energy consumption in the dilatancy technology of district heating system.

3.1. Annual heating load

According to the outside temperature, the calculation of heating load is developed. And accumulative total heat load is deduced on

Table 2
Parameters of the dilatancy water–water heat exchanger station.

Component	Temperature (°C)
Primary side-district heating network	120/50
Secondary side-local heating network	85/75
Tertiary side-local heating network	75/65