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Field Test Analysis of a Urban Sewage Source Heat Pump System Performance

Qunli Zhang^{a,*}, Zhiming Wang^a, Chaohui Yin^a, Qian Nie^a, Liwen Jin^b

^aBeijing Municipal Key Lab of Heating, Gas Supply, Ventilating and Air Conditioning Engineering, Beijing Advanced Innovation Center for Future Urban Design, Beijing University of Civil Engineering and Architecture, Beijing and 100044, China

^bGroup of Building Environment and Sustainability Technology, Building Environment and Equipment Engineering, Xi'an Jiaotong University, Xi'an and 710049, China

Abstract

The sewage flow rate of the urban drainage system is relatively large and generally stable, its sewage temperature range varies relatively lightly and maintains 10~15°C in winter. The sewage in the drainage system can be the low grade thermal source for building heating and cooling. Sewage source heat pump technology can efficiently extract or discharge the amount of heat from the sewage in the drainage system for building heating or cooling. The field test of the actual operation thermal performance of the sewage source heat pump were carried out and investigated. The sewage source heat pump system were continuously measured for 72 hours. Based on the test datum, the average COP of the heat pump was 4.5. The relationship between energy consumption of system and energy consumption of transportation are analyzed. The analysis shows that the pump of this system cannot match the load change well and the use of variable frequency pump can improve the energy efficiency of the system. Before the use of the sewage source heat pump system, the traditional coal-fired boiler and air-cooled chiller are the heating and cooling system of this building. Compared with the traditional coal-fired boiler and air-cooled chiller, the advantages of sewage source heat pump system in energy saving, economy and environmental protection are analyzed. The results show that: Compared with the original system, direct heat exchange type sewage source heat pump system can save 53% of the primary energy consumption, reduce the annual operating cost by 11%, increase the initial investment by a factor of 14.3%, and the payback period of incremental investment is about 4.7 years. This method not only has better energy saving, saving capital benefit, but also can reduce the local pollutant emission, and has better environmental emission reduction benefits.

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* Corresponding author. Tel.: 13522898182;
E-mail address: zhangqunli@bucea.edu.cn

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1. Introduction

Urban sewage water temperature and rate of flow stable throughout the year, and the characteristics of the temperature warm in winter and cool in summer^[1]. Urban sewage contains rich resources of low grade thermal energy^[2]. Chinese 13th Five Year Plan points out in the hot summer and cold winter areas to actively push the sewage source heat pump^[3]. The sewage source heat pump is a heat pump as cold heat source by sewage, through a small amount of electricity heating and cooling for the building^[4]. The sewage source heat pump system has significantly energy saving efficiency. According to the way of sewage heat exchanger, the sewage source heat pump system can be divided into direct sewage source heat pump system and indirect sewage source heat pump system^[5]. Indirect sewage source heat pump system is a kind of system that is not directly connected with heat pump heat pump, first, the sewage and clean water heat exchange, then the intermediary water into the heat pump heat pump. The direct sewage source heat pump system is the system of the heat transfer of the sewage directly into the evaporator or condenser of the heat pump heat pump.

2. Direct heat exchange sewage source heat pump system scheme

The sewage source heat pump system for the hotel building air conditioning system, located in Changchun of the cold area. The hotel construction area of 15 thousand square meters, the main purpose is to provide high standard rooms. Prior to the transformation of the project, the use of coal-fired boiler room heating, cooling air cooling chillers in summer; now direct heat exchange sewage source heat pump system for heating / cooling. The reconstructed heat pump is shown in Figure 1, the system flow chart is shown in Figure 2.



Fig.1 Sewage source heat pump heat pump

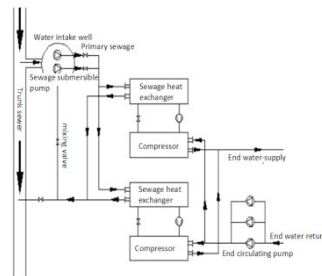


Fig.2 Direct sewage source heat pump system

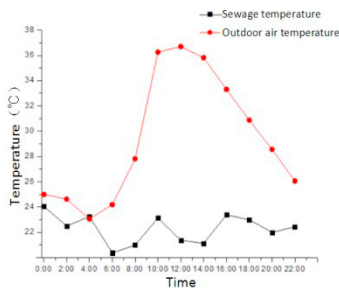


Fig.3 Sewage temperature and outdoor temperature in summer

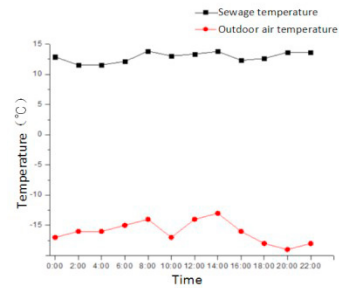


Fig.4 Sewage temperature and outdoor temperature in winter

Sewage flow and sewage temperature have a great influence on the operation of sewage source heat pump system. There is a diameter of 1000mm trunk sewer distance 15 meters from the building. The actual measurement of the minimum flow rate is 1000m³/h-1500m³/h. In winter, the temperature of sewage water is 12 ~13°C, and the temperature in summer is 22~24 °C, pH value is neutral. After operation, the inlet temperature and outdoor air

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