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ScienceDirect

Procedia Engineering 205 (2017) 694–701

Procedia Engineering

www.elsevier.com/locate/procedia

10th International Symposium on Heating, Ventilation and Air Conditioning, ISHVAC2017, 19-22 October 2017, Jinan, China

Analysis of the Secondary Network Flow Distribution in Absorption Heat Exchange Unit

Xiaoyin Wang[a], Xiling Zhao[a,*], Tao Sun[b] and Lin Fu[a]

[a]*Department of Building Science, School of Architecture, Tsinghua University, Beijing, 100084, China*
[b]*Beijing Tsinghua Tongheng Urban Planning and Design Institute, 100084, Beijing, China*

Abstract

An absorption heat-exchanger consists of an absorption heat pump driven by hot water and a conventional water-water heat exchanger. The return water of the secondary network is divided into two units: one part is sent into the water-water heat exchanger, heated by the primary network, and the other is heated in the absorption heat pump. Finally, the water of the two parts is mixed and transmitted to the end consumers. The flow distribution of the secondary network will affect the return water temperature of the primary network. The flow proportion of the secondary network and primary network in the water-water heat exchanger is selected 1:1~2:1, according to the experience in practice. However, the actual operation effect may not be optimal. The flow distribution principle of the secondary network is proposed in this paper through simulation calculation. The optimal flow distribution principle is obtained by calculating the minimum value of the return water temperature of the primary network. The results provide the reference for the optimized design and operation of the ab-sorption heat exchanger.

Keywords: Absorption heat exchanger; Flow distribution; Simulation

1. Introduction

In the current large area district heating system, the supply water temperature of primary network reaches up to 120-130 ℃, which can improve the delivery capacity of the network by increasing the circuit temperature drop. There is a large temperature difference between the primary and secondary network, resulting in an irreversible heat loss.

* Xiling Zhao. Tel.: +86-10-62788513; fax: +86-10-62770544.
E-mail address: zhaoxiling@126.com

1877-7058
10.1016/j.proeng.2017.09.887

Fu[1] put forward the absorption heat exchange technology to use the large temperature difference between the primary and secondary network as the driving force. The return water temperature of the primary network can be lowered to about 20 ℃ with the supply water temperature 120 ℃, while the supply/return water temperature of the secondary network being 50/40 ℃.

The application of absorption heat exchange units in substations can have the following effects: 1) The lower return water temperature means the larger temperature drop of the primary network. And the diameter of the pipe can be smaller, thus reducing the initial investment for a newly-built network and improving the transmission and distribution capacity for the existing network. 2) In the heat source, low-temperature return water is used to recover the low-grade heat (e.g. the exhaust steam of a turbine, low-temperature industrial waste heat).

The concept of absorption heat exchange and the technology of district heating system with co-generation based on absorption heat exchange are proposed by the researchers from Tsinghua university in 2008 for the first time[1]. Subsequently, these technologies have been studied by many researchers.

Li[2] puts forward a new heating method to realize low-grade renewable energy recovery by absorption heat pump in the substation of district heating system. Configuration and operation strategy of the system are also analyzed. Comparing with conventional district heating system, the new one can save energy by 23-46%. Sun[3] analyzes a new waste heat district heating system with combined heat and power based on absorption heat exchange cycle. According to the thermodynamics and exergoeconomic analysis, this system can enhance heat transmission capacity of the primary network by decreasing the return water temperature with new type absorption heat exchange. Li[4] introduces the technique of flue gas waste heat recovery in gas cogeneration based on absorption heat exchange. And the energy saving analysis, economic analysis are presented. Zhao[5] puts forward a flue gas recovery system for a natural gas combined heat and power plant with distributed peak-shaving heat pumps based on a 9F level gas-steam combined cycle unit. Low-temperature conditions are created in power plants in order to recover the waste heat.

The technology of absorption heat exchange has been applied in many projects successfully. The first demonstration project was set up in Chifeng at the end of 2008. After two heating seasons' continuous operation, each performance index of the system basically achieves the expected effect[6]. This technology has been applied in Datong No. 1 thermal plant, Shanxi province, in December 2010. The tests of the demonstration project indicate that the technology of district heating system with co-generation based on absorption heat exchange can improve the heating capacity of the heat source[7,8]. These objects in Datong have been operated successfully for three heating seasons by 2013 with stability and reliability[9]. Besides, this technology has been applied in many demonstration projects in Beijing, Shanxi, Inner Mongolia, and Shandong. According to long-term observation and detection, the operational units can run safely and steadily under different operating conditions, and performance indicators of the system can satisfy the design demands[10].

The absorption heat pump and the water-water heat exchanger are the main components of the absorption heat exchange unit, as shown in Figure 1. High-temperature supply water of the primary network is used as a driving force to successively release heat to the dilute solution in the generator of the heat pump and the water-water heat exchanger. Then it transfers heat in the evaporator and returns to the heat source at a low temperature. The return water of the secondary network is usually divided into two flows. It is heated in the absorber and the condenser of the absorption heat pump and water-water heat exchanger in parallel. Finally, they are mixed and transmitted to the end users. By means of this form, the secondary network with high flux is divided into two flows with smaller flux, which can decline the heating loss.