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# Energy saving potential of low temperature hot water system based on air source absorption heat pump

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ABSTRACT

Boilers are widely used to generate low temperature hot water for heating and domestic hot water. In order to improve the efficiency and decrease the emission of pollution in the process of producing low temperature hot water, a heating system based on air source absorption heat pump (ASAHP) is proposed. A simplified model of the proposed system is built based on the heat and mass balance. The model is verified by comparing the predicted results with those from a previous reference. The performances of ASAHP using $H_2O$/LiBr and $NH_3$/$LiNO_3$ as working fluids are simulated at different air temperatures. Based on the simulated performance, energy saving potential of the proposed system applied in four typical Chinese cities is analyzed. The results show that the proposed system can provide energy saving rates of 18%, 28.5%, 37% and 42% in Shenyang, Beijing, Shanghai and Guangzhou respectively, showing great potentials in future applications of low temperature hot water.



## 1. Introduction

Energy used for heating and domestic hot water accounts for a large portion in the whole energy consumption. According to the statistics, heating consumed about 226.2 million tons of standard coal in 2006, taking up 40% of the whole building energy consumption in China, while the energy consumption for domestic hot water is about 35 million tons of standard coal in that year [1]. As the building areas are increasing rapidly and the requirements of indoor environment are being improved, the energy consumption for heating and domestic hot water will also increase rapidly in the future.

The water temperature for heating is usually classified into four ranges: 90/70 °C (supply/return temperature) of high temperature heating, 55/35–40 °C of medium temperature heating, 45/25–35 °C of low temperature heating and 35/25 °C of very low temperature heating [2]. For domestic hot water, the supplied water temperature is mostly between 30 and 60 °C [3]. So the temperature involved in heating and domestic hot water needs not to be very high and it is a general tendency to use low temperature hot water, which can allow for efficient use of energy and provide flexibility in the choice of energy sources [4].

There are several kinds of methods for hot water production at present, such as combined heating and power system (CHP), district boiler system, decentralized coal or gas furnace, electric heat pump system, direct electricity heating and so on [1]. At present, the most commonly used method to produce hot water is based on fuel burning in a boiler. For boiler system, direct water mixing and heat exchange through a plate heat exchanger are two main approaches to generate low temperature hot water. The efficiency of coal boiler is usually between 60% and 85% while that of gas boiler is usually above 85%. In developing countries like China, the efficiency of coal boiler with small capacity can be as low as 35% [1]. According to the theory of second law of thermodynamics, the lower the required water temperature is, the higher the energy efficiency should be. Therefore, the energy efficiency of hot water production in heating and domestic hot water should be much higher than that in the production of high temperature hot water. However, the efficiency of boiler is not higher (sometimes even lower) when producing relatively low temperature hot water. The low efficiency is a response to the process of water mixing and heat exchange.

An effective technology to improve the energy efficiency of boiler is absorption heat pumping. Absorption heat pump (AHP) is a thermally activated device that can produce hot water from the heat released by the absorber and condenser [5]. If the high temperature hot water from boiler is used to drive the AHP which can then extract low-grade heat from evaporation side, the fuel consumption of boiler can be reduced greatly with the same heat production. Thus, the energy efficiency based on fuel can exceed 100% since energy stored in air is used.

There have been some researches and applications on absorption heat pump in heating area. In an application of waste heat

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