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The related problems and development situation of air source heat pump in the cold and serve cold climate areas

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Abstract

Due to high efficiency, energy saving, environmental friendliness and safety, the air source heat pump (ASHP) has drawn much attention in the cold and serve cold climate areas of China. In recent years, the Chinese governments further promote the application of air source heat pump in the cold and server area in order to reduce conventional energy consumption and haze occurrence frequency in heating season. The outdoor air temperature is low and fluctuates greatly in these areas, which might lead to unstable running, low efficiency and frequent frost. In this paper, the development direction of ASHP in cold and serve cold was pointed out by analyzing the existing problems of air source heat pump under low temperature condition. These results could provide some references for promotion and application of ASHP in cold and serve cold area like Qinghai province.

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Keywords: Air source heating pump (AHSP); Cold and serve cold area; Adaptability

1. Introduction

The main fuel for heating in winter has long been relying on coal in Chinese northern regions in future ten years. With the development of economy, the expansion of urban scale, energy conservation and environmental issues are increasingly drawn more attention from worldwide. The traditional way of heating cannot meet the requirements of sustainable development due to more and more prominent shortcomings. According to statistics, coal-fired heating

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has become the main source of air pollution in the northern winter city. So it is very practical significance for these areas to explore some of the sustainable development of clean heating technology. The air source heat pump developed rapidly in recent years because it is easy to use, high energy efficiency, no pollution emissions. The manufacturer has increased more than 40% from 1995. Up to 2002, the output of heat pump accounted for 70% of domestic air-conditioning productions, which are about 36 million units. There are a lot of brands of air source heat pump in China, which could realize the function of cooling and heating. At present, the application of air source heat pump is extremely widespread in Tianjin and Xi'an [1, 8, 9, 10], which indicates that its application of ASHP has the trend toward northward. The problems of frost in Chinese northwest, like Qinghai and Gansu province, is not as serious as that in Changsha because the moisture content is so low in these areas. If the air source heat pump can solve some operation problems in the low temperature environment, it will become the most competitive and potential technological means of replacing traditional heating mode because of energy saving and environmental protection for 21st century. How to use air source heat pump producing hot water of 50 °C in the winter of cold areas is of common concern. The preliminary application analysis of the air source heat pump in the cold areas is conducted in order to answer this problem.

2. The related operation problems of air source heat pump in the cold and serve cold climate areas

Air source heat pump is a kind of device which can be used in the natural resources and waste heat resources according to the principle of the inverse Carnot cycle. The low temperature heat source of air and the low level heat energy in the air could be fully used by inputting less electricity. The coefficient of performance (COP) of ASHP could be reach 3.0, which means 3 kW heat could be obtained only consuming 1kW electricity. It is easy to install and use in the worldwide due to relative higher energy efficient and environmental friendliness. When the ambient temperature is relative high, the air source heat pump's performance characteristic is relative higher. However, when the air source heat pump is applied to heating in the cold and severe cold area, the refrigerant inspiration specific volume increases along with outdoor ambient temperature reducing, which further causes the decreasing of the heating ability.

Meanwhile, the decrease of ambient temperature will results in a depression of the inspiration pressure, which would then, produce a sudden increase in the exhaust temperature of the unit. Relatively higher compression ratio can also cause the reduction of the compressor's gas transmission coefficient, as well as the air volume and the efficiency. The viscosity of the lubricating oil drops sharply, which affects the lubrication of the compressor. Thus, it is not suitable for heat pump system to be promoted and applied in North China considering the frequently start and stop of the system.

The frosting of air source heat pump is another important reason to popularize the air source heat pump. However, when the air source heat pump is running between -6 and 5 °C and the relative humidity is above 65%, outdoor heat exchanger surface is most likely to frost [7]. In literature [2], North China area and the Huanghe River valley are the mild rime areas. Therefore, instead of frosting, the low temperature applicability problem in these areas is the main problem of air source heat pump application.

Although frost problem is not serious in the cold area of northern China, due to indoor environmental temperature instability, frosting accident occurred frequently. Air source heat pump defrosting should include two cases from the full sense: First, the surface of the outdoor heat exchanger has frost, but the defrost system doesn't work when it should be; Second, the outdoor side of the heat exchanger surface only has a small amount of frost (not to achieve the requirements of defrosting frost) or no frost, but air conditioner central controller has issued a defrost command, thus, the heat pump will stop heating and the defrost system starts to operate. These two conditions are very harmful to the "safe, reliable, stable, economical" operation of air source heat pumps. These two kinds of phenomenon are too serious in actual operation. The hot and cold water unit defrost system probably has 27% is defrosts by mistake [3, 5, 6].

Take an air source heat pump hot and cold water unit (R22) as an example. Assuming that it operates in the major cities of the northern cold region, provide 50°C hot water for the central air conditioning system under outdoor heating temperature conditions. It is clear from the calculated compression ratio of the unit: Unit in the vast majority

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