The Exploration on the Energy Saving Potential of an Innovative Dual-temperature Air Conditioner and the Mechanism of the Theoretical Mixed Refrigeration Cycle

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Abstract A conventional room air conditioner can cause unpleasant draft sensations and to produce poor indoor air quality. A typical energy-saving radiant cooling air conditioning system makes use of chilled water for cooling. It may also incur energy losses due to secondary heat transfer existing in the whole process. To overcome these disadvantages, an innovative dual-temperature air conditioning system and its corresponding theoretical mixed refrigeration cycle are proposed. This consists of a separate air handling unit and a metal radiation panel as the dual-temperature evaporators, a compressor, a condenser, two thermal expansion valves and an ejector. Mass and energy conservation equations are established for the air handling process and the theoretical mixed refrigeration cycle is analyzed. The state properties in the thermal processes and system performance are determined and compared with those of the conventional air conditioner with fresh air. It is found that the coefficient of performance（COP）of the theoretical dual-temperature refrigeration cycle improves by 13.35% to 7.47.

Keywords dual-temperature air conditioner; mixed-refrigeration cycle; COP; ejector; metal radiation panel.

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In a room with a conventional air conditioner, the supplied air is not evenly distributed and there may be a draft sensation, which may cause "air-conditioning symptoms", such as headache, chest distress, dizziness, etc. [1] In comparison, the indoor air temperature distribution in rooms with radiant cooling is relatively even and the thermal comfort sensation can be improved. The energy consumption can be reduced to some extent as well. If the radiant cooling can be supplemented by a fresh air supplying system, it may even improve the indoor air quality [2, 3]. However, radiant cooling usually uses chilled water as the medium to supply cooling, that is, the chilled water flows through the pipes embedded on the panel which cools the surface of the panel by heat convection and conduction. Then the panel cools the indoor air and walls by heat convection and radiation to achieve the desired air-conditioning effect. It can reach thermal balance and meet the requirement of building cooling load. [4, 5] In general, low temperature water needs to be used to dehumidify the air to offset the indoor humidity generation. Thus, condensation on the panel surface may occur and the evaporation temperature of the refrigeration cycle is relatively low as well. Therefore, the COP of the refrigeration cycle remains relatively low. In addition, energy losses caused by secondary heat transfer leave more room for the whole system performance to be improved if they