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Specification Requirements for a Combined Dehumidifier/Cooling Panel: A Global Scale Analysis

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Abstract : The use of a radiant cooling solution would enable to lower cooling needs which is of great interest when the demand is initially high (hot climate). But, radiant systems are not naturally compatibles with humid climates since a low-temperature surface leads to condensation risks as soon as the surface temperature is close to or lower than the dew point temperature. A radiant cooling system combined to a dehumidification system would enable to remove humidity for the space, thereby lowering the dew point temperature. The humidity removal needs to be especially effective near the cooled surface. This requirement could be fulfilled by a system using a single desiccant fluid for the removal of both excessive heat and moisture. This task aims at providing an estimation of the specification requirements of such system in terms of cooling power and dehumidification rate required to fulfill comfort issues and to prevent any condensation risk on the cool panel surface. The present paper develops a preliminary study on the specification requirements, performances and behavior of a combined dehumidifier/cooling ceiling panel for different operating conditions. This study has been carried using the TRNSYS software which allows nodal calculations of thermal systems. It consists of the dynamic modeling of heat and vapor balances of a 5m x 3m x 2.7m office space. In a first design estimation, this room is equipped with an ideal heating, cooling, humidification and dehumidification system so that the room temperature is always maintained in between 21[◦]C and 25[◦]C with a relative humidity in between 40% and 60%. The room is also equipped with a ventilation system that includes a heat recovery heat exchanger and another heat exchanger connected to a heat sink. Main results show that the system should be designed to meet a cooling power of 42W.m^{−2} and a desiccant rate of 45 g_{H2O}.h^{−1}. In a second time, a parametric study of comfort issues and system performances has been achieved on a more realistic system (that includes a chilled ceiling) under different operating conditions. It enables an estimation of an acceptable range of operating conditions. This preliminary study is intended to provide useful information for the system design.

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