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Develop and experimental validation of a model for energy recovery

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Abstract

The present energy situation drives to optimize existing energy recovery systems. This work exposes a simple method to improve the thermal recovery of air conditioning systems that removes wastes, effectively modulates the plants involved in the recovery and improves the systems durability.

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Keywords: Energy Saving; Air Conditioning Systems; Recovery Systems; Experimental Validation

1. Introduction

At a time when the growing demand for goods and services contrasts with the need for energy saving and optimization of scarce resources, careful management of energy is all the more imperative. In our days, governing energy means to use the most modern and reliable technologies to ensure the correct use of primary resources in order to avoid any waste.

The growing importance of energy consumption in the management of air conditioning in every type of structures makes optimization a priority for management models. It is legitimate to ask whether the current recovery systems are the best ones that the current technology can offer.

The aim of this paper is to introduce a thermal recovery model for heating and air-conditioning, to analyze the efficiency and to evaluate the results obtained applying it to a real structure with significant energy requirements.

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2. Existing recovery systems issues

The need for creating, analyzing and testing a new energy recovery management model of air handling units comes from the observation that current methods are inadequate to handle climatic conditions, such as the ones that occur on Italian territory, where the temperatures fluctuate for long periods around plants operating temperatures and in any case quite mild.
There are two different types of system on the market:

1. Enthalpyc systems that recover heat from the exhaust air through the intersection on heat exchangers between the exhaust air and suction air

2. Hydronic systems, (as the ones object of the present discussion for a structural point of view), where the control system turns the recovery system on and / or off, according to the chosen gradient.

The first system can not be always used, but it must undergo specific standards of air, especially in a hospital setting where the external air supplies can't be contaminated from the exhaust air [2].

The second system only controls temperature and humidity and it often doesn't achieve optimized results that means a waste of energy. The innovation of the model object in this paper, to be applied to the hydronic system (2), consists in a different recovery management, optimized to achieve maximum energy savings and, at the same time, to safeguard the integrity and the durability operation of the plant. Furthermore, the model presents a careful management of the operating conditions, and then the recovery, through the use of a variable flow rate pump that further optimizes the system energy efficiency.

In plants, if the temperature difference between air-conditioned and external environments results modest it may not be convenient to implement energy recovery; instead if the temperature difference oscillates around the system start-up temperature, the situation would be even worse as the system would be subject to continuous shutdown / restart cycles that would cause a sudden wear of the mechanical components.
Finally, the use of variable flow rate pumps allows a gradual modulation of the recovery system which involves considerable increase of efficiency, as will be later analyzed.

3. Energy saving model

In an air conditioning system the AHU are asked to provide the primary energy to the building-plant system for the maintenance of the welfare conditions. The energy recovery system aims to transfer part of the heat that is wasted from the exhaust air from the facility to suction air (and vice versa in the summer). All of this makes the thermal load met the batteries of the AHU lighter [4-5]. In order to achieve this result it is necessary to insert energy recovery batteries inside the AHU to intersect the two air flows, as illustrated in Fig. 1.
The system adopted does not allow the use of enthalpyc exchangers as they can't be used - according to legislation - in hospital settings; furthermore the climate zone in which it is located the structure makes these exchangers not really advantageous [1].