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Review on physical and performance parameters of heat recovery systems for building applications

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ABSTRACT

Owing to global energy crisis, various technical strategies are adopted for energy conservation in buildings through energy-efficient technologies. One of the significant ways for this purpose is by installation or usage of heat or energy recovery device which is known as one of main energy-efficient systems that will decrease the power demands of building heating, cooling, air conditioning and ventilation loads. In order to have an insight into existing knowledge leading to understanding of previous works and researches carried out concerning the area, this paper presents and discusses physical and performance parameters of heat recovery unit and the significances of these parameters on operation and efficiency of the system. In addition, areas that have not received much research attention and that warrant future analysis of this technology are also highlighted.

Contents

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Nomenclature

CFD	Computational Fluid Dynamics
H_i	enthalpy of intake air, kg/kg
H_s	enthalpy of supply air, kg/kg
H_r	enthalpy of return air, kg/kg
H_e	enthalpy of exhaust, kg/kg
M_E	mass flow rate of exhaust air stream, kg/s
M_S	mass flow rate of supply air stream, kg/s
M_{min}	mass flow rate (minimum), kg/s
NTU	number of transfer units
T_i	temperature of intake air in, °C
T_r	temperature of return air to heat or energy recovery, °C
T_e	temperature of exhaust air out, °C
T_s	temperature of supply air to room, °C

Symbols

ε_S	sensible efficiency/temperature efficiency, %
ε_L	latent efficiency/moisture efficiency, %
ε_H	enthalpy efficiency, %
ε_{HR}	heat/energy recovery efficiency, %
ε_{NTU}	the effectiveness–NTU method
ω_i	moisture/humidity ratio of intake air, kg/kg
ω_s	moisture/humidity ratio of supply air, kg/kg
ω_r	moisture/humidity ratio of supply return air, kg/kg
ω_e	moisture/humidity ratio of exhaust air, kg/kg

1. Introduction

Over the past 30 years, the world has experienced large increases in energy consumption as a result of economic and population growth. In the context of built environment, literature has proven that buildings are responsible for about 40% of national energy demand in EU [1], 23% in Spain [2], 35.4% in Greece [3], 30% in China [4,5], 41% in US [6], 39% in UK [7,8], 20–40% in developed countries [2] and predicted to increase by 34% in the next 20 years [9]. In Singapore, the use of electricity in buildings constitutes around 16% of national energy demand [10]. Energy demand is also estimated to increase at the rate of 6.3 annually in Malaysia in order to sustain the nation's economic growth [11]. This increasing trend of energy consumption in buildings is contributed in large proportion by building space heating, cooling and ventilation. The International Energy Agency (IEA) estimated that by the year 2030, the consumption of energy sources will increase by 53%, whereby 70% will be derived from developing countries [12]. In relation to this, a study of World Energy Council (WEC) found that without any changes in our current practice, the world energy demand in 2020 would be 50–80% higher than 1990 levels [13].

In order to overcome energy consumption and at the same time to promote energy conservation in buildings, most countries in the world have shown their commitments by setting up new building standard, policies, regulations, recognition and new technologies. For instance, in the EU, the Energy Performance of Building Directive (EPBD) was adopted in December 2002 whilst in the UK, Building Regulations, a standard for limiting heat gains and losses through elements and other parts of the building services, was developed in October 2010. In Japan, Basic Energy Plan (BEP) was adopted in June 2010 which represents the significant statement of Japanese energy policy and energy crisis [14]. National Energy Policy was also formulated in Malaysia in 1979 with the principal energy objectives to ensure efficient, secure and environmentally sustainable supplies of energy, including electricity. Apart from that, in 2009 Malaysian Green Building Index (GBI) was introduced to promote green building design and sustainability in built environment. These policies, standards and rating tools would encourage the building design to adopt energy-efficient building materials, technologies and at the same time ensure that adequate means of ventilation are provided. Thus, in order to maintain good and healthy indoor environment, provide a habitable and comfortable place for human occupation as well as conserve the energy, energy-efficient technologies should be adopted in building services. Therefore, the challenge nowadays is to develop an energy-efficient system which can make a big contribution to CO_2 emission reduction, to fulfill the building code requirements and energy conservation either as an alternative to

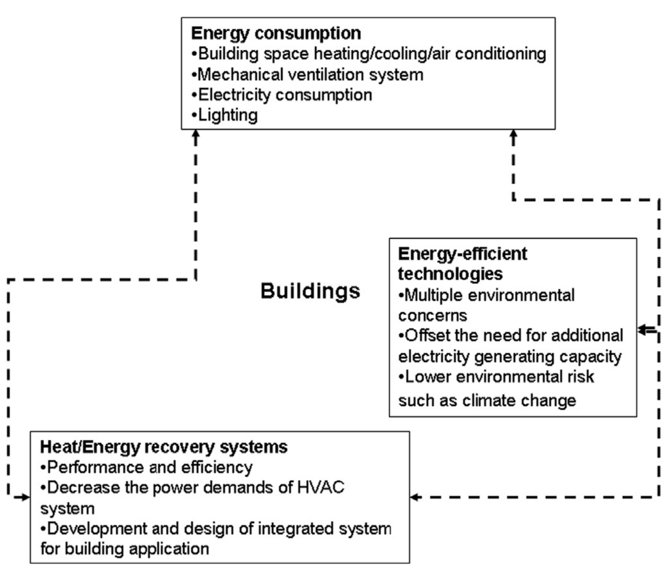

Fig. 1. Link between building and energy and the needs for heat or energy recovery.