



Energy saving potential and repercussions on indoor air quality of demand controlled residential ventilation strategies

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ABSTRACT

Ventilation is ambiguously related to the energy saving rationale originating from the mitigation of global warming, the reaching of peak oil or health concerns related to fossil fuel burning. Since it makes up for about half of the energy consumption in well-insulated buildings, it is an attractive target for energy saving measures. However, simply reducing ventilation rates has unwanted repercussions on the indoor air quality. Two main strategies have been developed to reconcile these seemingly opposing interests: heat recovery and demand control ventilation. This paper focuses on the energy saving potential of demand controlled mechanical exhaust ventilation in residences and on the influence such systems may have on the indoor air quality to which the occupants of the dwellings are exposed. The conclusions are based on simulations done with a multi-zone airflow model of a detached house that is statistically representative for the average Belgian dwelling. Four approaches to demand based control are tested and reported. Within the paper exposure to carbon dioxide and to a tracer gas are used as indicators for indoor air quality. Both energy demand and exposures are reported and compared to the results for a standard, building code compliant, exhaust system, operating at continuous flow rates. The sensitivity of the control strategies to environmental and user variations is tested using Monte-Carlo techniques. Under the conditions that were applied, reductions on the ventilation heat loss of 25–60% are found, depending on the chosen control strategy (with the exclusion of adventitious ventilation and infiltration).

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1. Introduction

Advances in several disciplines of knowledge such as the growing understanding of global warming (IPCC, 2007) and its effects on our environment, the increasing evidence of the limited nature of our major energy supply and the large cost, both economical and human, of air pollution related illnesses are dramatically altering the goals of innovations in building technology. The focus is shifted towards 'green' or sustainable buildings, seeking concepts that allow to maintain or even further increase the comfort level that we are accustomed to, while significantly reducing the associated energy use in every aspect of human life.

In a moderate climate, hygiene ventilation is responsible for about half or more of the energy expenditure in well insulated dwellings, while the energy use in buildings itself takes up about 40% of the energy use in the EU. Consequently, this field represents a massive gross energy saving potential. Simply reducing ventilation rates, however, will deteriorate the indoor air quality and therefore

sort unwanted effects such as an increase in the incidence of respiratory illness [1,2] and loss of productivity [3].

Two main strategies exist in contemporary building practice that allow to reconcile these opposing interests, namely the use of heat recovery units and the implementation of demand controlled ventilation. Heat recovery ventilation is widely spread in cold climates and its merits are discussed extensively in literature (e.g. [4]).

However, in the moderate climate zone of western Europe, especially in the Netherlands, France, the UK and Belgium, with about 2500–3000 heating degree days [5,6], the payback time for investments in heat recovery ventilation are long, especially in buildings with relatively low air change rates such as dwellings. Due to its competitive price setting as well as due to reports in popular media and scientific literature about possible health risks associated with heat recovery systems [7] simple mechanical exhaust ventilation dominates the residential ventilation market [8,9] in this region. In light of this exhaust ventilation tradition, home owners tend to prefer demand controlled exhaust ventilation over heat recovery systems to comply with tightening energy performance legislation. However, little information is available in

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