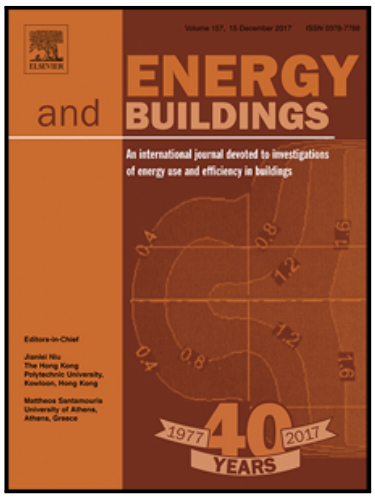

An Assessment of the Potential of Supply-side Ventilation Demand Control to Regulate Natural Ventilation Flow Patterns and Reduce Domestic Space Heating Consumption

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An Assessment of the Potential of Supply-side Ventilation Demand Control to Regulate Natural Ventilation Flow Patterns and Reduce Domestic Space Heating Consumption

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Abstract

Uncontrolled natural ventilation systems tend, by their nature, to deliver varying flow rates that are not necessarily optimised for human comfort or energy efficiency. Moreover these ventilation flow rates may not be delivered along the intended flow paths through a building, possibly further reducing ventilation effectiveness and increasing ventilation heat losses. These characteristics make natural ventilation systems a suitable candidate for ventilation demand control where the levels of fresh air delivered respond to a sensed parameter that indicates the level of ventilation demand. This paper makes a preliminary, comparative assessment of the impact an active supply-side CO_2 ventilation demand control system may have on the ventilation regime, flow levels and space heating consumption of a two-storey naturally ventilated domestic property. The dwelling is modelled in EnergyPlus and the performance of the ventilation demand control system simulated using EnergyPlus' run-time Energy Management System. Simulations are conducted for a variety of temperate climate contexts and building fabric leakage levels. The simulations demonstrate that the ventilation demand control system could reinforce desired flow regimes and provide comparable indoor air quality compared to the uncontrolled base case whilst delivering significant reductions in space heating consumption.

Keywords: passive ventilation, ventilation demand control, Smart Home,

1. Introduction

In climates that can result in a significant building heating season, ultra-low energy housing[1] is not generally considered possible with natural, or passive, ventilation. The environmental driving forces for passive ventilation (ambient temperature and wind pressure differentials) are highly variable, often over very short time scales, resulting in variable background ventilation flow rates that if too high can cause excessive ventilation heat loss and discomfort, and if too low can cause poor Indoor Air Quality (IAQ) and overheating. In more complex or multi-storey dwellings flow paths may also not be as intended, routing too little or much ventilation through particular areas of a building. These factors, coupled with a lack of heat recovery, makes it difficult for an uncontrolled passive ventilation system to consistently deliver the high levels of energy efficiency and IAQ required for ultra-low energy housing.

The type of domestic ventilation regime considered here is the only natural ventilation system still explicitly considered to comply in the latest revision of the UK building regulations [2] and is termed Passive Stack Ventilation (PSV) [3]. PSV consists of ducts that run from the wet rooms (kitchens, bathroom, toilets) to the roof line. The act of buoyancy, and low pressures generated at the roof line by wind action, draws air through the ducts and out of the wet rooms, lowering their pressure, which in turn draws air from the neighbouring dry rooms (living room, bedrooms) which in turn draw air through the periphery of the building; often via trickle ventilators situated within the window

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[1] Taken here to mean a dwelling with space heating consumption below 15 kilo-watt hours per square metre floor area per annum (kWh/m^2·a) as, for example, mandated by the PassivHaus standard [1]