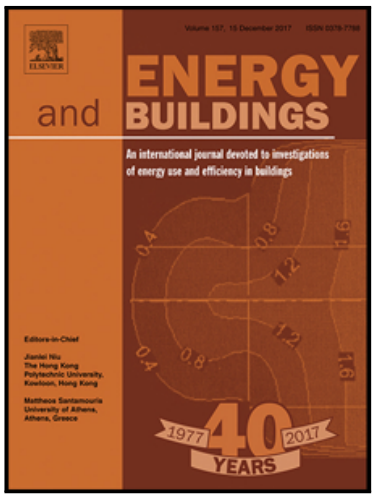

Experimental study of the pressure reset control strategy for energy-efficient fan operation Part 2: Variable air volume ventilation system with decentralized fans

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Experimental study of the pressure reset control strategy for energy-efficient fan operation

Part 2: Variable air volume ventilation system with decentralized fans

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Abstract

This paper is the second part of a two-part series which investigates the energy saving potentials in a novel mechanical ventilation system by replacing terminal dampers with decentralized fans. The present study (Part 2) proposes a method to control the main fan as well as the decentralized fans in such a way that the system is balanced for different demand requests. The control method comprises two levels, zone level and system level control, and is based on measuring static pressure in the duct system similar to the energy-efficient control proposed for the conventional ventilation system in Part 1. Two identical experimental mock-ups, one with the dampers and one with the decentralized fans were used in a laboratory environment to evaluate the performance of the novel ventilation system and to compare the two ventilation systems from power use point of view. Experimental results indicate the ability of the proposed method to control the ventilation system with decentralized fans. The measured power use of the two ventilation systems was almost the same for the range of tested total airflow rates, except when the total airflow rate was rather low. Calculations, however, reveal an energy saving potential of around 30% depending on the efficiency of the main fan.

Keywords: VAV ventilation system with decentralized fans, Energy efficient control, Pressure reset, Critical zone reset

1. Introduction

In Part 1 of this two-part series [1], energy saving potential in a conventional variable air volume (VAV) ventilation system with terminal dampers was investigated. Static pressure reset (SPR) control is a well-known strategy to energy-efficient control of supply fan in a VAV ventilation system [2]. Part 1 reviewed different strategies in the literature to implement SPR control in practice and proposed a new method based on measuring the static pressure at the terminal dampers. The proposed SPR control was applied on a mock-up of a VAV ventilation system, including a supply duct with four branches connected to four terminal dampers, in a laboratory environment. The experimental results showed a minimum reduction of 21% in main fan power use with the SPR control compared to constant static pressure.

In SPR control, static pressure in the duct is controlled such that at least one damper is kept wide-open at any load conditions. This minimizes the pressure drop across the wide-open damper. However, the rest of dampers are still introducing pressure drop in the duct. Part 2 of this two-part series investigates a novel ventilation system in which terminal dampers are replaced with decentralized fans to eliminate the pressure drop across the dampers. The novel ventilation system is different from regular fan-powered VAV boxes in which a small fan is used for better mixing conditioned air (so-called primary air) with room air (so-called secondary air) and improving ventilation effectiveness [3]. Either parallel or series fan-powered VAV boxes still contain a VAV damper to modulate the primary air. This damper, which produces the major pressure drop in VAV boxes, has been eliminated in the novel ventilation design.

The idea of replacing the terminal dampers with the decentralized fans was first introduced in a report by Fahlen [4]. The main focus in [4] is on capacity control of liquid-to-air heat exchangers. The report proposes to