Contents lists available at ScienceDirect



International Journal of Thermal Sciences



journal homepage: www.elsevier.com/locate/ijts

Improving the thermal performance of ventilation radiators – The role of internal convection fins

Jonn Are Myhren*, Sture Holmberg

Department of Fluid and Climate Technology, School of Technology and Health, KTH, Alfred Nobels Allé 10, SE-14152 Huddinge, Stockholm, Sweden

ARTICLE INFO

Article history: Received 3 July 2010 Received in revised form 18 October 2010 Accepted 19 October 2010

Keywords: Ventilation radiator Convection fins CFD simulation Exhaust ventilation Thermal comfort Energy consumption Low-temperature heating

ABSTRACT

This paper deals with heat output optimization of a ventilation radiator by varying the distribution of vertical longitudinal convection fins. A ventilation radiator, which combines ventilation air supply and heat emission to the room, has a higher driving force on air in between the radiator panels compared to traditional radiators and can for this reason have more heat transferring surfaces to improve thermal efficiency. Improving the thermal efficiency means a lower water temperature is required for heating and energy can be saved in production and distribution of heat in systems with heat pumps, district heating or similar.

The investigation was made using Computational Fluid Dynamics (CFD) simulations while analytical calculations were used for verification of different flow and heat transfer mechanisms. Results showed that heat transfer can be increased in the section where ventilation air is brought into the room by slightly changing the geometry of the fins, decreasing the fin to fin distance and cutting off a middle section of the fin array. This change in internal design could mean considerable increase in thermal efficiency for the ventilation radiator as a whole.

© 2010 Elsevier Masson SAS. All rights reserved.

1. Introduction

1.1. Background

In Sweden heat pumps are being increasingly used in heating systems. Development of low-temperature, hydronic heating systems that will improve efficiency of heat pumps is therefore an ongoing project at the Royal Institute of Technology (KTH). There are several ways to make heat emitters more thermally efficient. One is by enlarging heat emitting surfaces such as with whole floor or ceiling heating. In buildings or rooms, however, other solutions may be more appropriate. For example, in exhaust ventilated rooms the advances by having inlet air-convector or ventilation-radiator arrangements may be decisive. With these systems the risk of cold draught is reduced and it is possible to maintain a high ventilation rate even in cold northern winters [1,2]. A high ventilation rate has proved to be the single most important factor to reduce health problems such as Sick Building Syndrome Symptoms, allergies and asthma in many studies [3,4]. For this reason a major focus of the current project is on ventilation radiators and how to make

E-mail address: jonn.myhren@sth.kth.se (J.A. Myhren).

ventilation radiators more thermally efficient. In this study the focus is on the internal design.

Fig. 1 shows the principle parts of a ventilation radiator.

Cold air enters a vent in the building wall, passes trough a wall channel and a filter before it is directed to a channel formed by the radiator panels. Here the air is pre-heated to room air temperature. The driving forces are partly buoyancy forces and partly pressure differences between outdoors and indoors created by an exhaust ventilation system in the building. The filter prevents particles in the incoming air from reaching the indoor environment.

It should be noted that no or very little extra driving force is needed with ventilation radiators installed compared to systems where air is brought in through conventional ventilation inlets. This means that a standard exhaust ventilation system can be used and there is no extra energy consumption for ventilation with this system.

1.1.1. The main difference between traditional radiators and ventilation radiators

Radiators are made for maximum radiation heat transfer from outside surfaces and convective heat transfer from internal surfaces. Most traditional radiators have convection fins between the radiator panels to increase convection heat output. The purpose of convection fins is to lead heat from warm water in the radiator, through the

^{*} Corresponding author. Tel.: +46 739474871.

^{1290-0729/\$ –} see front matter \circledcirc 2010 Elsevier Masson SAS. All rights reserved. doi:10.1016/j.ijthermalsci.2010.10.011