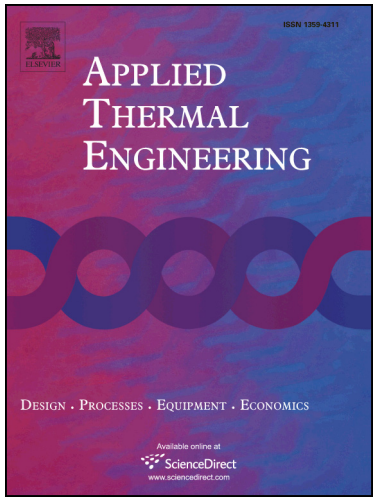

Research Paper

Rectangular Supply Ducts with Varying Cross Section Providing Uniform Air Distribution

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Rectangular Supply Ducts with Varying Cross Section Providing Uniform Air Distribution

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Abstract

A simple 1D theoretical model is suggested, with which it is possible to design ventilation ducts that are capable of providing uniform air distribution on the outlets. Detailed analysis is conducted for rectangular ducts with constant height and variable width. Optimal geometry is described by the width profile. The non-linear differential equation derived from the 1D model is solved numerically. The influence of different dimensionless parameters on optimal geometry is investigated. The model is validated with experiments performed on a unique hydraulically smooth rectangular duct with optimised geometry. The measured flow distributions is uniform with acceptable accuracy.

Keywords: ventilation, duct design, supply of air, fluid distribution, 1D continuous model, flow measurement

1. Introduction

Fluid distributors are used in a wide range of applications. An example is air supply through a duct system. The design of duct systems is well established (see [1]), but there are special cases, for which other methods can lead to better results. A long supply duct with several diffusers can be used for different purposes: for the control of relative humidity [2]; in HVAC (heating, ventilation and air conditioning) engineering to set air volume, and keep its temperature, humidity and the contaminant concentration at desired values. The objective of this research is to design a duct with variable cross sections, which is capable of distributing the air uniformly, can be manufactured easily and makes the use of balancing dampers in technical building systems unnecessary.

Distribution ducts or pipes were investigated by many researchers and the topic has a long history. McNown [3] conducted experiments to determine local loss coefficient of the main and branch flow in constant cross section distribution pipes. Schattulat [4] published a simple theoretical model to describe the fluid dynamics in rectangular ducts with a long continuous slot. He performed parametrical studies on different simple duct and slot geometries and determined the fluid distribution efficiency with his model. Schattulats' approach was based on continuous equations. Acrivos et al. [5] compared the continuous approach with the discrete one and concluded that continuous manifolds are limiting cases of discrete ones. Nevertheless, a huge number of papers deals with the continuous models as the results from these can be generalized more easily. For example, Moueddeb [6]

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