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Air Distribution System Design Optimization in Non-Residential Buildings: Problem Formulation and Generation of Test Networks

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Abstract

In most heating, ventilation and air conditioning systems, the ductwork layout, i.e., the network structure of the ducts, as well as the number and locations of the fans, is an important determinant of the installation's cost and performance. Nevertheless, the layout is not explicitly taken into account in existing duct design methods. Most methods assume the layout of the air distribution system to be predetermined and focus solely on the sizing of each fan and duct in the network. This paper aims to outline the current state-of-the-art in air distribution system design and highlights the main shortcomings. Additionally, previous research is extended by presenting a novel problem formulation that integrates the layout decisions into the optimization problem. In this problem, called the air distribution network design optimization problem, the optimal air distribution system configuration, i.e., the optimal ductwork layout, is determined jointly with the duct and fan sizes, thereby minimizing the total cost of the system. This novel combinatorial optimization problem is characterized by discrete decision variables, and non-linear constraints. This paper also motivates the need for benchmark instances to evaluate the performance of existing or new developed optimization methods and advance future research in the field of air distribution system design optimization. A test network generator is developed in this research to generate such a set of instances.

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