SOLAR CHIMNEYS FOR NATURAL VENTILATION OF BUILDINGS: INDUCED AIR FLOW RATE PER CHIMNEY VOLUME

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ABSTRACT

Ventilation of buildings can be based on mechanical systems, such as fans, or natural driving forces, such as wind or heat. Of common natural ventilation methods, solar chimneys convert solar heat gain on the envelope of buildings into flow energy to ventilate or to cool the buildings. As solar chimneys are typically integrated into the building envelope, i.e. walls or roofs, architects determine shapes and sizes of a chimney mainly based on available space on the envelope. This raises the need for maximizing the ventilation performance of a solar chimney for a given space on a building envelope.

In this study, ventilation performance of a typical vertical solar chimney was assessed in the term of the induced flowrate that it can provide per its volume. A three-dimensional numerical model based on the Computational Fluid Dynamics method was built to predict the induced air flow rate through the chimney as its dimensions changed. The tested dimensions included the height, the width, and the gap of the chimney. The induced air flow rate was obtained with different volumes of the chimney.

The results show that the induced air flow rate nominated by the chimney volume changed with all three dimensions. Higher flow rate per volume ~~were~~ was achieved with the chimneys with shorter heights and lower gap – to – height ratios. Therefore, it is suggested to maximize the air flow rate per chimney volume, smaller chimneys are preferred. These findings agree with the results in the literature.

Key words: *Natural ventilation, solar chimney, thermal effect, CFD, flow rate per volume.*

1. INTRODUCTION

Ventilation of buildings is to supply fresh air into the buildings to achieve desired levels of indoor air quality and thermal comfort. For driving the air flow, mechanical systems, such as fans, or natural driving forces, such as wind or heat can be used [1]. The methods based on thermal effects create air flows through a confined space with two conditions: temperature difference between the air inside the space and elevation difference between the inlet and the outlet of the space.

Solar chimneys [2] are of the common systems for natural ventilation of building based on thermal effects. The main component of a solar chimney is the air channel which had open inlet and outlet at the bottom and the top, respectively. Solar radiation is absorbed on either the front or the rear wall of the channel. When the front wall is a glazing (glass) plate, solar radiation is transmitted through the front wall and absorbed on the rear wall of the channel. In contrast, when the front wall is opaque, it absorbs solar radiation directly. The absorbed heat is then transferred to the air in the channel. As the air temperature rises, the pressure inside the air channel deviates from that of the ambient and induces an air flow through the channel. When the inlet of the channel is connected to a room, stalled air inside the room is withdrawn. Fresh air is then supplied to the room through suitable arrangement of windows or doors.

A typical solar chimney is illustrated in Figure 1 where it is integrated into the front wall of the building.