Enhancing induced flow rate through a solar chimney by a forced flow

Y Q Nguyen

Faculty of Engineering, Van Lang University, 45 Nguyen Khac Nhu St., Co Giang Ward, Dist. 1, Ho Chi Minh City, Viet Nam

Email: y.nq@vlu.edu.vn

Abstract. Solar chimneys absorb solar radiation for natural ventilation or cooling of buildings. In typical solar chimneys, the air flow is induced by the thermal effect which causes pressure gradient inside the chimney to deviate from that of the ambient air. The induced flow is employed to ventilate the connected building naturally. In this study, we aimed to boost the induced flow rate through a typical solar chimney by a forced flow at the inlet of the air channel which is divided into two ports for the forced and the induced flows. The air flow and heat transfer were modeled with a Computational Fluid Dynamics (CFD) model with the ANSYS Fluent CFD code. Changing factors included the forced velocity, the dimensions of the inlet port for the forced air flow and the length of the partition between the ports of the naturally induced and forced air flows. It is seen that the forced flow significantly reduces the pressure in the air channel compared to that of a typical chimney; hence increasing the induced flow rate. The flow rate was significantly enhanced as the forced velocity was above 0.2 m/s; the area of the inlet port for the forced flow was 12.4% of the total inlet area; and the partition height was less than 5.0% of the total height of the air channel. In this configuration, the forced flow can be the waste exhaust air flow from other mechanical ventilation systems of the building. Therefore, no additional energy is required for this solution.

Keywords: Solar chimney, natural ventilation, forced flow, induced flow rate, CFD.

1. Introduction

Thermal or chimney effect can be utilized for ventilation or cooling of a building with enclosed cavities on the building envelope, such as double – skin facades, which connect to the rooms in the building. As solar radiation is absorbed on the surfaces of the cavity, air inside the cavity is warmed, rises, and induces an air flow through the cavity and the connected room; hence natural ventilation. Such cavities are categorized as solar chimneys [1].

The naturally induced air flow through solar chimneys has been examined by a number of researchers [1-4]. These reports show that the induced air flow rate increases with the major dimensions of the air cavity, or air channel, including the height and the gap, and the heat flux on surfaces of the channel. With proper designs, solar chimneys can provide adequate ventilation rate and thermal comfort conditions for buildings [5].

Forced air flow can also assist the naturally induced one in solar chimneys. Elghamry and Hassan [6] considered both forced and natural ventilation and cooling of a room with the combination of a solar chimney, photovoltaic, and geothermal air tube. They reported that the daily ventilated air and heat