STUDY OF THE HEAT VENTILATION WITH INCLINED CHIMNEY IN THE ATTIC

* Sahabuddin Latif¹, Baharuddin Hamzah², Ramli Rahim³, Rosady Mulyadi³, and Andi Erwin Eka Putra³

¹ Doctoral Program on Faculty of Engineering, Department of Architecture, Hasanuddin University, Indonesia
² Faculty of Engineering, Department of Architecture, Hasanuddin University, Indonesia
³ Faculty of Engineering, Department of Mechanical Engineering, Hasanuddin University, Indonesia

* Corresponding Author, Received: 14 Aug. 2019, Revised: 16 Sept. 2019, Accepted: 20 Sept. 2019

ABSTRACT: This paper proposes the design of inclined chimney with horizontal outlets that integrated with a triangular roof. Utilize solar radiation to heat and induce air through natural ventilation in the interior of the house. For achieving this goal, Solidworks Flow Simulation software is used to visualize and simulate the 3-D flow plane performance of the chimney, by modeling using Navier-Stokes (RANS) for numerical investigations. The effect of depth the channel of solar chimney investigated in six configurations under the roof with a slope of 45°. The simulation is performed on steady-state, to predict the dynamics of heat transfer, velocity distribution, and mass flow rate. The results showed that the greater the depth of the chimney, the higher the airflow and quite effective in reducing the temperature of the interior space, but would result in a decrease in heat in the solar chimney channel. Solar chimney airflow is mainly caused by buoyancy due to differences between ambient temperature and in the channel. They confirmed that the more significant the difference in temperature inside and the environment, the more efficient the performance of ventilation. However, the triangle channel output is still a place to collect hot air and high airflow. Natural ventilation using a solar chimney in the roof cavity seems to be effectively applicable to solar incidence discharges in traditional homes in the Indonesian climate.

Keywords: Attics, CFD simulation, Natural ventilation, Solar collector, Thermal comfort

1. INTRODUCTION

Increased indoor temperature compared to outdoor temperatures in residential buildings that have triangular roofs have been a concern in designing buildings in a hot and humid tropical climate. Residents experience uncomfortable conditions because of the high temperature of the room [1]. Daytime sun radiation causes trapped accumulation of heat, which raises the temperature of interior space mainly from the upper part, which includes the attic area and roof [2]. To maintain the room temperature at the comfort level, generally, the use of mechanical devices such as fans becomes an option or air conditioning system [3]. Failure to design passive cooling systems and reliance on mechanical ventilation systems can result in additional costs for building installation, operation, and maintenance [4, 5].

Several studies to address the problem of heat in buildings in humid tropical climates have been carried out. Field studies of thermal comfort in office buildings [6], Research on the thermal comfort of schools in Indonesia's climate [5, 7-10], natural ventilation system various strategies [11, 12].

Some researchers see the potential the difference in the height of the attic temperature compared to the heat of the ambient environment in hot and humid tropical climates can support the stack effect on the solar chimney to purpose cool the room free [1, 2, 13, 14]. Natural airflow through a triangular loft using a solar chimney as a reliable renewable energy system has shown encouraging results [15, 16]. Tan and Wong [17], has investigated the geometry of solar chimneys with sloping outlets in Singapore. Yew et al. [18], propose a strategy of air flowing in the gap between the roof and the ceiling of a residence in the Malaysian climate. According to Shi et al. [19], the solar chimney has an excellent optimal performance at the lowest cost. Four main groups influence chimney performance, environmental conditions, installation conditions, material use, and including configuration. Improve performance, the solar chimney recommended with a gap of 0.2 to 0.3 m, the same inlet and outlet, a high/depth ratio of about 10, a slope angle of 45° to 60°. However, this condition certainly does not apply to some cases that have different characters, for example, as the case of horizontal chimney outlet geometry [16].

In this article, a solar chimney study buried under the roof of the Buginese traditional house, in the climate of South Sulawesi Indonesia has been carried out. This case bears a resemblance to what was done by DeBlois et al. [13], the difference is mainly due to the climate in the United States, and it only allows one roof area to receive sunlight,