Using ANFIS technique in prediction of reverse flow in a solar chimney

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Abstract. In solar chimney, in order to save resources in Computational Fluid Dynamics (CFD), this study aims to combine Adaptive Neuro-Fuzzy Inference System (ANFIS) to predict reverse flow and investigate the ventilation performance**.** The inputs to the model are heat flux in the range of 200-1000W/m^2, gap of 0.04-0.25m and height of 1-1.4m, while outputs are penetration depth and mass flow rate. The results of R^2 and RMSE are reasonable for training and testing data, hence the ANFIS model is validated.

Keywords: solar chimney, CFD, machine learning, ANFIS, reverse flow

1. Introduction

Passive ventilation for buildings using solar chimney has been studied since 1993 by Bansal et al. [1]. With a well-designed solar chimney, it is said that the air changes per hour (ACH) even meet the standard recommended by ASHRAE [2]. In addition, indoor temperature can be reduced up to 3.5°C from an experimental study of Chungloo and Limmeechokchai [3]. In a study by Miyazaki et al. [4], a Tokyo's office building can save up to 50% of the annual energy required for ventilation.

For solar chimney principle, due to higher temperature air heated by solar energy makes air flow out of the channel; hence, induces natural ventilation. However, Zamora and Kaiser [5] have detected the sudden change of the flow pattern due to the development of reverse flow regions, as they said it should be an optimal inter-plate spacing that maximizes the induced mass flow rate. Reverse flow in the solar chimney was also examined quantitatively by calculating its penetration depth by Khanal and Lei [6]. They have proposed the inclined wall design in order to enhance ventilation performance. Reverse flow in a solar chimney normally occurs at the outlet and in reality, it is quite complicated as it depends on the weather condition, height, and width or gap of the solar chimney. Since it causes a decrease in ventilation, Nguyen [7] has tried to suppress the reverse flow, which, by rearranging the heat transfer surface on the opposite side in the upper and lower halves of the solar chimney.

Machine Learning (ML) has been applied to many fields in order to solve complicated problems in Fluid Dynamics. As in the study of evaporator performance in Organic Rankine Cycle, due to its high nonlinear behavior and high thermal inertia, Enayatollahi et al [8] has utilized machine learning to solve such a complicated problem. Pourtousi et al [9] have also combined CFD and ANFIS for the bubble column hydrodynamics study. They mentioned that using both experiment and numerical methods in the field are still difficult due to cost and time. Another study of Beigzadeh [10] is to investigate the heat transfer