Abstract

A numerical and experimental investigation of a solar chimney was performed under varying geometrical features at Iraqi ambient conditions. Steady, two-dimension, turbulent flow developed by natural ventilation inside an inclined solar chimney was investigated numerically at different inclination angles varied between 15^o to 60^o, chimney air gap thickness 50, 100 and 150 mm and varying solar radiation intensity along the day time.

Numerically, the governing continuity, momentum and energy equations with a standard (k-ε) turbulence model associated with laws of the wall along solid boundaries were solved numerically, which was based on the finite volume method using SIMPLE algorithm with hybrid scheme, to compute the characteristics of two dimensional turbulent flow inside a room and chimney.

Experimentally, the work was carried out using a single solar chimney installed on the roof of a single room has a volume of 12 m^3. Chimney dimensions are 2 m length, 2 m width and three air gap thickness (50, 100, 150) mm. The induced air flow rate generated by the solar chimney was evaluated by predicting the temperatures of glass cover, absorbing wall, and temperatures and velocity of induced air flow in the chimney and the room.

Theoretical results of the present study show that the optimum chimney inclination angle is 60^o, at which the maximum rate of ventilation is obtained. At this inclination angle, the rate of ventilation is about 20 % higher than 45^o inclination angle. Highest rate of ventilation induced was found to be 30 air change per hour in a room of 12 m^3 volume, at solar radiation 750 W/m^2 on inclined surface 60^o with aspect ratio of 13.3 for 2 m length of solar chimney. Maximum air velocity was found to be 0.8 m/s for radiation intensity 750 W/m^2 at 50 mm air gap thickness. A good agreement was observed between the experimental and numerical results.