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Airflow and Heat Transfer Analysis within Flat-top Roofs Heated from Below

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Abstract: *Natural convection in attic of non-conventional rooftops has received considerable attention in recent years due to its importance in thermal management of modern pitched-roof buildings. In this study, a finite-volume numerical investigation of laminar fluid dynamics and heat transfer of air within the attic of a flat-top roof structure has been predicted for bottom isothermal heating at varying pitch angle. The heat transfer between the walls results in multiple thermal plumes and multi-cellular flow structure with the number, size and strength of the counter-rotating cells reducing with increasing pitch angle. The results further show that the peculiar shape of the roof has significant effect on the fluid flow and heat transfer. Particularly, the truncated triangular architecture of the roof prevents the formation of large, dominating and upper-row cells at the midsection of the attic. At low pitch, the intensity of the vortices results in thorough mixing of air and, hence, uniform temperature distribution within the attic. The averaged Nusselt number for the hot ceiling wall which depicts the rate of convective heat transfer into the attic is in negative-gradient quasilinear relationship with the roof pitch. The practical significance of the predicted results is that, due to the peculiarity of the flat-top roof structure, heat loss to the attic is minimised when the roof pitch is relatively high; particularly not less than 300 and made as low as possible if the attic is to be used for drying of food crops.*

Keywords: *Flat-top, triangular, roofs, heated below, pitch angle, heat transfer*