Mixed Convective Heat Transfer in Transitional and Turbulent Flows

Patrick H. Oosthuizen
Queen's University
99 University Ave, Kingston, ON, K7L 3N6, Canada

Abstract- When there is a forced flow over a body that has a surface temperature that is different from the temperature of the undisturbed forced flow the buoyancy forces that arise due to the density differences associated with the temperature differences in the flow can have a significant effect on the flow and consequently on the heat transfer rate from the body. Flows such as these are termed mixed- or combined natural and forced convective flows. The majority of past studies of mixed convection have been concerned with situations involving laminar flow but many practical situations in which mixed convection exists involve turbulent flows. The flow in such situations can be quite complex because the presence of the buoyancy forces not only effects the momentum balance but also effects the turbulent flow structure. Here mixed convective flow over a thin vertical flat plate for conditions under which transition from laminar to turbulent flow occur will first be considered. Attention will be given to the so-called laminarization phenomena. Attention will be given both to the case where the buoyancy forces act in the same direction as the forced flow, i.e., to the case of assisting mixed convective flow, and to the case where the buoyancy forces act in the opposite direction to the forced flow, i.e., to the case of opposing mixed convective flow. Mixed convective flow over flat plates that are inclined to the vertical and over cylinders will then be briefly discussed. Attention will lastly be given to a practical situation that involves mixed convection. The example chosen is that of flow from a hot-air floor mounted vent over a cold window covered by a blind system.