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Effect of Unsteady Separation on the Wall Heat Transfer During Interaction of an Axisymmetric Vortex Ring with a Heated Wall[1] HUSSAM JABBAR, AHMED NAGUIB, Michigan State University — A CFD investigation of an axisymmetric (primary) vortex ring interacting with a flat, constant-temperature, heated wall is conducted to explore the flow physics associated with the wall heat transfer during the interaction. The particular focus is on the role of the unsteady boundary layer separation in the heat transfer deterioration on the upwash side of the vortex. To understand this role, we compare two identical CFD studies having a different hydrodynamic boundary condition on the heated wall. One of the studies employs the physical no-slip boundary condition, and the other considers a hypothetical situation in which slip is allowed to eliminate boundary layer separation. Surprisingly, the results show that the Nusselt number (Nu) deterioration is worse in the absence of separation. Unlike the case with wall slip, when separation occurs, the minimum Nu is not found at the location of the thickest thermal boundary layer (TBL). Instead, the worst cooling occurs where the separation zone and the secondary vortex block the primary vortex flow, causing local upwelling of the near-wall hot fluid that is independent of global thickening of the TBL. This demonstrates that Nu deterioration is not simply caused by thickening of the TBL via the primary vortex upwash.

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Ahmed Naguib
Michigan State University

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