CHAPTER 5
CONCLUDING REMARKS

An experiment combining flow visualization and temperature measurement is conducted in the present study to explore the possible presence of new vortex rolls and some unique time-dependent vortex flow characteristics associated with a high speed air jet impinging onto a horizontal circular heated disk confined in a vertical cylindrical chamber. Effects of the inlet gas flow rate, temperature difference between the heated disk and cold air jet, and the jet-to-disk separation distance on the new vortex flow characteristics are inspected in detail. In this experiment the jet-to-disk separation distance is varied from 10.0 to 30.0 mm, the jet Reynolds number from 0 to 1,623, the Rayleigh number from 0 to 63,420 and the Grashof number from 0 to 90,600. The major results obtained in the present study can be briefly summarized in the following:

1. At sufficiently high jet Reynolds numbers a tertiary vortex roll can be induced in the chamber, in addition to the primary and secondary rolls identified in the early study [10]. The quaternary roll is only seen for H=10.0 mm at an even higher Re_j.
2. The critical Re_j for the onset of the tertiary and quaternary inertia-driven rolls are higher at increasing temperature difference between the heated plate and injection air for H=10.0 & 20.0 mm. But the tertiary inertia-driven roll is disappeared by increasing ΔT at H=30.0 mm.
3. At increasing jet flow rate the tertiary and the quaternary inertia-driven vortex rolls are larger in size and stronger in intensity. The opposite is the case for a higher temperature difference between the heated plate and injection air.
4. The buoyancy-driven instability does not exist at H=10.0 & 30.0 mm.

5. The onset of the inertia-driven time dependent vortex flow occurs at even higher Re_j than that for the onset of tertiary and quaternary rolls. This critical Re_j increases with ΔT for H=10.0 & 20.0 mm. Again the opposite is true for H=30.0 mm.
6. The time-periodic vortex flow appears at a slightly higher Re_j for the onsets of the tertiary and the quaternary inertia-driven rolls. The vortex flow inside the rolls deforms noticeably.
7. When the jet flow rate exceeds certain critical level, the vortex rolls somewhat deform and the flow pattern is like a polygon. The inner rolls tend to break into a number of well connected cells. Moreover, the deformed vortex rolls slowly rotate in circumferential direction.
8. At a high Re_j the unstable flow in the chamber with H=10.0 & 20.0 mm is initiated by the inertia-driven instability. But for H=30.0 mm the unstable flow results from the mutual pushing and squeezing of the large inertia- and buoyancy-driven rolls. Hence an increase in ΔT destabilizes the flow.
9. For H=20.0 mm both the inertia- and buoyancy-driven instabilities exist and reverse flow transition can appear at increasing Re_j.
10. The frequency of the temperature oscillation for a time periodic flow is mainly affected by the jet Reynolds number.
11. Flow regime maps are given to delineate the temporal state of the vortex flow and the boundaries separating various states are empirically correlated.

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