CHAPTER 5

CONCLUDING REMARKS

An experiment combining flow visualization and temperature measurement is conducted in the present study to explore how the jet-disk separation distance H affects the steady and time-dependent vortex flow resulting from a round air jet impinging onto a heated horizontal circular disk confined in a vertical cylindrical chamber when H is large. Particular attention is paid to examining the effects of H on the onsets and characteristics of steady and time-dependent inertia and buoyancy driven vortex flows. In this experiment the jet-disk separation distance is varied from 40.0 to 60.0 mm, the jet Reynolds number from 0 to 1,623, and the Rayleigh number from 0 to 507,348. The major results obtained in the present study can be briefly summarized in the following:

1. The primary inertia-driven roll does not appear at a very low jet Reynolds number and a very high buoyancy-to-inertia ratio for HD_j =6.
2. The secondary inertia-driven roll does not appear at larger jet-disk separation distance for HD_j =5 & 6. Moreover, for HD_j raised from 1 to 3 the critical Re_j for the onset of the secondary inertia-driven roll becomes earlier but the opposite is the case when HD_j is raised from 3 to 4.
3. The critical Re_j for the onset of tertiary inertia-driven roll varies nonmonotonously for HD_j raised from 1 to 6, which results from the complicate variations of the vortex flow structures with the jet-disk separation distance.
4. The buoyancy roll always appears for HD_j =3 even at a small ΔT of 5℃ and for HD_j =2 & 4 with a high temperature difference between the heated disk and injection air. Moreover, for HD_j increased from 1 to 2 the critical Re_j for the onset

of the buoyancy-driven roll is delayed to a higher Re_j but the onset becomes earlier as HD_j is raised from 4 to 6.

5. In steady vortex flow with the disk unheated, the primary, secondary, and corner rolls grow with HD_j. But the secondary roll becomes smaller as HD_j is raised from 3 to 4.
6. In steady vortex flow with disk heated, both the primary inertia-driven roll and the buoyancy-driven roll get larger at increasing HD_j. After the primary roll and buoyancy roll contact with each other, the primary roll is smaller and buoyancy roll is larger at the lower Q_j of 1 slpm and the opposite is true at the higher Q_j of 3 slpm .
7. The inertia-driven vortex flow instability does not appear for HD_j =3 with disk heated. The critical Re_j for the onset of the inertia-driven vortex flow instability is lower for a larger HD_j except for HD_j =3.
8. The mutual roll-pushing vortex flow instability does not appear at small jet-disk separation distance for HD_j =1 & 2. The critical Re_j for the onset of the mutual roll-pushing vortex flow instability is lower for a larger HD_j.
9. The type-1 buoyancy-driven vortex flow instability only prevails for HD_j =2 at high buoyancy-to-inertia ratio.
10. The type-2 buoyancy-driven vortex flow instability only occurs at very low Re_j with a large jet-disk separation distance for HD_j =4 to 6. The critical Re_j for onset of type-2 buoyancy-driven instability is delayed to a higher Re_j when HD_j is raised from 4 to 6.
11. The frequency of the temperature oscillation becomes lower and the amplitude of the oscillation gets larger in the unstable flow driven by the mutual roll-pushing vortex flow instability when HD_j is raised from 3 to 6.
12. The unstable vortex flow driven by the inertia-driven vortex flow instability with

the disk heated and the type-2 buoyancy-driven unstable flow are both nonperiodic in time for HD_j =4 to 6.

13.The mutual roll-pushing unstable vortex flow almost occupies the flow regime map for HD_j =4 and the region dominated by the nonperiodic inertia-driven unstable vortex flow becomes larger in the flow regime map as HD_j is raised from 4 to 6.

14. The region of the stable vortex flow in the flow regime map becomes narrow as increasing .HD_j which is resulting from both the stronger inertia and buoyancy forces.