CHAPTER 5
CONCLUDING REMARKS

An experiment combining flow visualization and temperature measurement is conducted in the present study to explore how the disk rotation affects the buoyancy driven vortex flow resulting from a vertically downward air jet impinging onto a heated horizontal disk confined in a vertical cylindrical chamber. Attention is focused on the possible suppression of the unstable impinging jet flow by the disk rotation. Effects of the inlet gas flow rate, temperature difference between the heated disk and cold air jet, and the disk rotation rate on the vortex flow characteristics are inspected in detail. Experiment is mainly conducted for the jet Reynolds number varying from 0 to 1,623, the Rayleigh number from 0 to 18,790, and the rotational Reynolds number from 0 to 3,892 for the jet-to-disk separation distance fixed at 20.0 mm. The major results obtained in the present study can be briefly summarized in the following:

(1). The typical steady vortex flow in the cylindrical chamber with the rotating disk consists of three circular rolls. They are the inertia-driven, buoyancy-driven and rotation-induced circular rolls. The size and strength of these circular rolls depend significantly on the magnitudes of the jet Reynolds number, Rayleigh number, and rotational Reynolds number. The rotation-induced roll is driven by the centrifugal pumping action associated with the disk rotation and appears in the outer portion of the chamber.

(2). At higher disk rotation rate ($\Omega \geq 20$ rpm) the buoyancy-driven roll can be substantially squeezed by the disk rotation to become smaller and weaker. Meanwhile, the primary inertia-driven roll is stretched out to become slender and weaker. Moreover, the secondary, tertiary, and quaternary inertia-driven rolls are completely wiped out.

(3). Significant nonmonontonic air temperature distribution in the radial direction resulting from the presence of the strong counter-rotating primary inertia- and buoyancy-driven vortex rolls and the deflection of the wall jet flow by the buoyancy-driven roll can be substantially reduced by the disk rotation. But at an even higher Ω the radial temperature variation near the chamber side can be larger due to the strong rotation-induced roll.

(4). The inertia-driven time-dependent and nonperiodic vortex flow prevailed at a higher Re_j in the chamber with the disk nonrotating can be stabilized to become steady when the disk is rotated at a high speed.

(5). At low and intermediate buoyancy-to-inertia ratios ($\Delta T < 15.0$ ℃) the buoyancy-driven roll can be completely suppressed by the disk rotation. Moreover, at higher buoyancy-to-inertia ratios the time dependent periodic or nonperiodic vortex flow oscillation can be completely stabilized by the disk rotation and the flow becomes steady for the disk rotated at a higher speed ($\Omega \geq 30$ rpm).

(6). The critical jet Reynolds numbers for the onset of the inertia-driven rolls are slightly higher for the disk rotated at a higher speed. But a substantial increase in the critical buoyancy-to-inertia ratio Gr/Re_j^2 results even when the disk is rotated at a low speed.

(7). A flow regime map is provided to delineate the the axisymmetric and nonaxisymmetric vortex flows with various disk rotation rates for H=20.0 mm