



## INTERACTION OF DOWNWARD AND UPWARD CONVECTION OF WATER BETWEEN TWO COOLING TUBES

Ichiro Nakane and Akira Narumi

Department of Mechanical Engineering, Kanagawa Institute of Technology

Takao Kashiwagi

Division of Mechanical System Engineering, Faculty of Engineering, Tokyo A&T

When water is cooled through  $4^{\circ}\text{C}$ , downward and upward convection may be produced due to its anomalous relationship between temperature and density. In the case of placing two horizontal cooling tubes vertically in a rectangular enclosure, a downward convection dominates the entire flow field in the early process of cooling. With the progress of cooling, the interaction of downward and upward convection occurs between the two cooling tubes. In most cases, the upward convection develops smoothly and becomes dominant between the two cooling tubes. In a rare case, however, the upward and downward convection keeps the balance making oscillation between the two cooling

tubes like a seesaw. Figures (a)–(j) shows the interferograms of this phenomenon, where  $d=30\text{ mm}$  and  $L/d=2.0$  (see Figure (k)). The heart-shaped fringe over the lower tube is formed because the development of the upward convection at the lower tube is prevented by the downward convection from the upper tube. Note that, when the upward convection develops further to reach just before the bottom of the upper tube, it comes back to the point of a heart shaped fringe. This behavior repeats several times. Finally the release of supercooling occurs at the lower tube, and then this behavior is ended. Figure (1) shows a schematic of this phenomenon.