A NUMERICAL AND EXPERIMENTAL STUDY OF NATURAL CONVECTION IN OPEN CAVITIES

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Introduction

The objective of this work is the experimental and theoretical examination of heat transport across a cavity opening as a function of aperture ratio and Rayleigh number.

Problem Statement

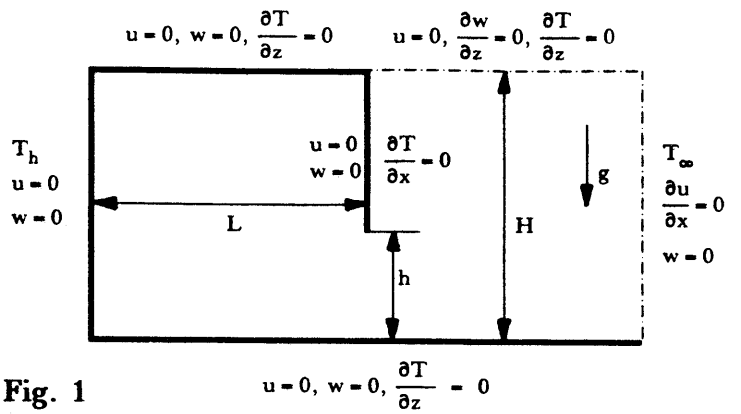


Fig. 1

The examined cavities in air are square (L/H = 1), open (aperture ratio $0 < h/H < 1$) and regarded two - dimensionally (Fig. 1). The vertical wall on the left ist heated isothermally (wall temperature T_h). On the opposite side the aperture ratio can be varied optionally. All the walls except the vertical one on the left are adiabatic.

Results

At opening the distributions of temperature and horizontal velocity are measured by a Mach - Zehnder interferometer and a Laser - Doppler velocimeter, respectively. In knowledge of both profiles the advective enthalpy loss of the open cavity can be calculated. An explicit finite volume method with an iterative pressure correction and variable properties is used for the presented calculations. It was tested on closed cavities, the obtained results are in good agreement with those of other authors [1]. For the open cavity our experimental results are compared with the numerical calculations.

Conclusions

Temperature field, streamline and velocity distribution plots are obtained (Fig. 2 and 3). Fig. 4 shows a comparison of numerical and experimental velocity data. The variation of the heat transport across the opening with Rayleigh number and the aperture ratio is plotted in Fig. 5.

References

1 G. de Vahl Davis and I.P. Jones, Natural convection in a square cavity AERE - R9955, HNSO, 1981

2 Y.L. Chan and C.L. Tien, A numerical study of two - dimensional natural convection in square open cavities
Numerical Heat Transfer, Vol.8, pp.65 - 80, 1985

Fig. 2: Temperature field, $Ra = 10^7$, $h/H = 1/3$

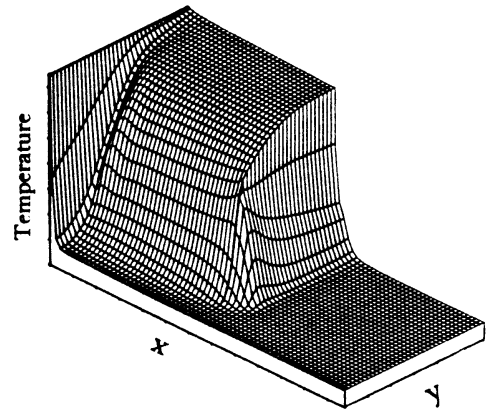
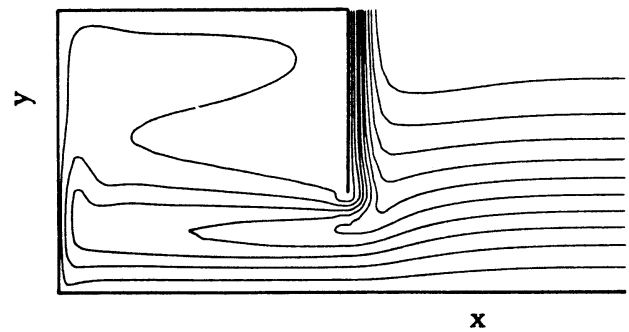


Fig. 3: Streamlines, $Ra = 10^7$, $h/H = 1/3$



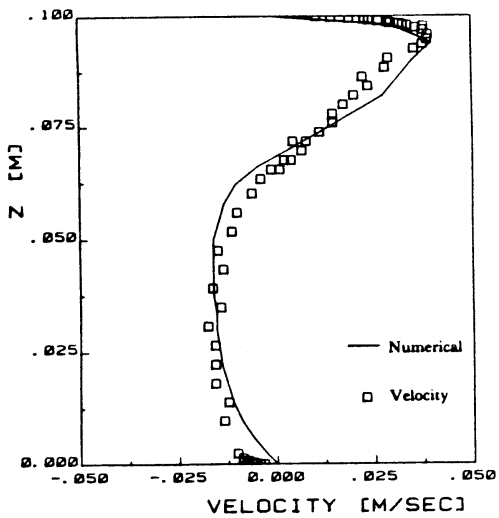


Fig. 4: Comparison of experimental with numerical results at the opening, $Ra = 10^7$, $h/H = 1/3$

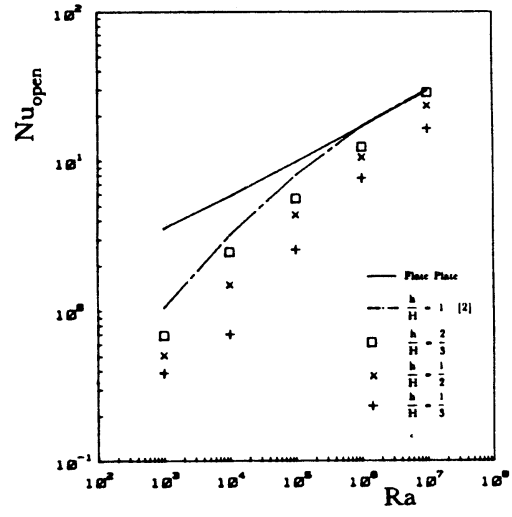


Fig. 5: Variation of Nu_{open} with Ra and h/H