Identification of Boundary Velocity Basing on the Internal Temperature Measurements

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In the paper the numerical method for identification boundary velocity basing on the measurements of internal temperature is presented. In many cases knowledge of velocity field is essential during various thermal problem modelling. Calculations of this field require boundary values of velocity to be known. Measurements of this quantity are rather difficult to carry out, so the procedure which allows to calculate boundary velocity seems to be very useful. This kind of computations, i.e. determination of boundary quantity from the internal measurements places this problem in the field of inverse methods. The nature of such problems is ill posed, what requires implementation of special numerical techniques in order to achieve stable results. The problems of this kind are very sensitive to measurements errors, which are always present in real measurements. Input data errors are not only transfered into inverse procedure results but they are also enlarged. There is another difficulty in such kind of problem: relatively poor link between descriptions of velocity and temperature fields. These fields are governed by separate equations so solution of such a set requires iterative methods to be employed.

In the algoritm The Sensitivity Coefficients Method is employed. Analysis of the coefficients answers the questions about the chances of achieving stable results as well as about the optimal localization of measurement sensors. Due to the presence of measuremental errors, placing additional sensors in the regions where the sensitivity coefficients are relatively small spoils the accuracy of results, and in some cases makes the procedure inconvergent. The algoritm was constructed after undertaking following assumptions:

- steady state problem;
- two dimensional, Cartesian geometry;
- incompressible, isoparametric flow.

Due to check the algoritm's correctness the technique called 'numerical experiment' was employed. As a results of measurements, the results of direct problem solution disturbed by random error were undertaken. Algorithm was tested in order to investigate the influence of several parameters on the stability of solution. Namely, the following parameters were taken under consideration:

- boundary velocity,
- location of sensors,
- number of sensors,
- temperature gradient in the fluid,
- geometry of the problem,
- measurmental error range.

During numerical tests the influence of above parameters on the accuracy of solution, as well as on the profile of sensitivity coefficients was investigated. It allowed to conclude about ranges of velocity, temperature gradients and other quantities, which allows to employ the algorithm successfully.