THE STATIC PRESSURE REDISTRIBUTIONS ON THE SURFACES OF REVERSE CHAMBER

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Abstract This paper will presents measurements results of static pressure distribution and pressure fluctuation on the inner surfaces of the reverse chamber. The test results described the distribution of pressure on the impinged wall and the reverse chamber wall. The results describing pressure changes and fluctuations for various inflow velocities and various distances between the pipe outlet and the impinged surface have been presented. The purpose of the paper is to indicate the differences between different flows: the axisymmetrical free jet outflowing to the stationary surroundings, a jet impinging a stationary flat surface, and a jet flow impinged flat surface in round close chamber which generated axisymetrical return flow.

INTRODUCTION

Late 1980's brought a dynamic growth of papers related to the numerical modeling of free jets and the description of turbulence within the jets, in particular [5]. Ever since then and until present, every year we see more and more works on free jets and the descriptions of their interaction with solids. Relevant from the point of view of free and restricted jets are the following test results: evolution of free jet flowing out of ventilation and being transformed into a wall jet [2], the natural convection effect on the heat exchange processes near the impinged surface [4], the effect of large temperature gradients on the transport processes on the impinged surface [8]. A separate group of papers are those describing the transport processes between free jets and rotating surfaces [7], descriptions of the correlations between the stresses on the impinged walls, appearing as a result of free jet inflow and helpful with corrosion reduction [3], or finally the tests on velocity distribution in the fluidal deposit the gas jet flows through [6]. The papers referred in the last paragraph indicate the wide use of free and impinging jets in technology especially in thermal-flow machines. The authors shows the analysis of the flow structure in a jet at variable geometry of the reverse chamber in the paper [1].

GEOMETRIC MODEL AND TEST METHODS

The main part of the tests is the axisymmetrical reverse chamber shown in figure 1. The main flow direction changes twice in the reverse chambers. The jets flowing out of the internal pipe, at beginning, is of free jet nature, then it impinges the flat surface of the chamber bottom, where the flow direction first time changes by 90^o. Such flow can be given as a simplified definition of the impinging jet. Upon change of direction, the wall jet get the radial direction. Before it reaches the side wall, it separates from the impinged surface and thus the second stagnation point is located on the side wall near the reverse chamber corner. Next, the jet changes its flow direction by the 90^o angle again. From this point, as the counterflow jet in relation to the basic jet, flowing out of the internal pipe, flows towards the reverse chamber outlet. The internal channel is built of a steel sharp-edged pipe of internal diameter of D = 0.04 m and 1.2 m length. The external chamber casing was made of plexi of internal diameter of R = 0.39 m and length 0.7 m. A photo of the test chamber is presented in figure 2 with pressure measuring points on the impinged wall and on the side wall. The points are distributed unevenly.

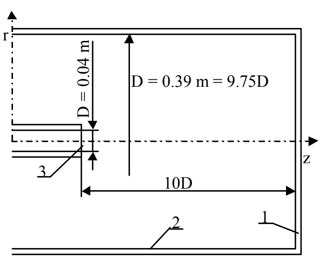

Figure 1. The schema of reverse chamber
1 – impinging wall, 2 – side wall, 3 – outlet of pipe

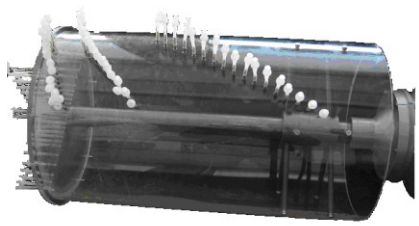

Figure 2. Photo of reverse chamber

The measurement set is built of two independent measurement circuits. The first is adapted to measure static pressures on the walls of the reverse chamber. The principal part is the pressure difference converter FCO14 manufactured by Farness Control Limited with measuring range from 0 to 10 kPa and average readout accuracy 0.4%. In case of measuring fluctuations of pressure in the measuring points, a microphone connected to a signal transducer was installed on the chamber walls. The set marked ICP Signal Conditioner SC-3000 manufactured by Energocontrol enables recording pressure fluctuations in two variants with two upper and lower pass filters (0.1-50 kHz and 1-100 kHz).

RESULTS AND SUMMARY

The figures 3 and 4 presents the redistributions of static pressures and its fluctuations on impinging wall and side wall for two distances between inlet of internal pipe and impinging wall. The results was presented for two distances between internal pipe and impinging wall.

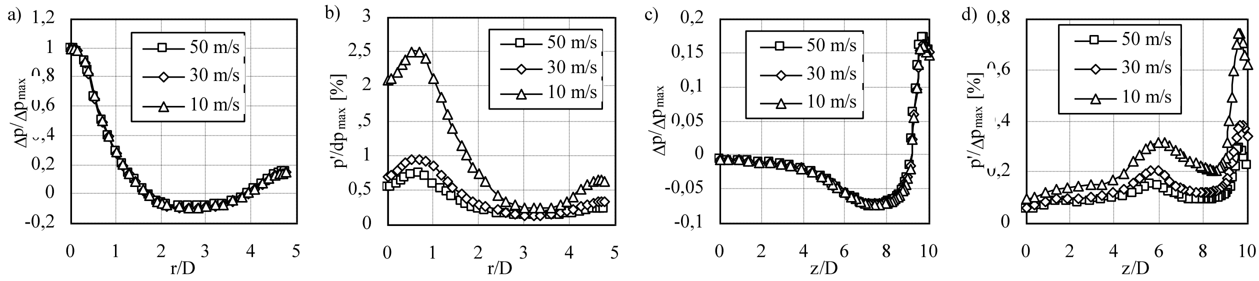

Figure 3. Radial and axial redistribution of static pressure and its fluctuation for distains between outlet of pipe and impinging jet 10D: a, b – impinging wall; c, d – side wall

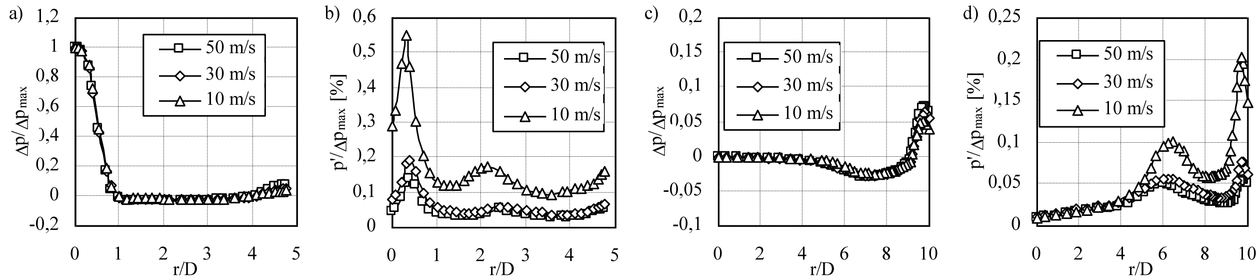

Figure 4. Radial and axial redistribution of static pressure and its fluctuation for distains between outlet of pipe and impinging jet 1D: a, b – impinging wall; c, d – side wall

As a result of the measurements numbers of differences between the free impinging jet and the jet flowing in the reverse chamber can be indicated. The most important ones include:

- increase to $z/D \approx 6$ of the potential core length in the axis of the outflow jet, potential core is longer than in free jets,
- decrease of the jet mixing zone on the side of the outflow axis and its asymmetry caused by the counterflow jet effect,
- diversified distribution of velocities in the jet flowing out of the chamber, depending on the jet flow velocity from the internal pipe,
- unlike the free jets, with maximum velocity fluctuation shifts away from the axis, we observe a local shift towards the axis caused by the counterflow effect,
- the increase of the stagnation area, compared to the impinging free jet and its decrease along with decrease of the distance between the internal pipe outlet and the impinged surface of the reverse chamber,
- the occurrence of under-pressure on the impinged wall and its expansion along with decrease of the distance between the emitter's outlet and the impinged wall,
- the impact of the jet outflow velocity and the change of distance between the outflow and the impinged surface observed on the distributions of pressure fluctuation on both walls is really significant.

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