Paper ID: 64912
oral

IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Science Results from Ground Based Research (4)

Author: Mr. Linar Gareev
Lomonosov Moscow State University, Russian Federation

Dr. Julia Zayko
Lomonosov Moscow State University, Russian Federation
Mr. Vladimir Trifonov
Lomonosov Moscow State University, Russian Federation
Dr. Alexander Reshmin
Lomonosov Moscow State University, Russian Federation
Prof. Vasily Vedeneev
Lomonosov Moscow State University, Russian Federation

EXPERIMENTAL INVESTIGATION OF PERTURBATION GROWTH IN LAMINAR JETS

Abstract

Laminar jets, either planar or axisymmetric, are employed in various industrial processes, including air curtains that can be used in space industry. Creation of laminar jet flows is difficult due to very low critical Reynolds numbers: 4.02 for the planar Bickley jet and 37.6 for axisymmetric jet with "far-downstream" velocity profile. It is important to have a robust theory for predicting evolution of perturbations in jet flows. However, the classical linear stability theory, which have been carefully tested experimentally for boundary layer, plane channel and pipe flows (Schubauer and Skramstad, 1947; Boiko et al., 1994; Nishioka et al., 1975; Kozlov and Ramazanov, 1981; Eckhardt, 2009), has not been validated by experiments for the case of free jets. There are just a few experiments conducted with jets whose laminar portion was about one diameter in length (Crow and Champagne, 1971; Cohen and Wygnanski, 1987; Petersen and Samet, 1988), which is not enough for robust validation of the linear stability theory.

Recently, our group proposed a new technique for generation of laminar jets (Zayko et al., 2018). Experimental facility provides a submerged air jet flow of diameter $D = 0.12$ m with Reynolds number up to 10 000 and laminar region length up to five jet diameters. Such parameters provide excellent conditions for experimental analysis of small controlled perturbations in laminar jet. Moreover, the jet velocity profile obtained in our experiments has three inflection points and two different axisymmetric modes of instability (unlike classical shear flows with one inflection point and one mode of instability), thus providing the opportunity to excite and analyse these two modes separately.

In the present experimental study, two branches of growing perturbations are excited independently through a thin vibrating ring; wave lengths, growth rates and radial distributions of perturbation amplitudes are measured through the flow visualization and thermoanemometer measurements. Excellent agreement between theoretically predicted and experimentally measured characteristics of waves is obtained.

This work is supported by the Russian Science Foundation under grant 20-19-00404.