ON THE POSSIBILITY OF TURBULENT FLOW NOISE CONTROL IN SUPERSONIC JET

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Abstract: In the problem of realizing the idea of active jet noise control two main aspects should be distinguished. The first aspect is a fundamental one and it concerns the development of the reduction strategy itself. The problem here lies in our poor understanding of the basic noise generation mechanisms. This hampers the formulation of the noise control strategy, because, for eliminating the origin of noise, i.e., for an active action upon the emitting component of turbulence, it is necessary to understand the basic mechanisms underlying this origin, i.e. the main point of the problem rests on the absence of conceptual study of the reduction strategy itself and this, in its turn, reflects our insufficient understanding of the principal mechanisms of noise generation by turbulence, i.e. understanding of the radiating turbulence structure and peculiarities. The situation turns out to be fundamentally different for subsonic and supersonic jets. The mechanism of noise generation for supersonic jets is essentially clear and is connected with instability waves developing downstream from the nozzle. This situation is quite different from that for subsonic flows, where a complete understanding of these mechanisms is yet absent. The second aspect that arises after the formulation of the noise control strategy is connected with the development of an elemental base (sensors, actuators, etc.) suitable for production the control action on the radiating part of the turbulence.

In the paper we deal both of these problems. Firstly we formulate the noise control strategy for supersonic jets. It is known that the supersonic jet noise is determined mainly by instability waves developing in the flow. Therefore the task of control can be formulated as the task of reducing the instability wave amplitudes and, in particular, of those waves which radiate sound. We demonstrate the basic possibility of the active control over the instability waves in jets. Precisely the idea of controlling a small part of turbulence (rather than the whole one) makes this approach quite attractive and, presumably, realizable (provided that the problem of sensors-actuators will be solved). In the second part of the paper we consider a new system of actuators, namely plasma actuators, and demonstrate that it can influence upon the processes take place in the turbulent jet quite effectively though the energy of the action is negligibly small in comparison with the total energy of the flow. The results obtained allow us to expect that in prospect this system can be effective in the control of instability waves.