NASA TECH BRIEF
Marshall Space Flight Center

Analyses of Unsteady Entropic-Flow Processes

A report has been published which discusses the analyses of unsteady entropic-flow processes. One important aspect in these analyses is the derivation of the physical mechanism of converted entropic perturbations, which is also directly related to the mixing of fluids. In the development of frictional fluid motion, entropy gradients of the moving fluid particles perpetually increase. This entropy growth is due to fluid particles which have been heated by frictional flow effects and are constantly lagging behind the colder fluid. In particular, there is a continuous conversion process of the available mechanical energy into unavailable heat energy, which results in a constant steepening of the thermal gradients.

Mathematically, this steepening of the thermal gradients is implicit in the nonlinear character of the governing equations and their solutions. Physically, such steepening processes cannot sustain themselves indefinitely. Eventually, a sudden collapse of the convected disturbance must occur with a resultant mixing of the warmer and colder fluids.

The actual implementation of these analyses is accomplished by the introduction of the entropy as the relevant thermodynamic variable. In effect, it is postulated that all the remaining thermodynamic variables may be regarded as functions of entropy only. The postulate also indicates that the analysis is restricted to simple, progressive wave motion, so that the Jacobian of the transformation of these variables vanishes identically in the flow region under consideration. In other words, a given set of physical characteristics is mapped into a single characteristic in the thermodynamic velocity-entropy plane of the same family.

It is shown that the collapse of the thermal gradients is inversely proportional to the initial shape of the entropy function, which indicates that large entropy gradients shorten the life-distance of the entropic perturbations. A sudden collapse of the entropic disturbance induces mixing and an effective redistribution of entropy gradients. The resultant distribution of the thermal fluid properties causes a successive thermal gradient collapse. Therefore, the complete shear layer of fluid is subject to a mixing process.

Notes:

1. This information may be of interest to researchers in the field of unsteady gas dynamics and aerodynamic sound generation.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&PS-TU
   Marshall Space Flight Center, Alabama 35812
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