G. A. Saltanov

TWO-PHASE SUPERSONIC FLOW.

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Among the many engineering problems associated with two-phase media, one of the most important is that of predicting the properties and controlling the formation of a disperse condensed phase in supersonic vapor and vapor-gas flows. A systematic description of the methods for studying such systems; the properties of particles suspended in flows, which govern their behavior; the theory for the formation of condensed phases and the corresponding calculation methods for the formation of two-phase systems; and questions of the external gas dynamics of two-phase flows can be found in the monograph by G. A. Saltanov, published by the Vysshaya Shkola publishing house in 1972, under the editorial supervision of M. E. Deich and V. F. Stepanchuk.

The book generalizes the large body of information which has been built up by Soviet and foreign researchers; much of the book deals with the results obtained in the department of vapor and gas turbines of the Moscow Power Engineering Institute, with which the author was directly concerned. The book has eight chapters. The first describes methods for studying high-velocity two-phase flow; most significantly, there is a detailed discussion of the latest macro-optics methods based on the use of coherent monochromatic illumination. A set of gas-dynamics installations for studying two-phase flow over a broad range of parameters, developed in the department of vapor and gas turbines, is described.

The second chapter deals with the mechanics of single particles in gas flows, the laws governing transport to particles of the disperse phase, coagulation processes, and deformation and disintegration of particles. Also here are data on the shape of the size distribution of drops encountered in these systems.

The third chapter, "Study of spontaneous condensation in supersonic flow," is particularly good. After setting forth the classical theory for spontaneous nucleus formation in a vapor phase, the author turns to an analysis and a systematic classification of the large body of experimental evidence. Particular attention is paid to the specific features of the formation of a condensed phase in a supersonic flow — the effect of longitudinal pressure gradients on the course of condensation, multidimensional effects, and eddy perturbations. Of particular interest are attempts to analyze transient phenomena due to spontaneous condensation in nozzles, in particular, periodically migrating condensation jumps. There are discussions of questions related to the features of condensation in the absence of noncondensing components, the state of aggregation of a condensed phase, and nucleus formation in binary vapor mixtures. There are important theoretical and experimental demonstrations of the possibility of spontaneous condensation in subsonic eddy flows at relatively low vapor supersaturations, which would not cause condensation in an eddy-free flow. The conditions under which the flow of a moist vapor is governed by heterogeneous, rather than homogeneous, condensation are determined.

A logical continuation of the third chapter is the fourth, on mathematical methods for describing supersonic flows with condensation in the quasione-dimensional approximation. Since there are fundamental difficulties involved in the physical analysis of nucleus formation, the author develops phenomenological approximations which lead to predictions accurate enough for engineering purposes regarding the position and shape of the condensation jumps and the parameters of the condensed phase.

Chapter 6 deals with experimental data on shock-wave propagation in two-phase media and the corresponding changes in the disperse phase. These results are used as the basis for a new phenomenological approach to the description of shock waves, developed in Chapter 7. Through this approach, an important

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contribution is made to the theory of separated flow. The author exploits the analogy between the processes in relaxation zones behind thermal shock waves and behind condensation jumps. An extremely important conclusion is drawn regarding the possibility of not only evaporation but also condensation in shock waves, depending on the properties of the two-phase medium.

Interesting conclusions about features of two-phase flow around objects which distinguish this type of flow from that involving a single-phase medium are drawn in Chapter 8. In particular, a correlation is established between the properties of the two-phase medium and the geometric properties of the bow discontinuity, and it is shown that the steepness and intensity of the added discontinuity as well as the velocity distribution in the perturbed zone depend on the slip of the liquid phase.

In view of the rapid development of scientific knowledge regarding gas-disperse media and the circumstance that the results of research on such systems are published in a wide variety of journals it would be difficult to expect a complete exposition of all the latest results on each topic touched on in the book. However, in giving the equations governing transport to particles the author should have included the expressions incorporating the effects of large Mach numbers, instead of limiting the discussion to the laws of condensation, evaporation, and heat transfer in a fixed medium. Certain terms are used incorrectly; for example, the phrase "finely dispersed vapor" should have been replaced by "highly dispersed moisture" or "vapor with highly dispersed droplets." (These and certain other incorrect terms are also used by other authors.)

This book is addressed primarily to specialists in physical gas dynamics, but the problems covered and the approach developed by the author for solving them are also of interest to investigators in many related scientific and engineering fields, in particular, specialists in the physics of aerodisperse systems. This book is an important contribution to the development of engineering calculation methods for two-phase systems and will undoubtedly receive wide approval.