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Brief 70-10615

NASA TECH BRIEF

Analysis of Surface Ablation of Noncharring Materials

The problem:

The development of heat shields for space vehicles and long-range missiles has stimulated an increased effort to understand the process of ablation. This intensified study is contributing to the understanding of natural ablative phenomena that occur when extraterrestrial bodies enter the Earth's atmosphere. Ablation data obtained in the laboratory, in arc-jet wind tunnels for example, do not duplicate in any single experiment all the conditions of entry flights; hence, there is a need for analytical methods of predicting and explaining the ablative phenomena.

The solution:

A computer program which solves the combined problem of heat transfer and material response for the stagnation region of blunt bodies experiencing melting and vaporizing or subliming ablation.

How it's done:

A number of well established equations are used by the program; however, some of the features and equations are new. The program takes into account the fact that entry bodies initially fly in the free-molecule regime, then in a transitional regime, and finally in the continuum regime of gas dynamics. The program contains formulas for the transitional regime to bridge between the free-molecule and continuum regimes; these formulas have been rationally derived from simple models and are believed to fill an important gap in previous analyses of small objects entering a planetary atmosphere.

Several options are available to the user. Internal radiation in the body is accounted for, or the body can be assumed to be opaque. Flight cases as well as wind-tunnel cases can be calculated; the flight cases can be applied to any planet, provided certain characteristics of the atmosphere are known. The rear boundary conditions for the ablating material can be those for a heat shield, or the aerodynamic base heating for an object can be accounted for. The ablating material can be a type that melts and/or vaporizes, sublimes, or undergoes a surface chemical reaction in the ablation process. The various material properties and the external flow conditions can be input to the program arbitrarily so that a variety of ablation research problems can be studied.

Notes:

1. This program is written in FORTRAN IV for use on the IBM 7094 computer.
2. Inquiries may be made to:
   COSMIC
   Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: B70-10615
3. The following documentation may be obtained from:
   Clearinghouse for Scientific
   and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-TN-D-3758 (N67-12779), Analysis of Surface Ablation of Noncharring Materials with Description of Associated Computer Program

Source: F. W. Matting
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