NASA TECH BRIEF

NASA Tech Briefs are issued to summarize specific innovations derived from the U.S. space program, to encourage their commercial application. Copies are available to the public at 15 cents each from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Experiments to Investigate Particulate Materials in Reduced Gravity Fields

The widespread use of particulate materials in industry and their occurrence in space and on the planets has sustained interest in obtaining a fundamental understanding of their behavior. The thermal and strength properties of particulate materials have been studied for over 100 years. In particular, the effects of heat transport through powders at reduced pressures laid the groundwork for subsequent theoretical and experimental studies of high efficiency thermal insulations and the means to improve them. Detailed information on the behavior of particulate materials would provide additional information on the physical properties of possible cometary materials, and the behavior of particles in other planetary environments.

A study was initiated to establish the feasibility of characterizing the state of agglomeration and the macroscopic behavior in reduced gravity fields of particles of known physical characteristics by measuring and correlating the thermal and acoustical properties of particulate materials. On earth, the effects of gravity on the properties of an ensemble of particles overrides other interactions except under carefully controlled and severely limited conditions. Based upon theoretical predictions of the magnitude of these interactions, it is not possible to assume that the properties of bulk particles measured in the earth's gravity field will be the same as in a reduced or near zero gravity environment.

Experimental procedures were evaluated (1) to provide a phenomenological basis for the development of a theory to describe particle behavior, (2) to measure the bulk properties of particulate materials in reduced gravity, (3) to use in the design and engineering application of particulate materials, and (4) to further the understanding of particulate material behavior in planetary and cometary environments.

The heat transfer mechanisms, which operate simultaneously and interact with each other, are not easily identified. Consequently, the thermal conductivity of powders has not been completely defined analytically in terms of the important variables, such as the temperature of the boundary walls, the particle shape and arrangement, density, physical properties of the solid, and interparticle forces. One of the major obstacles to such a definition is the degree to which thermal resistance controls the heat flow across contacts between individual particles. Efforts to improve the thermal effectiveness of evacuated powder materials have resulted in intensified research to establish the various physical phenomena occurring at contact points and in defining the radiation across the void spaces.

Using the results of these extensive investigations of the physical properties of powders, the possibility has been examined of designing space experiments that will yield useful information about the behavior of particulate materials under reduced gravity conditions. In previous studies, it has been shown that short time simulation experiments are insufficient to complete the measurements. Even with more sophisticated experimental apparatus, constraints on the experiment and uncontrollable environmental effects, such as residual accelerations, prevent meaningful simulation. Only long term experiments carried out in a manned space laboratory will achieve the desired experimental conditions. In a manned space laboratory, experimental conditions can be controlled, experiments can be adjusted immediately, and the results can be evaluated quickly.

(continued overleaf)

Note:

Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B67-10394

Patent status:

No patent action is contemplated by NASA.

Source: M. Bowden, H. F. Eden,
P. Felsenthal, P. E. Glaser,
and A. E. Wechsler
of Arthur D. Little, Inc.
under contract to
Marshall Space Flight Center
(MFS-13308)