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THE DESIGN FEATURES OF INFLATABLE LARGE-SCALE MIRROR CONCENTRATORS FOR SPACE HIGH-TEMPERATURE SOLAR POWER PLANTS

Abstract

While creating space high-capacity high-temperature solar power plants (units) it is required to design mirrors which will concentrate solar radiation, or mirror concentrating systems (MCS) with sizes much greater than transport modules of existing launch vehicles. That's why the design of transformable large-scale MCSs is actual. Inflatable structure is one of the most prospective ways for such systems creation.

Speaking about the structures of this class one has to take into account the necessity of maintenance of excessive internal pressure and to deal with additional strains caused by this pressure; low rigidity of the obtained structure, not typical for common approaches, should also be studied. These features may be partly eliminated by applying rigidizable (curing) structural materials which do not require permanent support of internal pressure and improve rigidity of structures by the installation of accessory structural components (additional cavities, ribbing etc.) which increase the structural-load capacity.

At the design stage it is required to possess rather reliable and economic methods and means to determine the operating shape of a MCS, and to assess, analyze and forecast its radiation and power characteristics.

Ground experimental determination of characteristics of large-scale rigidizable inflatable MCSs is complicated and one has to carry out the expensive tests. The results of these tests are characterized with serious interpretation problems due to the sizes of the structure and gravity influence. That's why, the mathematical models' development is of the special interest, providing us with an opportunity to estimate such MCS parameters and taking into account the effect of operation conditions, structural features, strains, roughness etc.

In this context, a mathematical model which allows the determination of MCS parameters with respect to the mentioned above factors is now being created and implemented in a software package. By now, determination of the cutting shape of the concentrator and simulation of its structural components' behavior before curing are implemented using the technical theory of soft shells. When structural materials are already cured, another model is being used based on the thin-walled shell theory and the finite-element method. A radiation exchange model is composed on the principles of static simulation and uses Monte Carlo methods.

An assessment possibility of numerous alternative versions of MCS structure and configuration at early phases of the design using mathematical simulation makes it possible to obtain a rational structure that will provide maximum power and mass performance and will require minimum costs for its realization.