

SPACE PROPULSION SYMPOSIUM (C4)  
Advanced and Combined Propulsion Systems (8)

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ADVANCED SOLAR THERMAL PROPULSION WITH SPECTRAL-SELECTIVE MULTI-STAGED  
CONCENTRATOR-ABSORBER SYSTEM

**Abstract**

Advanced solar thermal propulsion (STP) with multi-staged spectral-selective concentrator-absorber system (CAS) for inter-orbital transfer missions is considered. State-of-the-art STP concepts provide more efficient space flight compared with liquid propulsion. However, practical realization of conventional STP is complicated due to series of technical requirements to solar high-temperature energy source, particularly, to conditions of precise Sun tracking by CAS during engine firings. Purpose of the presented paper composes an improvement of STP operating performances, in particular, simplification of the Sun tracking requirements as well as light-weight thin-film concentrator design and technology simplification. The carried out analysis has also shown that payload mass for inter-orbital transfer can be increased in the case of the advanced STP use. To attain these goals, trade study of the considered STP employment is carried out. The advanced STP contains CAS with multi-staged absorber of concentrated sunlight, designed as a number of co-axial absorption elements (stages) for hydrogen heating, located in the concentrator focal plane. The absorber contains high-temperature central stage, located in the sunspot maximum concentration area, and low-temperature peripheral stages. Location of the stages corresponds to distribution of concentrated solar energy in the focal plane. Surface of each absorption stage includes high-temperature multi-layer coating with spectral-selective purposes and high level of selectivity parameter for current temperatures of heating. In this case thermal losses due to heat emissivity decrease sharply and total efficiency of such advanced CAS increases as compared to CAS with single-staged absorber. This leads to drastic reduction of the required concentration ratio of sunlight compared with conventional absolute black body absorber or CAS having single-staged spectral-selective absorption surface. It permits to use non-precise thin-film inflatable concentrator of pseudo-parabolic or near-spherical shape. Such light-weight concentrators can be rather simply designed and formed in space conditions. Sun tracking requirements in this case are simplified and in some tasks with use of CAS dynamic orientation mode can be approached to those for solar arrays. More easy operational conditions for such advanced STP provide its preferential use for practical realization of inter-orbital transfer missions. Some important technical and technological problems and restrictions of practical realization of the considered multi-staged spectral-selective CAS for the advanced STP creation are also discussed in the presented paper.