

19TH IAA SYMPOSIUM ON HUMAN EXPLORATION OF THE SOLAR SYSTEM (A5)
Human Exploration of Mars (2)

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ALL SOLAR ELECTRIC OR ALL CHEMICAL, THAT IS THE QUESTION

Abstract

For the design of manned missions to Mars, a difficult problem is the choice of the propulsion system for interplanetary transfer between Earth and Mars. Recent studies suggest the use of solar electric propulsion systems (Drake et al, Raftery et al) while others are still based on chemical propulsion (Salotti). A review of the different benefits and drawbacks is proposed. SEP is particularly appropriate for cargos that can be sent to Mars in advance without time constraints. Chemical propulsion is best suited for a manned vehicle if the duration of the trip has to be minimized, e.g. less than 6 months. Beyond these well-known considerations, other parameters are discussed. An important finding is that aerocapture allows important mass savings and makes chemical based interplanetary transportation competitive with SEP, especially for Mars landing vehicles. On the other hand, the SEP option allows more flexible departure strategies. Another idea is to use both chemical and solar electric propulsion. In the first part of the mission, all modules are sent to a high Earth orbit by means of SEP, for instance the Earth Moon lagrangian point. Once assembled, a small chemical propulsion system or kick stage is used for a quick escape of the gravity well. The efficiency of the maneuver can eventually be improved by means of an Earth flyby. SEP is then used for the remaining part of the interplanetary travel. The duration of the trip is nevertheless still longer than with chemical propulsion only and the mission remains complex, especially for the manned trip. An important parameter of the problem is the number of crew. With 3 astronauts, it is shown that the all chemical option with aerocapture is competitive in terms of IMLEO and much simpler than the SEP one. With a larger crew, the number of heavy launches quickly increases. SEP becomes much more interesting for the cargos but chemical propulsion might still be preferred for the manned vehicle in order to speed up the interplanetary transit.