

Feasibility Study of Venus Surface Cooling Using Chemical Reactions with the Atmosphere

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A literature search and theoretical analysis were conducted to investigate the feasibility of cooling a craft on Venus through chemical reformation of materials from the atmosphere. The core concept was to take carbon dioxide (CO₂) from the Venus atmosphere and chemically reform it into simpler compounds such as carbon, oxygen, and carbon monoxide. This process is endothermic, taking energy from the surroundings to produce a cooling effect. A literature search was performed to document possible routes for achieving the desired reactions. Analyses indicated that on Venus, this concept could theoretically be used to produce cooling, but would not perform as well as a conventional heat pump. For environments other than Venus, the low theoretical performance limits general applicability of this concept, however this approach to cooling may be useful in niche applications. Analysis indicated that environments with particular atmospheric compositions and temperatures could allow a similar cooling system to operate with very good performance. This approach to cooling may also be useful where the products of reaction are also desirable, or for missions where design simplicity is valued. Conceptual designs for Venus cooling systems were developed using a modified concept, in which an expendable reactant supply would be used to promote more energetically favorable reactions with the ambient CO₂, providing cooling for a more limited duration. This approach does not have the same performance issues, but the use of expendable supplies increases the mass requirements and limits the operating lifetime. This paper summarizes the findings of the literature search and corresponding analyses of the various cooling options.