FPFD Radio Isotope Heat Sourced Stirling Engine for Powering Stirling Cryocooler and Other Devices in Space

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Cryocoolers are used in space applications to cool the sensors and other electronic equipment. In satellites, Image capturing sensors are used for enhancing the spectral coverage range of these devices from visible to far-infrared, which requires low temperature cooling. An onboard power system is used to drive the cryocooler. This poses significant challenges if traditional solar arrays are used to power the rover. Dynamic Radioisotope Power systems, which are far more efficient compared to solar arrays and the currently used Radioisotope Thermoelectric Generator (RTG), are still under development and their capability to power the cryocooler along with the subsystems in the rover have not been studied extensively. In this study, a Free Piston Stirling Engine, in the medium power range, is designed to work with Radioisotope Power Source to power the rover. Part of the generated power is used to run a Stirling Cryocooler, which is designed to work with minimum power. Both the engine and the Cryocooler are designed using SAGE software and the engine results are verified using an Axisymmetric 2D CFD analysis in ANSYS Fluent. The developed CFD model is further validated using the available results from GMRL GPU-3 engine, The designed engine is found to have a maximum efficiency of 40% at a power output of 250 W and is found to be sufficient to power the Cryocooler as well as other subsystems in the rover.