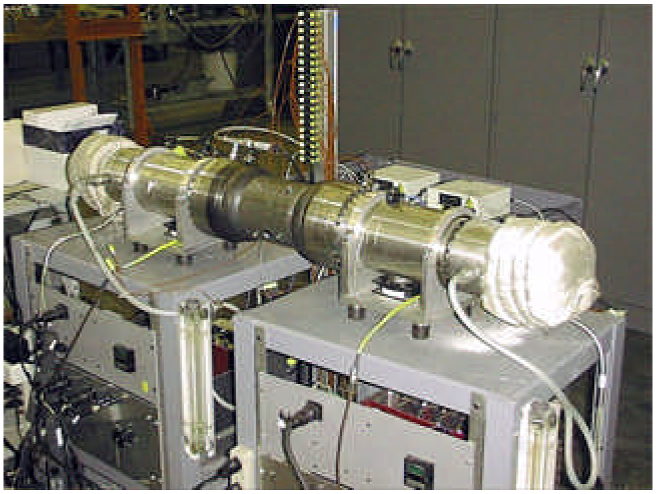
Parallel Stirling Converters Being Developed for Spacecraft Onboard Power

Stirling Technology Co., as part of a NASA Lewis Research Center Phase II Small Business Innovation Research contract, has successfully demonstrated paralleling two thermodynamically independent Stirling converters. A system of four Stirling converters is being developed by NASA and the Department of Energy as an alternative high-efficiency radioisotope power source for spacecraft onboard electric power for NASA deep space missions. The high Stirling efficiency, exceeding 20 percent for this application, will greatly reduce the necessary isotope inventory in comparison to the current radioisotope thermoelectric generators (RTG's), significantly reducing mission cost and risk. Stirling is the most developed converter option of the advanced power technologies under consideration.

Previous Stirling development had focused on single converters and had not addressed how to connect multiple converters in a system. However, in most potential space applications, multiple converters are important for reliability and modularity. Thermodynamically independent converters allow one converter to fail without affecting the performance of the other. Finally, the use of multiple converters is important to controlling vibrations, a critical issue for a dynamic space power system. Synchronization of converter pairs operating in an opposed configuration provides balanced operation with minimal vibration.



Parallel Stirling converters synchronized for system operation and low vibrations.

Synchronization was achieved with two 350-We converters (see the photograph) operating over a wide range of conditions, including simulated degraded operation for one of the two converters. This produced a 40- to 50-fold reduction in vibrations in comparison to an unbalanced converter. Equal power generation between the two converters was shown for normal operation and simulated degradation with constant power input. Successful system operation was demonstrated with the two synchronized converters feeding a battery charger load, as would most likely be used in a radioisotope power system. Transient data taken during various connections and disconnections of the two converters showed that the converters could be synchronized reliably and rapidly. The two converters were connected electrically in parallel and mechanically through external attachments on the cold-end pressure vessels. A mechanical coupler was developed that precisely aligns the two converters and can compensate for any inherent misalignments.

This connection method for multiple converters will now be utilized to connect the prototype converters that are being developed by the Department of Energy and Stirling Technology Co. for potential use in a 150-We Stirling isotope power system.

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