



Green Design

Grid-Tied Photovoltaic Power System

This method can be used for generating clean, sustainable electric power.

John H. Glenn Research Center, Cleveland, Ohio

A grid-tied photovoltaic (PV) power system is connected directly to the utility distribution grid. Facility power can be obtained from the utility system as normal. The PV system is synchronized with the utility system to provide power for the facility, and excess power is provided to the utility.

Operating costs of a PV power system are low compared to conventional power technologies. This method can displace the highest-cost electricity during times of peak demand in most climatic regions, and thus reduce grid loading. Net metering is often used, in which independent power producers such as PV power systems are connected to the utility grid via the customers' main service panels and meters. When the PV power system is generating more power than required at that location, the excess power is provided to the utility

grid. The customer pays the net of the power purchased when the on-site power demand is greater than the on-site power production, and the excess power is returned to the utility grid.

Power generated by the PV system reduces utility demand, and the surplus power aids the community. Modern PV panels are readily available, reliable, efficient, and economical, with a life expectancy of at least 25 years. Modern electronics have been the enabling technology behind grid-tied power systems, making them safe, reliable, efficient, and economical with a life expectancy equal to the modern PV panels.

The grid-tied PV power system was successfully designed and developed, and this served to validate the basic principles developed, and the theoretical work that was performed. Grid-tied PV power systems are reliable, mainte-

nance-free, long-life power systems, and are of significant value to NASA and the community. Of particular value are the analytical tools and capabilities that have been successfully developed. Performance predictions can be made confidently for grid-tied PV systems of various scales. The work was done under the NASA Hybrid Power Management (HPM) Program, which is the integration of diverse power devices in an optimal configuration for space and terrestrial applications.

This work was done by Dennis J. Eichenberg of Glenn Research Center. Further information is contained in a TSP (see page 1).

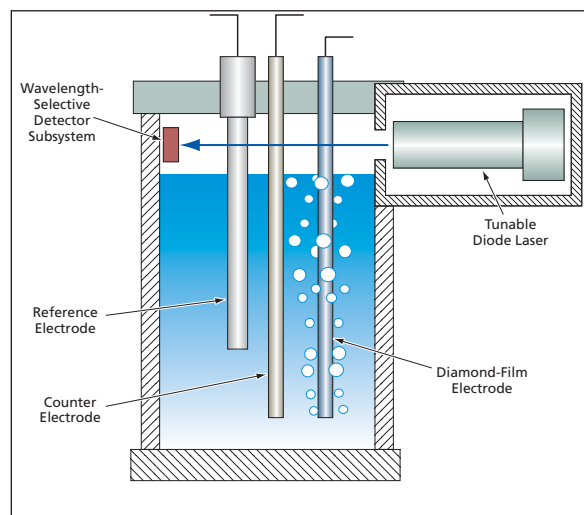
Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18623-1.

Spectroelectrochemical Instrument Measures TOC

No hazardous reagents, ultraviolet light, or high temperature are needed.

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A spectroelectrochemical instrument has been developed for measuring the total organic carbon (TOC) content of an aqueous solution. Measurements of TOC are frequently performed in environmental, clinical, and industrial settings. Until now, techniques for performing such measurements have included, variously, the use of hazardous reagents, ultraviolet light, or ovens, to promote reactions in which the carbon contents are oxidized. The instrument now being developed is intended to be a safer, more economical means of oxidizing organic carbon and determining the TOC levels of aqueous solutions and for providing a low power/mass unit for use in planetary missions.



CO₂ Would Be Produced by electrochemical oxidation of organic constituents of the aqueous solution, and the concentration of CO₂ in the headspace above the solution would be inferred from infrared absorption.

The proposed instrument exploits an electrochemical-oxidation principle that has also been investigated as the basis of a method of disposing of toxic organic industrial wastes. The method has found limited use, largely because the most common electrode materials (non-diamond carbon-based materials and such metals as platinum, silver, gold, mercury, and nickel) eventually become fouled or oxidized when operated at the high anodic potentials (between 2 and 2.5 V versus a standard hydrogen electrode) needed for efficient oxidation of organic compounds. An effort to overcome this limitation has led to consideration of electrodes consisting of substrate materials (e.g. silicon or tita-

nium) coated with diamond that has been heavily doped with boron to promote p-type semiconductivity to a nearly metallic level. Such boron-doped diamond (BDD) electrodes have been found to be robust, capable of withstanding high anodic potentials, and resistant to self-oxidation.

This new TOC instrument (see figure) includes a BDD electrode, a counter

electrode, and a reference electrode in a cell containing an aqueous solution to be tested. A positive potential of about 2.5 V versus the reference electrode is applied to the BDD electrode to cause the organic material in the solution to become oxidized, thereby producing H₂O and CO₂. A headspace above the solution traps escaping CO₂. The concentration of the CO₂ can be measured by a minia-

ture infrared absorption spectrometer comprised of a tunable diode laser and an associated wavelength-selective detector subsystem. The TOC of the solution is proportional to the concentration of CO₂ in the headspace.

This work was done by Sam Kounaves at Tufts University for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14814-1