Solid Oxide Fuel Cells

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Technology

What is a Solid Oxide Fuel Cell?

Solid Oxide Fuel Cells provide a reliable source of DC power by converting chemical energy into electricity. Ultra-USII’s P250i Solid Oxide Fuel Cells are capable of providing days, weeks and even months of reliable, clean, extended-run backup power protection for a variety of critical infrastructure needs.

How It Works?

A Solid Oxide Fuel Cell (SOFC) is an electrochemical reaction device that converts fuel and air into electricity without combustion. A SOFC is comprised of three parts: an electrolyte, an anode and a cathode. The electrolyte is a solid ceramic material and the anode and cathode parts feature coatings of electrolyte. SOFC are high temperature fuel cells. Warm air enters the cathode side and steam mixes with fuel (propane/natural gas) to produce reformed fuel, which enters the anode side. This process leads to a chemical reaction as the reformed fuel crosses the anode it attracts oxygen ions from the cathode. The oxygen ions join with the reformed fuel to produce DC electricity, water, and small traces of carbon dioxide. The warm water is continuously recycled to produce steam needed to reform the fuel and generate the heat required for fuel cell operation.

Advantages

- “True Standby Mode” - only operates when needed
- Reliable operation in extreme temperatures
- Zero maintenance
- Lower lifecycle costs than diesel/gas generators and other fuel cell technologies
- “Turnkey solution” with minimal setup

Disadvantages

- Startup is not instantaneous
- Ongoing fuel supply required
- Larger upfront cost than gas/diesel generators
- Not well suited for 24/7 prime power applications
- Stack life is cycle limited
An extended power outage from an ice storm, wind storm, hurricane or other phenomena doesn’t have to paralyze your operation. While battery back-up can provide hours of protection, extended up-time isn’t ensured unless your equipment is proactively backed-up with Ultra-USII’s P250i (250W @ 12, 24, 48 VDC) Solid Oxide Fuel Cells.

**System Operation**

The P250i is designed to easily integrate with existing power infrastructure (utility grid, generators, batteries, solar & wind, solar charge controllers, DC-DC converters, fused external communications, computers, modems and other customer electronics). Powered by readily available and low cost propane or natural gas, the P250i has the ability to sit in standby mode for months to years at a time monitoring battery voltage. The P250i will automatically start once the batteries dip below a pre-determined lower threshold voltage. After a 25-30 minute startup period, the P250i will begin charging the batteries and powering the load. Once the batteries reach a pre-determined upper threshold voltage, the P250i will automatically begin to cool-down and return to standby mode.

**Railroads**

- Highway Crossings
- Intermediate Signals
- Control Points
- Solar Hybrids
- Telecom Equipment
- Security/Surveillance

**Oil & Gas**

- SCADA Equipment
- Remote Telemetry
- Monitoring Equipment
- Control Systems
- Solar Hybrids
- Security/Surveillance

**Infrastructure**

- Traffic Signals
- Evacuation Signage
- Advanced Warning Systems
- Border Control Systems
- Weather Stations
- Remote Monitoring
- Security/Surveillance
- Solar Hybrids
Key Features & Benefits

Propane or Natural Gas
The P250i is powered by readily available, easily transportable and low cost propane or natural gas. During operation the P250i efficiently burns 1/4lb LP/hour and can provide 130-160 hours of run-time on two (2) BBQ style propane tanks. Larger tanks can be used to improve runtime.

Zero Maintenance
The P250i needs no oil changes, has no moving parts and requires no routine maintenance. In fact, the P250i is impervious to time and can sit in standby mode for months to years at a time monitoring battery voltage and only run when its called upon.

All-Weather Performance
The P250i utilizes a ceramic electrolyte which is not susceptible to freezing and thawing cycles common among other fuel cell types. Its robust design allows the P250i to reliably operate in virtually any climate -40°F to 158°F.

Easy Integration
The P250i integrates seamlessly with the utility grid, generators, batteries, solar & wind, solar charge controllers, DC-DC converters, fused external communications, computers, modems and other customer electronics.
## Technical Specifications

### Power

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Charge Power</td>
<td>250W</td>
</tr>
<tr>
<td>Nominal Operating Voltage</td>
<td>12, 24, 48 VDC</td>
</tr>
<tr>
<td>Nominal Charging Current</td>
<td>20, 10, 5A</td>
</tr>
<tr>
<td>Fuel Efficiency (LHV)</td>
<td>20%</td>
</tr>
<tr>
<td>Engine Controller</td>
<td>&lt;0.05W</td>
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<tr>
<td>Design Target Life</td>
<td>250 Cycles / 3,000 Hours</td>
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</tbody>
</table>

### Environmental

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature</td>
<td>-40°C to 70°C (-40°F to 158°F)</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to 71°C (-85°F to 159°F)</td>
</tr>
<tr>
<td>Humidity</td>
<td>0%-95%* RH</td>
</tr>
<tr>
<td>Operating Altitude</td>
<td>Up to 10,000 ft</td>
</tr>
</tbody>
</table>

* Non-condensing

### Operational

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (P250i only)</td>
<td>18.5 lbs / 10.7kg</td>
</tr>
<tr>
<td>Dimensions (P250i only)</td>
<td>13”H x 17”L x 7”W</td>
</tr>
<tr>
<td>Noise</td>
<td>40 dB (A)</td>
</tr>
<tr>
<td>Engineering Data</td>
<td>Serial RS232 9600 8N1</td>
</tr>
<tr>
<td>Data Display</td>
<td>VFD</td>
</tr>
<tr>
<td>Fuel Consumption LPG</td>
<td>0.25 lbs/hour</td>
</tr>
<tr>
<td>Fuel Consumption CNG</td>
<td>3.27m³/day</td>
</tr>
</tbody>
</table>
What is Telematics?

Telematics is Ultra-USSI’s real-time monitoring system for it’s P250i Solid Oxide Fuel Cells. Fuel Cells equipped with Telematics benefit from increased uptime, fewer site visits and a significant reduction in transportation/maintenance costs. Telematics is an optional (yearly subscription) based service.

How It Works?

Telematics provides real-time and historical operational visibility of Ultra-USSI’s P250i Solid Oxide Fuel Cells via cellular/satellite service to a web portal dashboard with data logging, status alerts, reporting and 2-way communication for quick system diagnostics, software upgrades and remote starting. Telematics can be setup so end users receive text message or email alerts for pertinent system status alerts so proactive measures instead of reactive measures can be taken.

Status Alerts

- Active
- Battery Voltage
- Fuel Remaining
- Output Current
- System Voltage
- System Current
Hybrid Power Systems

Hybrid Power Systems are a popular option for applications seeking to improve overall system availability and reliability, especially during winter months with limited sun-hours. Solar power systems are effective in most places with unobstructed access to sunlight, while fuel cells are suitable for use in a variety of climates but must have access to a local fuel supply.

Basic Operation

The solar array, wind generator, fuel cell and batteries all work together as a “hybrid” system.

How It Works?

The solar array converts sunlight into electricity. The batteries are charged by the solar controller assembly. If the batteries are fully charged and being maintained above a certain predetermined threshold voltage by the solar array, the P250i fuel cell is idle. When the batteries reach the lower threshold voltage level, the fuel cell will automatically turn on. After a 25-30 minute start-up period, the fuel cell will begin charging the batteries and powering the load. Once the batteries reach a pre-determined upper threshold voltage, the fuel cell will automatically begin to cool-down and return to standby mode. A wind generator is often added (for sites with adequate wind resources) to provide supplemental power to the system during periods of inclement weather.

Hybrid System (pictured above) combines Solar, Wind, Batteries and a Solid Oxide Fuel Cell for maximum site reliability
About

RedHawk Energy Systems, LLC is a value-added manufacturing subsidiary of the Arthur N. Ulrich Company. Since the early 1980’s, we’ve helped hundreds of commercial and industrial customers tackle their critical prime and back-up power challenges with innovative solutions ranging from a few watts to several kilowatts.

- Solar Power Systems
- Solid Oxide Fuel Cells
- Stirling Engines
- Micro-Wind Turbines

- Hybrid Power Systems
- Batteries
- Battery Boxes
- Battery Enclosures

Ultra-USSI, a division of Ultra Electronics designs and manufactures solid oxide fuel cells (SOFC) for back up and portable power. Their tubular ceramic cell design allows them to offer compact and rugged systems that can operate in the most austere and remote locations. Ultra-USSI has manufacturing facilities in Ann Arbor, MI and Columbia City, IN.

Website: https://www.ultra-fuelcells.com