REDHAWK ENERGY

Solid Oxide Fuel Cells

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RH - P250i (GEN4) SOFC

Technology

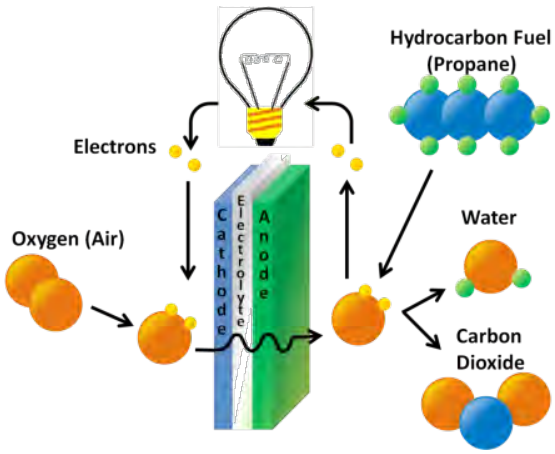
What is a Solid Oxide Fuel Cell?

Solid Oxide Fuel Cells provide a reliable source of DC power by converting chemical energy into electricity. Edge Autonomy (formerly Adaptive Energy) 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 requirements.

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.
- SOFCs are high temperature fuel cells, reaching internal temperatures upwards of 600°C for operation.
- 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.



Solid Oxide Fuel Cells

P250i

Edge Autonomy's P250i Solid Oxide Fuel Cells (SOFC) provide a reliable source of DC power by converting chemical energy into electricity. The P250i is an eco-friendly alternative to maintenance-intensive gas/diesel generators; working in conjunction with 12/24/48V battery banks to keep batteries charged and loads powered. The P250i can provide days, weeks and even months of extended-run backup power protection for a variety of critical infrastructure requirements.

Performer Series

The Performer Series P250i is capable of providing 250W of charging power for **250 start/stop cycles and/or 3,000 hours** of runtime before stack replacement.

Endurance Series

The Endurance Series P250i is capable of providing 250W of charging power for **10 start/stop cycles and/or 10,000 hours** of runtime before stack replacement.

Basic Operation

Our P250i Solid Oxide Fuel Cells work as a "**battery tender.**"

- The system can sit in standby mode for months to years at a time monitoring battery voltage.
- The P250i utilizes voltage sensing leads and a remote temperature probe to detect the actual battery voltage and temperature.
- When batteries dip below a certain pre-determined lower threshold voltage the SOFC will automatically start and after a brief startup period (25-30 minutes) will charge the batteries until an upper threshold voltage is reached and at that point will automatically begin to cooldown and return to standby mode.

Environmentally Friendly

The P250i is an eco-friendly alternative to gas/diesel generators that are noisy and emit harmful pollutants. During operation, the P250i is extremely quiet and only emits small traces of carbon dioxide.

The P250i can help organizations large and small save energy, reduce green-house gas emissions, meet sustainability initiatives and improve the predictability, performance and reliability of their operations.

Key Features & Benefits

P250i SOFC

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-Climate Operation

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, batteries, solar & wind, solar charge controllers, generators, DC-DC converters, fused external communications, computers, modems and other customer electronics.

Automated Operation

Once installed and commissioned the P250i is completely automated as it senses battery voltage to turn on/off as long as there is a connected fuel source of propane or natural gas.

Remote Monitoring

The P250i can be remotely monitored via available Telematics system, dry contacts or SNMP functionality.

GEN4 Updates

The GEN4 P250i Solid Oxide Fuel Cell features several enhancements for easier end user setup, operation and monitoring.

Front Panel - Commission Test Functionality

Fuel Reset Button

SNMP Monitoring

Configurations / Options

P250i SOFC

Integrated System

Our P250i Solid Oxide Fuel Cell is housed inside of an outdoor NEMA rated enclosure with input and output terminations; provisions for customer supplied 2-20# propane cylinders; integrated 3,000 or 10,000 hour fuel filter assembly; gas regulator, manifold and valve assembly; hinged and lockable access door; fuel cell datalogger and cell modem for remote communications; and ethernet and USB ports.

Mounting Configurations:

Bungalow

Foundation Piers

Pad Mount

Solar Hybrid Systems

The P250i can be used in conjunction with a solar array as a solar hybrid system to increase overall system reliability and availability during winter months or other times of insufficient solar production.

Hybrid Operation:

- The solar array, P250i and batteries all work together as a "hybrid" system.
- The solar array converts sunlight into electricity.
- The batteries are charged by the solar controller assembly. If the batteries are fully charged, the P250i is idle.
- When the batteries dip below a certain pre-determined threshold voltage, the P250i will automatically be signaled to turn on.
- After a 25-30 minute startup period, the P250i will begin charging the batteries and powering the load.
- Once batteries reach a pre-determined upper threshold voltage the P250i will automatically began to cool-down and return to standby mode.

Applications

Extended-Run Backup Power

The P250i is an eco-friendly, long-life, low maintenance alternative to gas/diesel generators. It is best suited for providing extended-run backup power protection in the event of a power outage and/or insufficient solar production (solar hybrid).

With extended power outages from ice storms, blizzards, wind storms, hurricanes, wildfire public safety power shutoffs becoming more common, the P250i keeps your batteries charged and operations running smoothly no matter what!

Trackside Rail

- Highway Crossings
- Intermediate Signals
- Control Points
- Temporary Power
- Telecom Equipment
- Hybrid w/Solar

Oil & Gas

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

Telecom

- Radio Communication
- Repeater Sites

Critical Infrastructure

- Traffic Signals
- Evacuation Signage
- Advanced Warning Systems
- Border Control Cameras
- Weather Stations
- Remote Monitoring
- Security/Surveillance
- Solar Hybrids

Technical Specifications

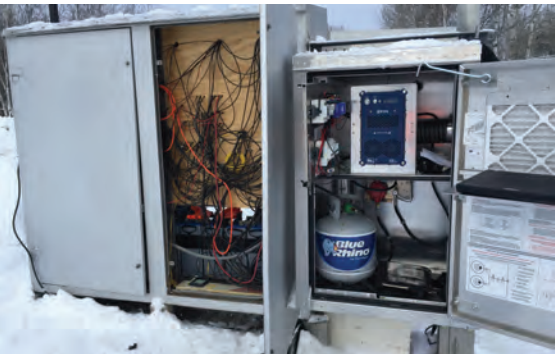
P250i SOFC

Power	
Continuous Charge Power	250W
Nominal Operating Voltage	12, 24, 48 VDC
Nominal Charging Current	20, 10, 5A
Fuel Efficiency (LHV)	20%
Standby Power Draw	0.150 W
Design Target Life (Performer)	250 Cycles / 3,000 Hours
Design Target Life (Endurance)	10 Cycles / 10,000 Hours

Environmental	
Operating Temperature	-40°C to 70°C (-40°F to 158°F)
Storage Temperature	-65°C to 71°C (-85°F to 159°F)
Humidity	0%-95%* RH
Operating Altitude	Up to 10,000 ft

Operational	
Weight (P250i only)	18.5 lbs / 10.7kg
Weight (Overall Sys.)	350 lbs / 158.8 kg
Dimensions (P250i only)	13”H x 17”L x 7”W
Dimensions (Overall Sys.)	50”H x 24”L x 30”W
Noise	40 dB (A)
Engineering Data	Serial RS232 9600 8N1
Data Display	OLED
Fuel Consumption LPG	0.25 lbs/hour
Fuel Consumption CNG	3.27m³/day

*Specifications subject to change



RedHawk Energy Systems, LLC is an ISO 9001:2015 certified value-added manufacturing subsidiary of the Arthur N. Ulrich Company. We help 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**
- **RP Series Retractable Mast**
- **Solid Oxide Fuel Cells**
- **Alkaline Fuel Cells**
- **Stirling Engine Generators**
- **Micro-Wind Turbines**
- **Hybrid Power Systems**
- **Batteries**
- **Battery Boxes**
- **Switch Boost™ 120V, 24V & 12V Systems**

EDGE AUTONOMY ENERGY SYSTEMS

Edge Autonomy Energy Systems (formerly Adaptive Energy) designs and manufactures Solid Oxide Fuel Cells (SOFC) for back up and portable power applications. Edge's tubular ceramic cell design allows for compact and rugged systems that can operate in the most austere and remote locations. The company offers 250 – 1kW watt fuel cell systems that are powered by globally available and energy dense propane, butane, and natural gas.

*RedHawk Energy is the exclusive rail distributor for Edge Autonomy in the US & Canada.

Website: **https://edgeautonomy.io/**

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