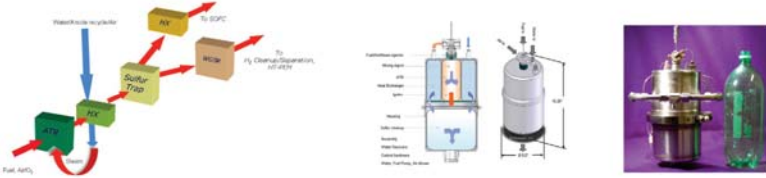


WATER-NEUTRAL DIESEL REFORMING

Subir Roychoudhury

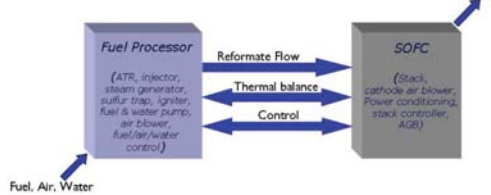
Ambient Temperature Air, Water, Fuel In SOFC Quality Reformate Out



Fuel sulfur converted to H_2S in ATR and sorbed in sulfur trap

- Size: 3 liters; Weight: 5.2 kg
- Room-temp start-up; No preheat required
- Off-the-shelf pumps & blowers being implemented
- Automated "push button" start, load changes & shutdown
- Control logic/algorithm implemented via PC-based interface
- Readily integrated w/SOFC, PEM, H_2 generation systems

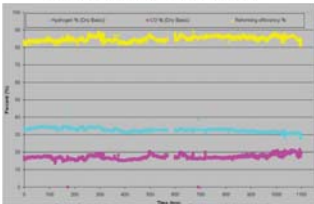
Fuel Cell Test Results



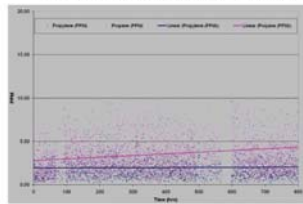
Operated w/ $1KW_e$ SOFC stack
6 thermal cycles; 1100kW-hr produced
DC Gross efficiency of 34% achieved
Maximum power of $1.5KW_e$ obtained

Successful startup/operation/shutdown demonstrated
1102 hours total testing- 370hrs longest steady-state period
Successfully tested manual load-following
On post inspection, no carbon or deleterious effects on stack observed

ATR Durability (1000 hours)



Higher HC Formation (<20 ppm)



Reformate Composition vs. Equilibrium

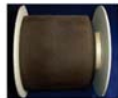
Fuel Spec: JP-8 w/ 77 ppm sulfur

| Fuel | S/C | O/C | H ₂ O | H ₂ | N ₂ | CO | CO ₂ | CH ₄ | C ₂ | C ₃ | S (ppb) |
|---------------|------|-----|------------------|----------------|----------------|------|-----------------|-----------------|----------------|----------------|---------|
| JP-8 (liquid) | 0.95 | 0.9 | 12.7 | 38 | 37.7 | 14.3 | 5.4 | 0.14 | 0.02 | 0.00 | 0.0005 |
| JP-8 (gas) | 0.95 | 0.9 | 12.1 | 29.5 | 37.5 | 15.3 | 5.7 | 0.01 | 0 | 0 | - |

Microlith® Manufacturing

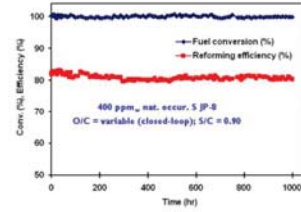
Catalyst-coated metal mesh (Microlith®) made to PCI specifications in continuous production line

Application-specific formulations developed at PCI and applied by a proprietary process



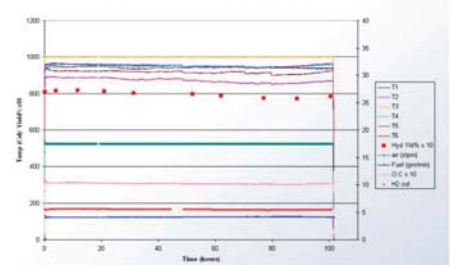
Effect of Fuel Sulfur on Performance

1000 hour durability w/ 400 ppm S



Complete fuel conversion
Stable, LHV-based efficiency,

CPOX of Diesel (waterless)



Near complete fuel conversion
High H_2 yield

Anode Gas Recycle Data (ex. 50% recycle)

| | From experiment | From ASPEN analysis |
|------------------------|--------------------|---------------------|
| AGR-air mixture T (°C) | 200°C | 350°C |
| External O/C ratio | 1.45 | 1.30 |
| External S/C ratio | 0.72 | 0.72 |
| Reactor T (°C) | 920°C | 911°C (adiabatic) |
| Products | Vol. % (dry basis) | Vol. % (dry basis) |
| H ₂ | 11.4 | 11.6 |
| N ₂ | 65.4 | 62.8 |
| CH ₄ | 0.04 | Trace |
| CO | 9.5 | 14.4 |
| CO ₂ | 13.7 | 11.3 |

Shows feasibility of AGR as water source
Various O/C, S/C ratios examined

Scale-up: Shipboard Fuel Processors



50 - 250 kW Systems under Development

