

TECHNOLOGY FACT SHEET

MULTI-FUNCTIONAL FUEL CONVERTER

Introduction

This invention sets a new standard in the flexibility to use energy-dense liquid fuels in the rapidly evolving world of small-scale power generation. Researchers at the Sensors and Electron Devices Directorate of the U.S. Army Research Laboratory (ARL), Adelphi, Maryland, developed and successfully tested a micro-converter that is compatible with a variety of common fuels. The device can be tuned to operate in three functional modes: (1) create heat for thermoelectric power, (2) produce hydrogen for fuel cells or (3) synthesize custom fuels to meet other power needs. As a front-end for these diverse power trains, the ARL invention exhibits a range of capabilities unlike any other in the marketplace today.



Multi-functional fuel converter could enable a wide variety of power solutions, some of which could be used to reduce the weight burden for Soldiers, first responders and others with a need for versatile power sources (Image sources: www.army.mil)

Concept

Among its many potential applications, ARL researchers envision this technology as a replacement for primary batteries that power communications and other equipment worn by today's dismounted Soldiers. Army calculations suggest a JP-8 fueled hybrid charger/battery recharger system could dramatically reduce the cost and weight burden of expendable materials, a significant logistical concern for deployed forces. It is estimated that a single battalion on a 96-hour mission uses about 4,400 primary (non-rechargeable) batteries at a cost of \$500,000 and a weight penalty of 8,800 lbs. In contrast, the fuel cell option, which uses rechargeable batteries, would expend about 200 gallons of JP-8 at a cost of just \$400 and carry 1,600 lbs, which is less than 40% of the present load.

The ARL multi-functional fuel converter would go a long way to help realize these and other efficiencies for the military, but it could also greatly advance power options for consumer electronics, such as hybrid personal fuel cells that are being prototyped and tested by companies around the globe.

Invention Overview

- ❖ *Creates, transforms or uses fuels for power generation*
- ❖ *Designed with commercial-off-the-shelf (COTS) components*
- ❖ *Reliable operation and scalable to meet a wide range of power needs*
- ❖ *TRL 4 – Fully functioning engineering prototype and data available for inspection by commercialization partner*
- ❖ *U.S. Patent Application filed, SN 12/870,916*
- ❖ *Available information - "Catalytic Combustion of Ethanol and Butanol" ARL-TN-0374; "Scalable Catalytic Burner..." 27th Annual Army Science Conference (2010); "Catalytic combustion of alcohols for microburner applications" J Power Sources 195 (2010) 2008–2013; "Catalytic partial oxidation of i-butanol..." J Hydr Energy 37(2012) 1399-1408*

Doing Business with ARL

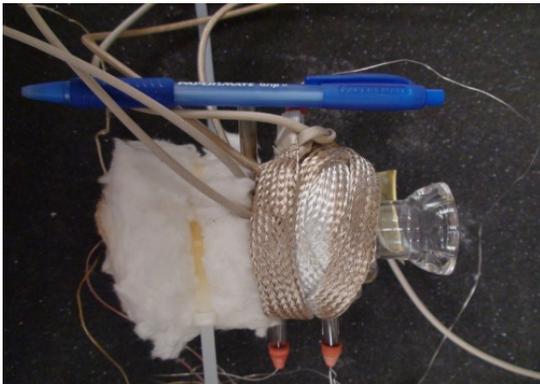
- ❖ *ARL is a leader in partnering with domestic firms*
- ❖ *Successfully developed and implemented innovative tools to ease the technology transfer process*
- ❖ *Tools include Patent License Agreements (PLAs), Cooperative Research and Development Agreements (CRADAs), Test Services Agreement (TSA) and others*
- ❖ *Visit www.arl.army.mil for more information*

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Features/Capabilities/Intellectual Property

Current fuel converter technology restricts system runtime and reliability due to inefficient conversion and poor fuel atomization at low flow rates (i.e., less than 10 milliliters/hour). These first-generation fuel converters also tend to be geared toward one type of application (e.g., only fuel reforming).

To overcome these efficiency and reliability problems, the ARL invention uses a new combustor design and a recently developed electro-spray atomizer that facilitates low fuel flow rates. Another novel feature of this technology is the capability to operate in three distinct fuel flow regimes. In the first regime, the converter runs at full combustion and generates substantial amounts of heat, making it ideal for thermoelectric applications. With the second regime, the converter operates as a fuel reformer to produce hydrogen gas for solid oxide fuel cells. At the third regime, the invention performs as a bio-refinery, creating hydrocarbon chains that can produce synthetic fuels.



Multi-Functional fuel converter prototype, shown next to pen for scale (Image source: ARL)

Key Advantages & Benefits

- ❖ *Low cost*
- ❖ *Compact size*
- ❖ *Reliable design*
- ❖ *Uses COTS components*
- ❖ *Simple to operate*
- ❖ *Bench-scale model tested with thermoelectric generation device*
- ❖ *ARL inventor team available to work with commercialization partner*

Potential Markets/Applications

This invention is an enabling technology that is envisioned for use with thermoelectric power generators and hydrogen fuel cells, and it can also serve as a hydrocarbon fuel synthesizer. Under these three broad application categories, there are many potential commercial uses: waste-to-energy (e.g., combusting agricultural waste that contains substantial amounts of butanol and other useful organics); supplying hydrogen from exhaust gas fuel reforming (e.g., onboard automotive system to deliver hydrogen as either a pure fuel or an additive to fossil fuels); and long-term unattended ground sensors (i.e., using synthetic fuel derived from less energy-dense precursor feedstock). Other potential applications/industries include:

- Solid oxide fuels cells – Leisure activities (transportable devices for camping, hiking), emergencies (mobile auxiliary power units for cell phones, computers, two-way radios), and back-up power (stationary power supply when grid service is interrupted)
- Thermoelectric power – Long-term, remote equipment operation; portable battery charger; and quiet-operation power source
- Chemical manufacture – Paraffin and olefin production (unit operation for bio-refinery) and waste management reactor (produce value-added products from waste).

Contact Information

This technology was developed by ARL. It is now available for licensing and CRADA opportunities.

For further information please contact:

*Mike Rausa, ARL-ORTA,
410-278-5028, mrausa@arl.army.mil.*

*Julio Suarez, SAIC,
717-398-2365, julio.suarez@saic.com*