provide electricity for Eilat with ultralow NOx, SOx and particulate emissions. Finally, methanol is used in a biological nutrient removal process to help clean up some of the world's most sensitive aquifers in wastewater treatment plants in the U.S., Europe and China.

So welcome to Vancouver, and welcome back methanol!

Gregory Dolan is CEO of the Methanol Institute.

FUEL CELLS

Synergistic Industries: As Fuel Cell Markets Grow, So Does Syngas Potential

Novel syngas and gasification technologies are enabling fuel cell growth in niche markets.

By Jennifer Gangi

The fuel cell industry is gaining traction in a wide range of markets and proving to be a viable, reliable power source to help move the world toward a cleaner future. As this growth continues in existing sectors (e.g., primary power, backup power and material handling) and nascent ones begin to take hold (e.g., fuel cell-powered light-duty vehicles and buses and energy storage), the need for increased hydrogen pathways will grow as well. Since syngas consists primarily of hydrogen, this opens up an opportunity for the syngas and gasification industries to help answer that call.

What is a fuel cell?

Fuel cells generate electricity using an electrochemical reaction—not combustion—producing zero or near-zero polluting emissions, depending on the fuel source.

Fuel cells' unique combination of proven benefits makes them an ideal technology for a number of applications. Fuel cells are reliable, inherently efficient and they also are scalable. Commercially available products range in size from palm-sized micro units to forklifts, passenger cars and buses and small- and large-scale fuel-cell power plants.

Fuel flexibility is another one of the attractive benefits fuel cells offer, helping create a bridge pathway from fossil fuels to renewables while using those fuels more efficiently with reduced emissions in the process. Most fuel cells use hydrogen, the most abundant element in the universe. Hydrogen can be produced from a wide range of feedstocks, including natural gas, syngas, landfill and anaerobic digester gas, biomass and water via either grid or renewably powered electrolysis.

Fuel cells are a family of technologies. There are several different fuel cell types and each has its own unique chemistry characterized by its electrolyte and providing different attributes and benefits such as varying fuel types, operating temperatures, energy efficiencies and applications of use.

Two types of fuel cells, molten carbonate fuel cells (MCFC) and solid oxide fuel cells (SOFC), operate at very high temperatures and are capable of internal fuel reforming to directly generate power from fossil fuels without intermediary steps. The high operating temperature allows these types of fuel cells to be unaffected by chemical compounds such as carbon monoxide (CO) or CO2 that can adversely affect other systems. These high-temperature fuel cells can use various fuels, including natural gas, biogas or syngas derived from coal or biomass.

Within the fuel cell system hydrogen is stripped from the feedstock—commonly via steam reformation—and then converted into electricity. Since this is a chemical reaction—not combustion—fuel cells are inherently more efficient than conventional technologies, reaching efficiencies of 50% to 60%. Some fuel cells also produce heat as a byproduct so when sited near the point of use this heat can be captured (called combined heat and power, CHP or cogeneration) for space heating, hot water or even cooling, resulting in system efficiencies of 90% or greater.

FuelCell Energy's 1.4-MW MCFC power plant at Hartford Hospital in Connecticut. (Source: FuelCell Energy Inc.)

Syngas also can be directly used in MCFCs and SOFCs to produce electricity directly from hydrogen as well as CO. After converting CO to methane (a process known as methanation) syngas can be used in these fuel cells to produce electricity at even higher efficiency.

MCFCs and SOFCs are primarily used for large-scale stationary power generation applications and can range in scale from a few hundred kilowatts up to tens of megawatts. Fuel cells are able to be installed as part of the electric grid, or in parallel to it, so they can deliver seamless and reliable power without disruption due to grid failure or blackouts. Hundreds of systems are providing primary power and backup power across the country in a range of applications, including data centers, utilities, retail facilities, universities, hospitals and more. The two largest companies involved in this space, FuelCell Energy (MCFC) and Bloom Energy (SOFC), have almost 500 MW of fuel cell capacity installed or on order around the world.

There are also companies working on

developing smaller SOFCs (five to 50-KW range) for home and retail use, and in Japan, several companies involved in the country's residential fuel cell program are now offering SOFCs as a choice to consumers.

Syngas use is not limited to these high-temperature fuel cells, however. Syngas can be further reformed to produce high-purity hydrogen for use in lower temperature fuel cells, such as polymer electrolyte membrane fuel cells that are being deployed in fuel cell vehicles such as cars and buses, material handling equipment and backup power for telecommunications and other sites. Material handling and telecommunications backup are two of the fastest growing sectors for the fuel cell industry with high-profile customers and thousands of deployments all around the world.

Syngas also can be converted into synthesis fuel (synfuel), a liquid fuel produced via the Fisher-Tropsch process, which removes sulfur streams resulting in ultraclean fuel as well as to methanol, which is used as a liquid hydrogen carrier for a range of fuel cell applications, particularly in areas where obtaining delivered hydrogen is a challenge.

Past to present to future

The U.S. Department of Energy, through the Office of Fossil Energy and the National Renewable Energy Laboratory (NETL), established the Hydrogen & Syngas Program back in 2004 to use coal as a resource to produce, store and deliver hydrogen. One of the program's main focus areas was coal gasification to produce hydrogen from coal via syngas. The program no longer exists in that form, but NETL continues to support R&D projects as well as working with industry and universities on SOFCs, syngas use in fuel cells and coal as a source for hydrogen with carbon capture and storage.

Specifically, NETL's Advanced Energy Systems Program includes:

- The gasification systems program: developing advanced technologies to reduce the cost and increase the efficiency of producing syngas;
- Coal and coal-biomass to liquids program: focused on technologies to foster the commercial adoption of coal and coal-biomass gasification and the production of affordable liquid fuels and hydrogen; and
- Solid oxide fuel cell program: developing low-cost, highly efficient SOFC systems that use natural gas or coal with carbon capture capabilities.

These NETL programs, along with the investment and work the fuel cell and industrial gas companies are conducting on their own, are helping answer the demand for increased pathways for hydrogen generation and use syngas more efficiently.

As more markets develop for fuel cells (both high temperature and low temperature) and existing ones continue to grow, such as reliable stationary power and zero-emissions transportation, the need for hydrogen fuel and innovative breakthroughs such as using syngas and reforming synfuel to generate it will grow as well.

Jennifer Gangi is director of communications and outreach for the Fuel Cell and Hydrogen Energy Association.

NEWS BRIEFS

Gas To Liquids

Velocys Progresses Envia Energy GTL, Puts Ashtabula GTL on Hold

Construction of the ENVIA Energy gas-to-liquids (GTL) plant in Oklahoma City, which will act as the commercial reference plant for Velocys' technology, is progressing well, according to a company update earlier this year. All modular process units, including those incorporating the Velocys reactors, and all other major packaged equipment skids, including the steam methane reformer, cooling towers, landfill gas inlet and syngas compression units, have been set in place on site. System integration, piping and electrical work is ongoing, with about 150 personnel currently working on site.

The ENVIA Energy GTL plant in Oklahoma City is progressing on schedule. (Source: Velocys)

Following additional equity and debt funding Velocys made available to ENVIA Energy earlier in the year, the company gained a greater influence in the commissioning, startup and operations of the plant. Since then, Velocys has been further engaged to provide an operability review, commissioning planning, operating manuals and training for the project. In this role, Velocys will support the engineering, procurement and construction contractor, Ventech, in leading the commissioning and startup of the plant.

A second agreement has been signed by ENVIA and Velocys for a team of experienced Velocys operators and engineers to be on site serving under the ENVIA plant manager during commissioning and startup until year-end 2016.

The company continues to progress the opportunities in its commercial pipeline as outlined in its recent annual report. For example, Red Rock Biofuels, which is developing a biomass-to-liquids plant using forestry waste as feedstock in Lakeview, Ore., continues to make progress on permitting, financing and offtake agreements. All of the jet fuel that will be produced by the plant has been contracted to Southwest Airlines Co. and FedEx Corp.

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