Fuel cells, energy conversion and mathematics

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Concerns about dwindling fossil fuel resources, current levels of petroleum consumption, and growing pressure to shift to more sustainable energy sources are among the many factors prompting the transition from our current energy infrastructure to one that uses less carbon and requires the efficient conversion of energy. This necessitates collecting energy from ambient sources including wind, solar, and geothermal power, and converting it into appropriate forms for distributing electricity. While it is possible for this electric power to be distributed efficiently, conversion is necessary for use in automobiles and large-scale storage is problematic.

PEM Fuel Cells

Fuel cells are highly effective devices for converting energy from one form to another, they are more energy-efficient than combustion engines, and a variety of sources can be used to power them. In particular, Polymer Electrolyte Membrane (PEM) fuel cells, also called Proton Exchange Membrane fuel cells, take hydrogen and oxygen from the air to create electricity. They are typically used in automobiles. When pure hydrogen is used as a fuel, these fuel cells emit only heat and water as byproducts, eliminating concerns about air pollutants and greenhouse gases.

According to the U.S. Department of Energy, fuel cells have the potential to replace the internal combustion engine in vehicles and provide power in stationary and portable power applications as they

are energy-efficient, clean, and fuel-flexible. The paper PEM Fuel Cells: A Mathematical Overview published on July 17 in the *SIAM Journal on Applied Mathematics: Special Issue on Fuel Cells* examines the mathematical issues that arise when modeling PEM fuel cells.

Math and PEM Fuel Cells

PEM fuel cells are good examples of energy conversion systems that have several levels of interacting functional structures. The interactions range from proton exchange at the nanoscale level to interactions at the macroscale level among the layered media of which the cells are made. Accurately simulating the resulting multiscale interactions requires carefully constructed mathematical models that faithfully represent the physics at the various scales. Modeling and analysis of PEM fuel cell **structures, their construction, performance, and degradation also requires the development of new mathematical solutions and highly structured and highly adaptive numerical techniques. Mathematical analysis and scientific computation will play a large role in the resolution of these important issues and as a result will affect the progress of PEM fuel cell research and development.**

More information:

The paper PEM Fuel Cells: A Mathematical Overview is co-authored by Keith Promislow of the Michigan State University and Brian Wetton of the University of Vancouver. To read this article in its entirely, visit http://www.siam.org/journals/siap/70-2/72080.html**.**

To learn more about PEM fuel cells and how they work, visit www.fueleconomy.gov/feg/fcv_PEM.shtml

Source: Society for Industrial and Applied Mathematics **(**news **:** web**)**