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CELL INTEGRATED ENERGY SYSTEM FOR RESIDENTIAL AND COMMERCIAL APPLICATIONS

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ABSTRACT

Until recently, the cost of space-age fuel cell technology for terrestrial applications was prohibitive. Recently, however, considerable development activity has occurred in this area, with encouraging results. With at least a dozen companies working to develop high-performance, long-life and cost-effective fuel cell systems, units are now becoming available for stationary applications. Additionally, these systems can be operated in conjunction with other energy systems to increase overall operational efficiency.

A recently completed technology demonstration project at the University of Louisiana at Lafayette, sponsored by the Louisiana Department of Natural Resources, involved the installation, operation and analysis of a fuel cell and a desiccant dehumidification system, which is considered a good combination for the hot, humid climate of the U.S. Gulf coast. The three-year project involved a technology assessment, hardware selection and procurement, and installation and operation of the two systems, followed by a performance analysis. The results were reported in a regional symposium. This presentation describes the project, focusing on system operation and the results obtained, and predicts future possibilities for integrated energy systems of this type.

Energy organizations on a global scale are currently researching better ways to produce energy for residential and commercial applications. This project covers the installation of fuel cell at one of the buildings on the university campus where the desiccant dehumidifier was already installed and working efficiently in conjunction with the air conditioning unit. This project also proposes the analytical integration of the two systems.

The dehumidifier used was the Munters HC-300, an absorbent rotating honeycomb desiccant wheel system, in which the wheel slowly rotates in and out of the makeup air stream, picking up moisture from the makeup air and thus dehumidifying the air before it enters the air conditioner. Simultaneously, regeneration air is heated from a 6 kW set of electrical heating strips and is used to dry the remaining part of the wheel, making it ready for further moisture removal from the makeup air.

A 5 kW Proton Exchange Membrane (PEM) fuel cell was installed in the same location. The fuel cell operates using natural gas as its fuel (reformed) and air as oxidizer producing electrical power, waste heat and water. Under normal operation conditions, the fuel cell was tied into the local electrical grid system.

Two research theses form the basis for this work. One of these discusses the theoretical design of a desiccant dehumidifier designed to meet the requirements of the specific building; the other deals with the theoretical design of a fuel cell and different types of fuel cells under development as well as a proposed method of integrating the fuel cell with a desiccant system, to make use of the waste heat of the fuel cell to increase the overall system efficiency, thus decreasing the operating cost of the integrated system.

To begin with, a complete mapping of temperature, humidity levels, flow rates and power consumption were implemented. This included, a set of readings of relative humidity, dry bulb temperature and flow rate at the inlet and outlet of the conditioned air flow as well as regeneration air at the dehumidifier. After determining the energy used by the heater for the regeneration air to remove moisture from the desiccant wheel, the exact amount of energy produced by the fuel cell in the form of electricity and useful heat were determined. Calculations were then performed for possible replacement of the heater in the dehumidifier by analytically integrating as much as the waste heat of the fuel cell into the dehumidifier as was realistically achievable.

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