TMI SOLID OXIDE FUEL CELL PORTABLE POWER GENERATION

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Abstract

Technology Management, Inc. (TMI) has developed and demonstrated a sulfur tolerant, integrated hot assembly (vaporizer-reformer-stack) using a proprietary reforming catalyst and anode composition. Avoiding the extra sulfur removal subsystem or supplemental fuel preprocessing allows direct insertion of the TMI fuel cell system into many existing fuel supply infrastructures. JP-8, a standard fuel used by US military forces worldwide and other sulfur containing fuels (i.e., natural gas, digester biogas) have been tested by TMI in the lab. The sulfur tolerant hot assembly permits the design of compact scalable systems packages capable of delivering electric power to a wide range of portable, mobile and stationary applications with varying fuel requirements.

System Design Approach

Technology Management, Inc (TMI) has been developing advanced solid oxide fuel cell (SOFC) power generation systems for military and civilian application since 1991. From its inception, TMI has emphasized design simplicity and practical economics over optimized electrochemical performance. This product design criterion assumed that maximum competitive advantage requires low product life cycle costs (low first costs and low operation and maintenance expenses. This approach has resulted in the current entry-level system, a very compact, highly integrated system capable of operating on a variety of gaseous and liquid fuels. The sulfur tolerant anode/reformer technology combined with thermal properties of the SOFC, has resulted in a dramatically simplified single packed thermally integrated column. The TMI SOFC system does not require elaborate fuel processing or complicated sulfur pre-removal systems. In 1999, TMI will demonstrate a portable subkilowatt-class SOFC system developed to address DARPA-specific design requirements.

Figure 1 illustrates a representative TMI SOFC integrated system. In this prototype design, a radial co-flow stack 6 – 12” tall sits directly on top of the fuel processing column in a cylindrical enclosure. Fuels (gaseous or liquid) are combined with water (for steam reforming) and fed to a vaporizer at one end of the column. The vaporizer feeds the reformer which in turn feeds the stack. The fuel processing flow chart is included in the lower left corner of the figure. Spent fuel is oxidized at the rim of the stack (at near stack temperatures) releasing residual heat which is used to drive the other thermally activated processes. The stack is cooled by heat exchange with the incoming air.

A number of enabling technical advances were required to make this integration possible. Foremost was the an anode and catalyst material capable of sustained operation on sulfur containing fuels. TMI has demonstrated single cell and small stack operation on 300 ppm H_2S doped H_2 fuel for extended times (> 1000 hours). In 1999, a 25 cell stack integrated stack – reformer was operated for over 500 hours on 0.3 w% sulfur in military JP-8 (kerosene). The electrochemical efficiency was ~ 36% at a power density of approximately 140 mW/cm^2. SOFCs, by their nature, are unaffected by exposure to CO in a fuel stream.

To build prototype units, a number technical challenges are being addressed such as extending stack life, thermal cycling/restart, system turn-down, and scale-up of production capacity.

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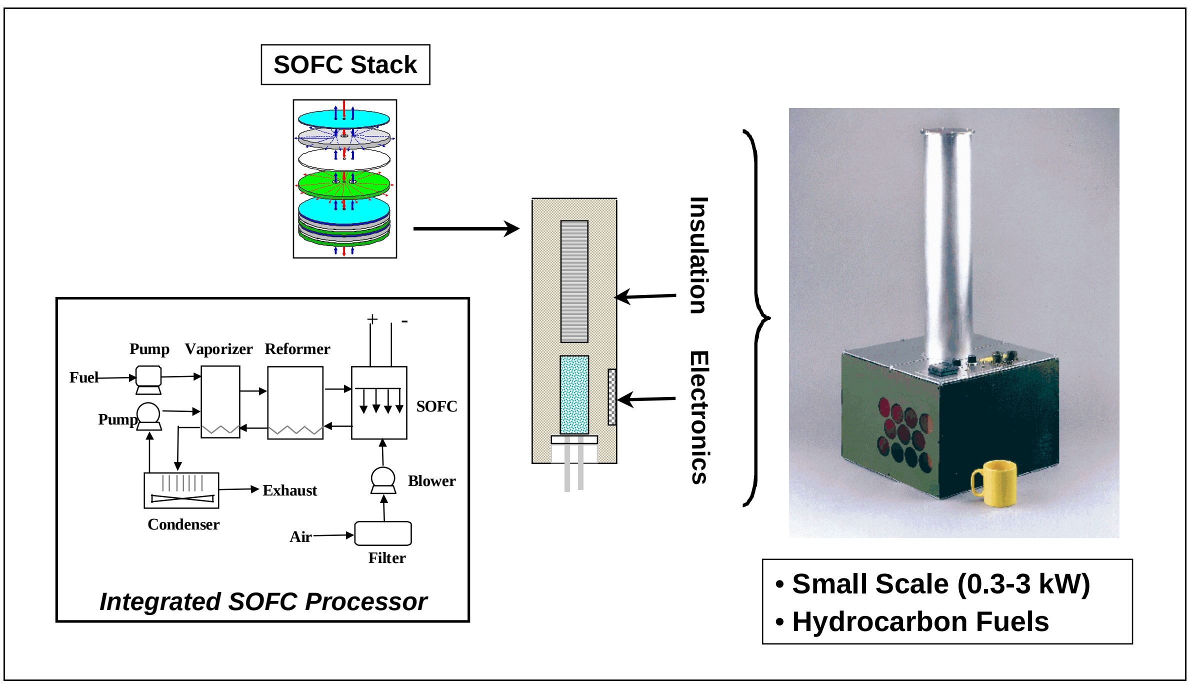

Figure 1. Prototype Portable SOFC Reactor with Integrated Fuel Processing