

*Green Energy Education*

**PEM Fuel Cell  
Unit Operations  
Experiment**



TVN Systems' PEMFC Test-Stand



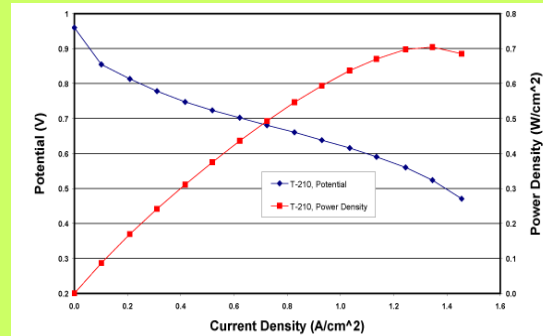
Fuel Cell Stack



Customized Flow Field Plate and MEA

**Customized Membrane Electrode Assemblies and Flow Field Plates**

TVN Systems manufactures high quality, five layer, high performance membrane electrode assemblies (MEA). A typical performance of our MEAs is shown below. TVN can make MEAs of different sizes up to 400 cm<sup>2</sup> and shapes with varying catalyst loadings. MEAs are available in standard sizes of 5 cm<sup>2</sup>, 16 cm<sup>2</sup>, 25 cm<sup>2</sup>, and 100 cm<sup>2</sup>. The catalysts can be Pt, Pt/Ru, or other chosen catalysts a customer may have for a specific application. Please contact TVN for pricing.



Performance of TVN's T-210 MEA  
Temp = 60 C, ambient pressure, dry air cathode @ 3 x stoich, H2 anode @ 1.3 x stoich, humidified at 80 C, serpentine flow field pattern, nation 112 membrane



100 cm<sup>2</sup> MEA

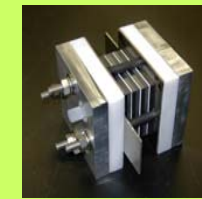
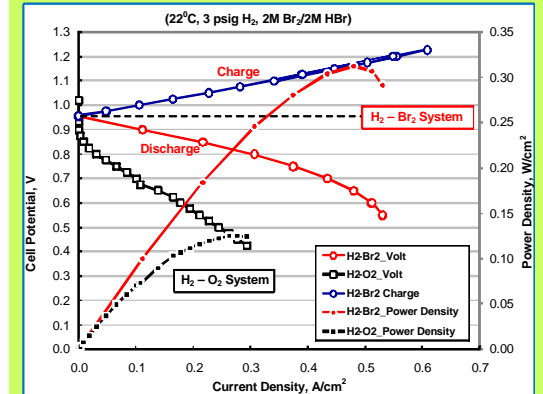


100 cm<sup>2</sup> multi-channel serpentine flow field plate

TVN has the capability to design and machine different flow field plate patterns including serpentine and interdigitated up to 400 cm<sup>2</sup> in area.

**Redox Flow Batteries**

TVN Systems also manufactures electrodes and stack components for flow batteries. Performance of a H<sub>2</sub>-Br<sub>2</sub> flow cell with a TVN MEA is shown below. At peak power the efficiency of a H<sub>2</sub>-Br<sub>2</sub> system is 70% versus 40% for a H<sub>2</sub>-O<sub>2</sub> system under similar operating conditions.



4-cell redox flow battery

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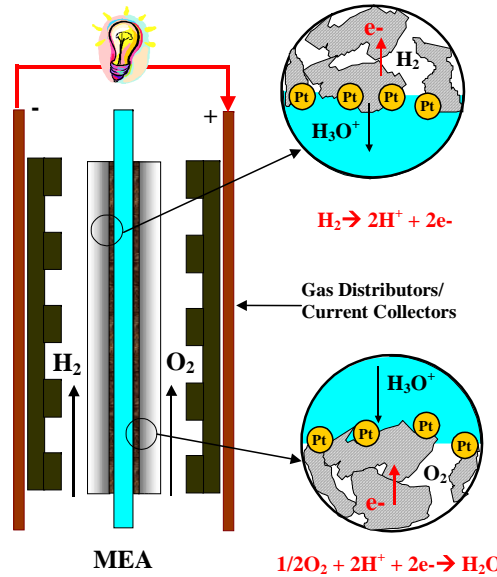
# About TVN and Fuel Cells

# Proton Exchange Membrane Fuel Cell Experiment

TVN Systems, Inc. is a Proton Exchange Membrane (PEM) Fuel Cell company based in Lawrence, KS. TVN is dedicated to developing and advancing this highly efficient and environmentally friendly power generation device. PEM fuel cells are being considered for portable power and onsite generation of electricity, for both commercial and residential power.

### Schematic of a PEM Fuel Cell

With both automotive and stationary power applications



targeted for the use of fuel cells, the market potential is enormous. In order to achieve these goals in fuel cell technology, a trained professional work force will be needed. TVN believes this work force will develop from engineering students at universities around the world. One invaluable way of educating this work force (and making it more marketable) is the “hands-on” experience provided by a unit operations scale experiment.

TVN also provides fuel cell stacks and components used in research and development. In collaboration with NK Technologies, TVN also makes portable hydrogen generators and passive air-breathing fuel cell systems. For more information refer to [www.nk-tek.com](http://www.nk-tek.com).

TVN Systems’ PEM Fuel Cell Unit Operations Stand is a unique fuel cell system. TVN understands the needs of a Unit Operations laboratory as well as the needs of a research laboratory. The UO-1001 and RU-2101 have been designed specifically to meet these demands.

### UO-1001 Product Line

The UO-1001 is a fully functional unit operations experiment designed by engineers with extensive experience in unit operations laboratories. The unit comes with everything needed for complete operation. This includes a three cell PEM fuel cell stack and the user friendly data acquisition software, DataWolf. Because the main objective of a unit operations experiment is to teach, the UO-1001 system also includes a comprehensive education manual. TVN’s education manual includes background on PEM fuel cell theory and operation, detailed experiment guidelines, as well as both qualitative and quantitative data analysis techniques for evaluating the experiments performed. You will find that the UO-1001 is a safe, durable, and affordable learning tool, with easy setup of both the system’s hardware and data acquisition software. Additionally, TVN offers an upgrade package, the RU-2101.

The test-stand comes fully operational. All that needs to be provided is ventilation duct work, hydrogen and air reactant gases, and a 120 VAC power supply.

### RU-2101 Upgrade

The RU-2101 upgrade adds precision mass flow controllers and electronic pressure sensing to allow digital collection of flow rate and pressure data. While allowing full computer control with ControlWolf software, the RU-2101 offers a cost effective dual-purpose unit that may be operated manually or via computer. This versatility can make the unit effective in both the unit operations laboratory and in the research laboratory.

### UO with Hydrogen Recirculation

TVN now offers unit with an option to recirculate the hydrogen gas and minimize the loss of unused hydrogen. The recirculation mode greatly increases the hydrogen utilization, and reduces the hydrogen cost and the requirement on ventilation system.

### The UO-1001 Features:

#### Complete Control of Fuel Cell

The UO-1001 allows for exploration of several operating parameters that significantly influence performance. Students can easily control current (reaction rate), reactant flowrates, reactant humidification, temperature, and pressure.

#### Complete Range of Operation

Unlike power generation or demonstration units, the UO-1001 will allow students to explore the entire operation range of the fuel cell, which is essential for understanding and evaluating the transport and kinetic parameters.

#### Convenient Data Acquisition

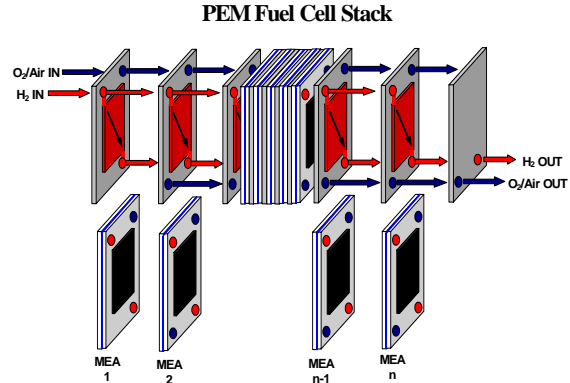
Included within the UO-1001 package is TVN’s DataWolf software, which was designed specifically for the UO-1001. DataWolf, which communicates through any serial port, is designed for easy setup and operation. The UO-1001 also provides an analog data output port for those who wish to use their own acquisition systems.

#### Emphasis on Safety

Finally, the UO-1001 is designed with safety as a key parameter. The frame is made of 14 gauge steel with sturdy Lexan windows. Internal devices are powered with low DC voltage in order to reduce the exposure to high AC voltage. Hydrogen and air reactant gas connectors are of different sizes for “fool- proof” connections. Additionally, imbedded within the system is a hydrogen sensor with automatic shut down, should hydrogen be detected within the unit.

### Fuel Cell Stack

TVN PEM fuel cell experiment test-stand comes with a three-cell stack. Additional standard single cell stack and five-cell stack are available as well. TVN can also customize and manufacture fuel cell stack design to customer’s specification.



Examples of Universities with UO or RU test stations:

- [Arizona State University](#)
- [Brigham Young University](#)
- [Bucknell University](#)
- [Cleveland State University](#)
- [Illinois Institute of Technology](#)
- [Kettering University](#)
- [Kansas State University](#)
- [Lamar University](#)
- [Michigan State University](#)
- [McNeese State University](#)
- [New Mexico Technology](#)
- [North Carolina State University](#)
- [Northwestern University](#)
- [Ohio University](#)
- [Rochester Institute of Technology](#)
- [Stanford University](#)
- [Texas A&M University - Kingsville](#)
- [University of Alabama](#)
- [University of Dayton](#)
- [University of Tennessee - Chattanooga](#)
- [University of Washington](#)