Progress Toward Enabling Storage of Off Peak Nuclear and Intermittent Renewable Energy As Sustainable Domestic Transportation Fuels

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Renewable and nuclear based power generation are challenged in today's electric grid markets. Transportation fuels are of higher value and expose most societies to greater economic and strategic vulnerability than grid power. The technologies required to efficiently reverse the fossil fuel combustion cycle, converting carbon dioxide to liquid hydrocarbon transportation fuels as a store of nuclear and renewable energy, have been demonstrated and are on the verge of economic feasibility.

An energy storage technology should be extremely efficient, energy intensive, scaleable, durable and produce a commodity in strong market demand while offering environmental advantages over current practices. High temperature CO_2-electrolysis coupled with Fischer-Tropsch (FT) synthesis is close to meeting these objectives. Currently the greatest challenge ahead for these technologies is in scaling up the electrolysis systems and scaling down the FT systems.

Key advances in Ceramatec's research portfolio include:

1. An SOEC material set that has demonstrated stable electrolysis stack life
2. A degradation model that reflects the parabolic growth law of primary degradation mechanism and which may be used to estimate the total productivity over the life of a stack
3. A techno-economic performance map giving guidance to which operating conditions will yield the most economical product
4. A ground up manufacturing cost model that gives confidence that the stack cost basis of our techno-economic models are realistic.
5. Entering a collaboration with the Weizmann Institute to develop scalable high temperature CO_2 electrolysis using a molten Li_2CO_3 cell.
6. Small, modular Fischer-Tropsch plant technology needed to convert the electrolysis products into storable, transportable fuels.

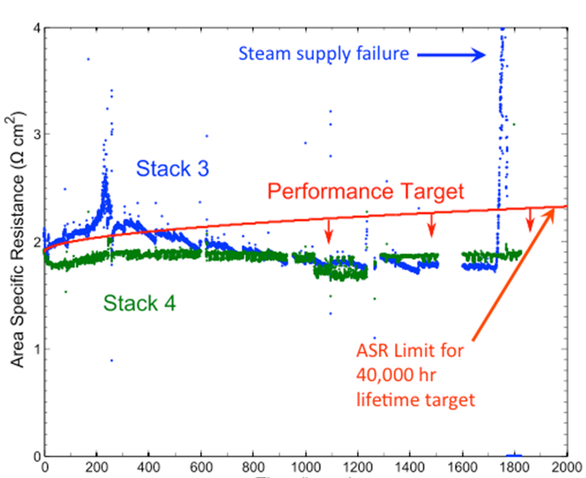


Figure 1. Demonstrated stable SOEC performance

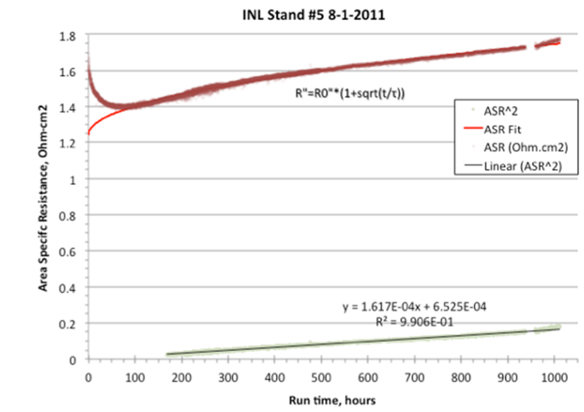


Figure 2. Parabolic Rate Law Fitting of Degradation

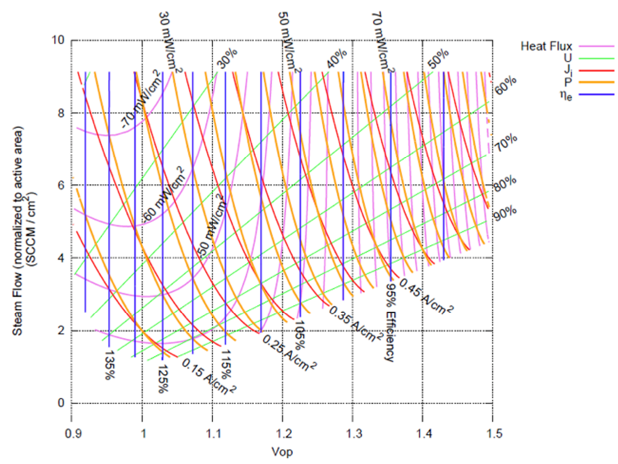
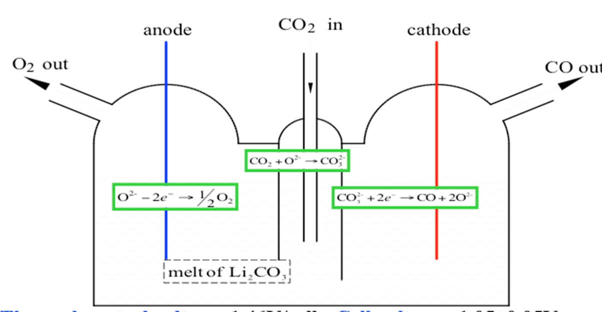


Figure 3. SOEC Performance Map



Thermal neutral voltage: 1.46V/cell **Cell voltage:** 1.05±0.05V
Faradaic efficiency: 100 % **Current density:** 100 mA/cm²
Thermodynamic efficiency: 100% **No Degradation in 700hr test**

Figure 4. Molten Lithium Carbonate Electrolysis Cell

Figure 5. Ceramatec 4" Fischer-Tropsch Reactor Skid