Dear Colleagues and Students,

Dr. Maximilian Gorensek of SRNL will give a seminar on Friday, February 11th, at 2pm in room B213 at 300 Main Street. Please see summary below.

Conceptual Design for a Hybrid Sulfur Thermochemical Hydrogen Production Process

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A conceptual design for a Hybrid Sulfur (HyS) cycle has been developed and modeled, using Aspen Plus, and material and energy balances have been prepared. Stream data for this flowsheet, normalized to a 1-kmol/hr H2 production rate, as well as thermal efficiency estimates, will be presented.

The HyS process can be thought of as comprising three different sections. The first section includes the electrolyzers and their associated equipment. Sulfuric acid concentration and decomposition operations, which produce water and gaseous mixtures of SO2 and oxygen, make up the second section. Finally, the need to separate a clean O2 product stream from the SO2/O2 mixture coming from sulfuric acid decomposition, and dissolve the remaining SO2 in the anolyte, leads to a third flowsheet section where these tasks are accomplished. Each of these flowsheet sections will be described in detail.

The overall net thermal efficiency for this version of the HyS cycle was calculated as 46.5%. The efficiency was based on the higher heating value of the hydrogen product divided by the total thermal energy requirements, including the thermal energy required to generate electricity (assuming a 50% thermal-to-electric conversion efficiency). It should be noted that this efficiency is considerably higher than the estimated thermal efficiency for a direct electrolysis plant, which is expected to be only 36-40% (HHV) maximum. Furthermore, the highest reported efficiency for the SI cycle using the same reactor heat input conditions is only 42%. Higher thermal efficiencies, exceeding 50% HHV-basis, are deemed feasible for the HyS cycle at increased reactor outlet temperatures and with further process flowsheets optimization.

Preliminary estimates for the capital cost and the hydrogen production cost for an Nth-of-a-kind nuclear hydrogen production plant using the HyS cycle were calculated. The nuclear heat source design and cost prepared for a recent NERI study using General Atomics Modular Helium Reactors and the SI thermochemical cycle were used as a cost basis. The cost of hydrogen production for the HyS Cycle nuclear hydrogen production plant was determined to be $1.73/kg at the plant gate for the baseline case. This cost was $2.03/kg for higher cost ($3,500/m²) electrolyzers and $1.53/kg for lower cost ($1,025/m²) electrolyzers. These costs are nearly the same as the hydrogen cost of $1.65/kg reported for the SI nuclear hydrogen production plant.