Task 30: Electrolysis

The electrochemical production of hydrogen by water electrolysis is a well-established technological process worldwide, dating back more than 100 years. Since it is currently more expensive to produce hydrogen through electrolysis than from fossil energy carriers (such as natural gas and coal), only about 4% of hydrogen requirements worldwide are covered by electrolysis today. However, in future energy systems, where renewable energy represents a major share of the energy mix, electrolytic hydrogen will play a major role both as a storage medium and as an energy carrier, for instance in the transportation or heating sector.

The decomposition of water by electrolysis involves two partial reactions separated by an ion-conducting electrolyte. The three relevant techniques of water electrolysis are categorized according to the choice of electrolyte:

- Alkaline electrolysis with a liquid alkaline electrolyte;
- Acidic PEM electrolysis with a proton-conducting polymeric solid electrolyte; and
- High-temperature electrolysis with a solid oxide as an electrolyte (SOEC).

To date, alkaline electrolyzers remain the primary commercially available means of electrolytic hydrogen, which has been the case for the past several decades. PEM electrolysis has however been in research and development over the last 40 years and is only recently beginning to break through into some small niche commercial markets. Although high-temperature electrolysis is currently being pursued by a number of institutes and companies, no commercial product is yet available on the market.

If water electrolysis technology is to be widely and sustainably used on the mass market for the storage of renewable energy, further steps must be taken to solve the outstanding technical issues such as low power densities and inadequate stability, as well as the high manufacturing and operating costs associated with the technologies currently in use.

Important challenges in the further development of alkaline water electrolysis include, in particular, increasing the power densities of stacks, enlarging the partial load range, reducing system size and complexity, and improving the dynamics of the entire system. The main priority in the field of PEM electrolysis is cost reduction. Activities in catalyst development for PEM electrolysis therefore concentrate on reducing or completely replacing noble metals in the membrane electrode assembly without affecting performance. Another challenge of PEM electrolysis is the very small production runs and specific requirements have led to relatively high costs for the titanium-based separator plates and current collectors, which have to be coated with additional and expensive protective layers to prevent hydrogen embrittlement and the formation of oxide layers leading to increased contact resistance. SOEC development has profited from SOFC know-how, but further work is still required, especially with respect to the optimization of electrode materials and improvement of long-term stability. Apart from materials research, process engineering studies are urgently needed on the provision of heating energy for water vaporization and preheating.

The topics covered are reflected in the sub task structure of the Task30:

- PEM electrolysis (electrodes, CCMs, stacks, lifetime enhancement, test protocols, balance of plants, etc.)
- Alkaline electrolysis including alkaline membrane electrolysis
- Solid oxide electrolysis

This Task will be a task-shared activity with a focus on information sharing and learning between experts with knowledge and experience on electrolyzer technologies and its applications to accelerate the development of all three technologies of water electrolysis towards commercialization. Task 30 holds a series of annual workshops where representatives from the participating countries present the status of electrolysis research, development and demonstration in their respective countries, in addition to discussing a selected topic. Where possible, these workshops will be linked to other relevant conferences, in order to minimize travelling costs. The workshops lead to open discussions relating to common problems and should have realizable and achievable aims.