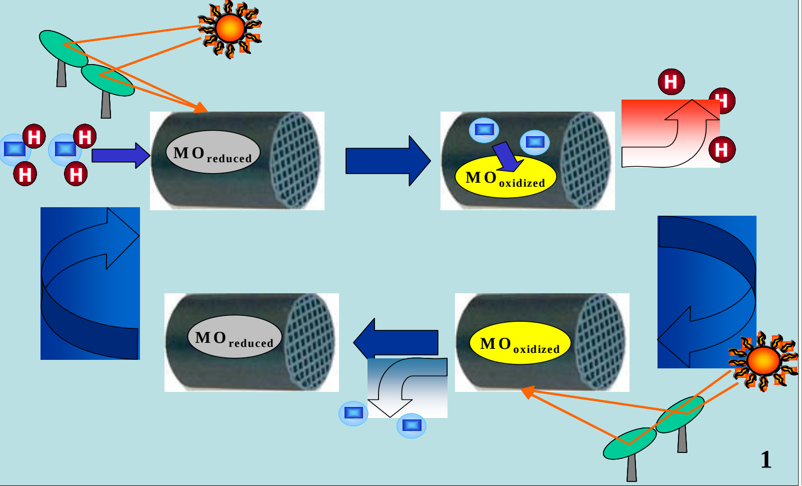

Solar Thermo-Chemical Splitting of Water Using Coated Ceramic Monoliths

The aim of the project is to exploit solar energy for a thermo-chemical two-step water splitting process using redox systems generating directly solar hydrogen (Fig.1). The active redox pair materials are capable of performing water dissociation and can at the same time be reversibly reduced and oxidized, so that the complete operation (water splitting and redox material regeneration) can be achieved in a single solar monolithic energy converter.

This technology offers promising perspectives concerning thermodynamics and yields and produces pure hydrogen without any separation needs. Moreover, the process is free of emissions and free of the consumption of fossil fuels.

A solar test reactor (Fig.3) was designed and built, containing a ceramic honeycomb support structure covered with multivalent mixed iron oxides as a redox pair system suitable for the water dissociation and also for the regeneration step at temperatures below 1300 °C. The advanced design of two separate reaction chambers in one reactor unit allows a simultaneous performance of the water splitting and the redox material regeneration so that hydrogen is continuously produced in a cyclic operation of both reaction steps.

Experimental test campaigns were carried out in the Solar Furnace at DLR (Fig.2) providing the concentrated solar radiation. It was succeeded to generate solar hydrogen using differently coated monoliths in a continuous and multi-cycling operation with a high number of cycles.

The experimental data base is applied to design studies on a scale-up of the process using a solar tower system.

Process flow-sheets of a plant concept in commercial scale were generated including efficiency analyses and economic evaluations of the plant operation. The results are auspicious indicating that there is potential to reduce hydrogen production costs down to 10-12 Eurocent/kWh in the future.

The next step towards a superior technology is the qualification and application of a model reactor with an advanced design to verify a process strategy for the continuous production of hydrogen in larger scale by incorporation in solar tower facilities.

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