Project SOL2HY2

Solar tower demonstration of sulphuric acid cracking

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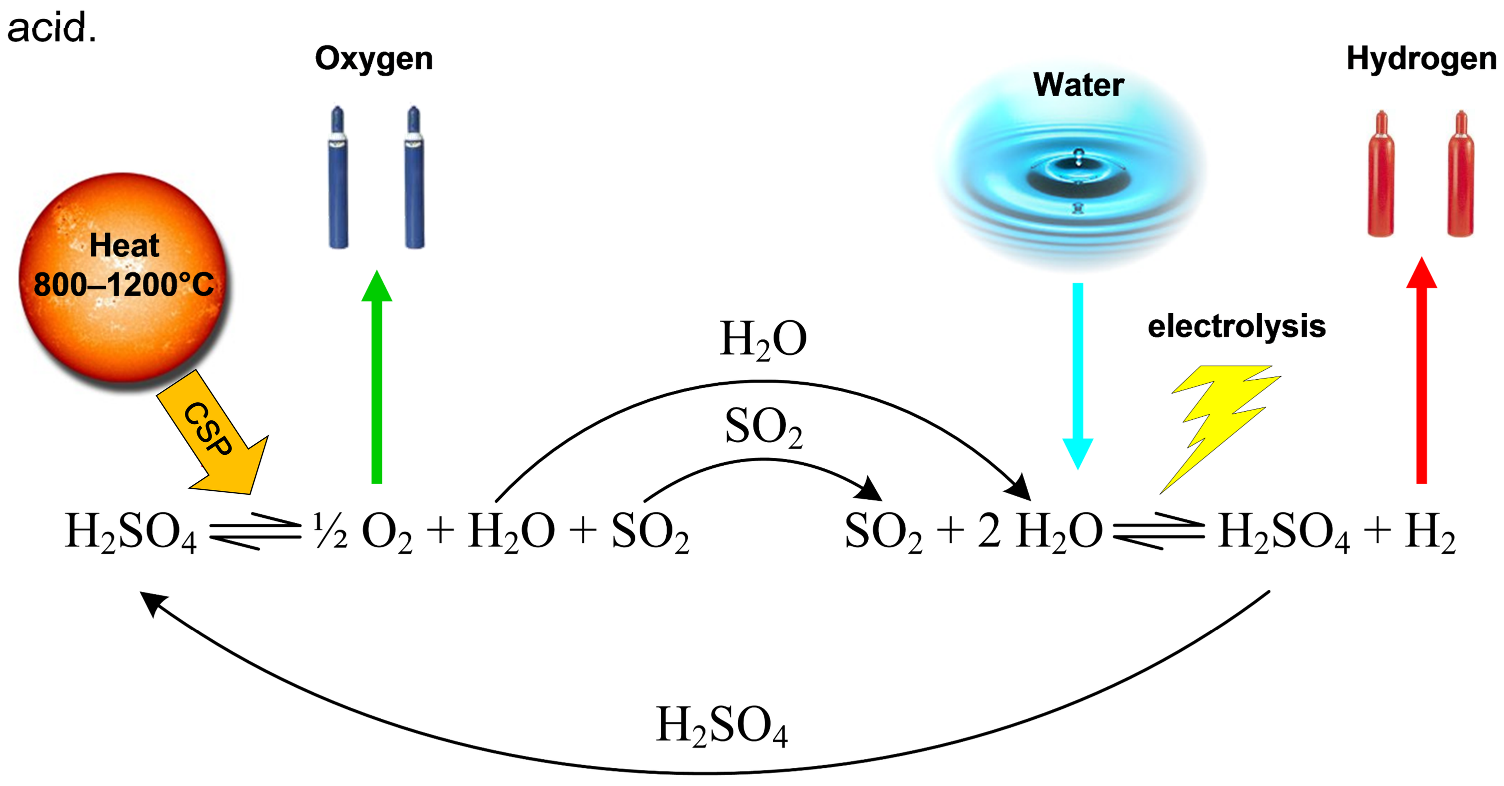
SOL 2HY2 Solar To Hydrogen Hybrid Cycles

Introduction

The **European research project SOL2HY2** (Solar to Hydrogen Hybrid Cycles) investigates the Hybrid-Sulphur-Cycle (HyS-Cycle), considered as one of the most promising approaches to generate emission free **hydrogen by the use concentrated solar power (CSP).**

The HyS-Cycle is a two-step process producing hydrogen and oxygen out of water:

1. **Thermal evaporation and decomposition of sulphuric acid** at high temperature, forming sulphur dioxide and oxygen.
2. **Electrolysis of sulphur dioxide** and water generating hydrogen and sulphuric acid.

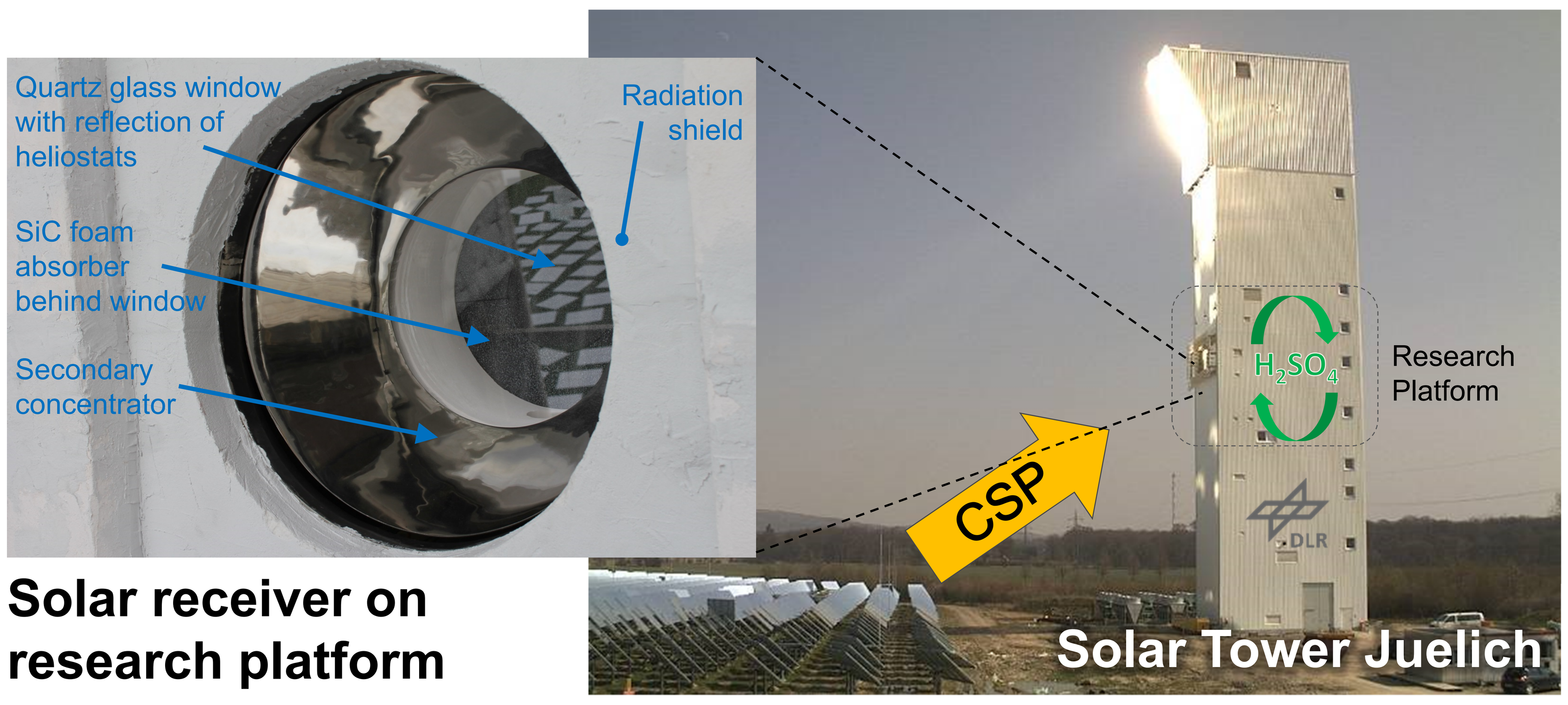


Hybrid-Sulphur-Cycle (HyS)

Oxygen is separated from the product gas as a by-product, and **H_2SO_4 is recycled** within the process. The electrical power required for the electrolysis is only about a tenth of that needed for conventional water electrolysis, so that the **energy demand** for hydrogen production is **significantly reduced**.

The **project aims to develop and demonstrate all key components** of the HyS-process – solar sulphuric acid cracker, sulphur dioxide depolarized electrolysis, gas separation, heat storage – **at industrial relevant scale**.

DLR developed a demonstration plant for **solar decomposition of sulphuric acid on the research platform of the Solar Tower** in Juelich, Germany. The thermal power of this pilot plant will be in the **100 kW** range.



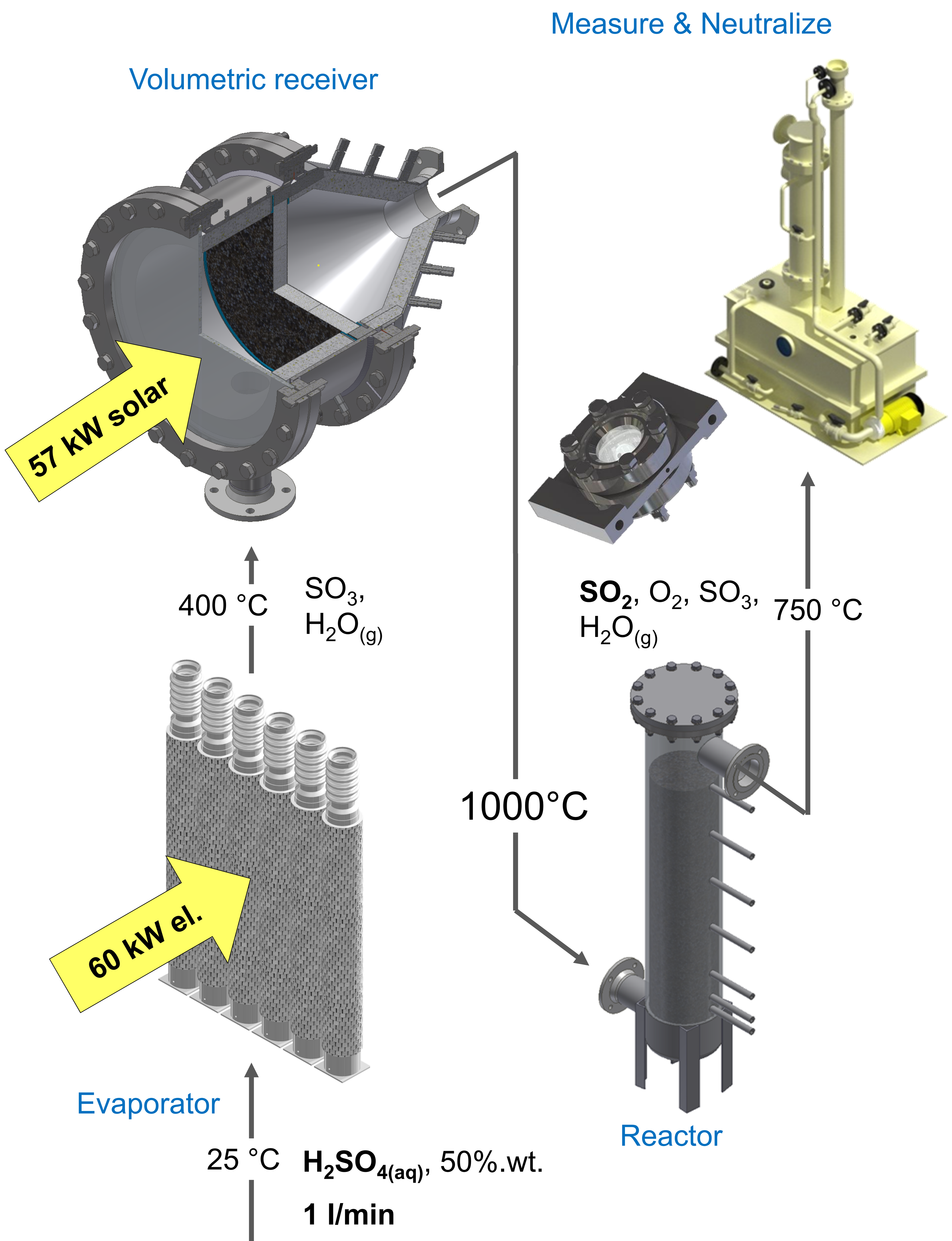
Solar receiver on research platform

Demonstration plant design and setup

The **developed components** are:

- A **tube type evaporator** consisting of six vertical tubes, using SiC inliner to protect against corrosion, and filled with SiC foam structures to enhance heat transfer. The system is preliminarily joule heated and investigated for direct solar application.
- A **directly irradiated, closed volumetric receiver** to superheat the gases. Main component is a porous foam made from SiC to absorb the solar radiation and transfer the heat. Target is to achieve outlet gas temperatures higher than 1000 °C.
- An **adiabatic packed bed reactor** with variable bed size of catalyst (iron-III-oxide) and on substrate (aluminium oxide). A conversion rate higher than 70% is aspired.
- A **UV-Vis spectroscopic cell**, operating at a temperature >300 °C to avoid corrosion originated from sulphur species.

As project milestone, the pilot plant **design has been completed by the end of 2014**, including equipment dimensioning, concept evaluation, prototype design, and integration of state-of-the-art components such as the product gas scrubbing unit.



Demo plant - Main process components and arrangement

Status and next steps

Mounting and initial operation of the demo plant was completed in September 2015. **On-sun testing** was carried out in **October 2015 (thermal operation with water)** and **March/April 2016 (thermo-chemical operation with sulphuric acid).** The experiments are accompanied by modelling of the receiver-reactor system and process simulation of a HyS plant at industrial scale. This will lead to a techno-economic study in order to asses the prospects of the technology.

Solar receiver during initial operation in September 2015

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