SOLAR INTEGRATED PRESSURIZED HIGH TEMPERATURE ELECTROLYSIS

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Hydrogen is expected to play a key role as energy carrier for the transport sector and as storage medium. Therefore the development of carbon lean technologies producing hydrogen from renewable energy is very important. It is the case of the high temperature electrolysis operated by the use of renewable resources.

The FCH-JU project SOPHIA (Solar integrated pressurized high temperature electrolysis) aims to develop a new generation of high temperature steam electrolyser (HTE), which will be operated under pressure at 800 °C. The total energy demand of the electrolyser unit consists of electricity and heat. This can be generated by solar concentrating energy systems like the solar tower.

Solar thermal energy is able to provide electricity and heat at the same site. The power tower converts sunshine into electricity for the world's electricity grids. The technology utilizes many large, computer controlled, sun-tracking mirrors, so called heliostats to focus sunlight on a receiver at the top of a tower.
The high concentrated solar radiation is used in the solar receiver placed on the top of the tower to produce hot air at 680°C and 1 bar, which will act as heat transfer fluid to generate electricity in a Rankine cycle as well as feed steam for the HTE.
A steam to hydrogen conversion of 60% is assumed. Further heating is achieved by an electrical heater in order to maintain the inlet steam temperature at 800°C. The product stream contains hydrogen and water steam, which is separated by condensation.

To provide the electrolyser with superheated steam at a temperature of 600 to 700°C a tubular solar receiver was developed and tested in DLR's high flux simulator in Cologne. Saturated steam enters the absorber pipes at 100°C and is superheated to 700°C by concentrated solar radiation.
After a successful initial operation of the system a series of test runs was conducted superheating steam with a flow rate of up to 5 kg/h achieving a thermal efficiency of 40 % with about 4 kW of solar power.
Higher mass flows will be tested in upcoming experimental campaigns. It is planned to couple the receiver with an electrolyser stack to demonstrate the integrated operation of a solar HTE.

In addition a steady state simulation will be carried out for a hydrogen production in MW-range and the overall process will be evaluated regarding the thermal to hydrogen efficiency.
Moreover different power-to-gas scenarios of complete process chain will be identified for the technological concept development and its end-products valorisation.

Fig. 1 Solar Tower Jülich, Germany

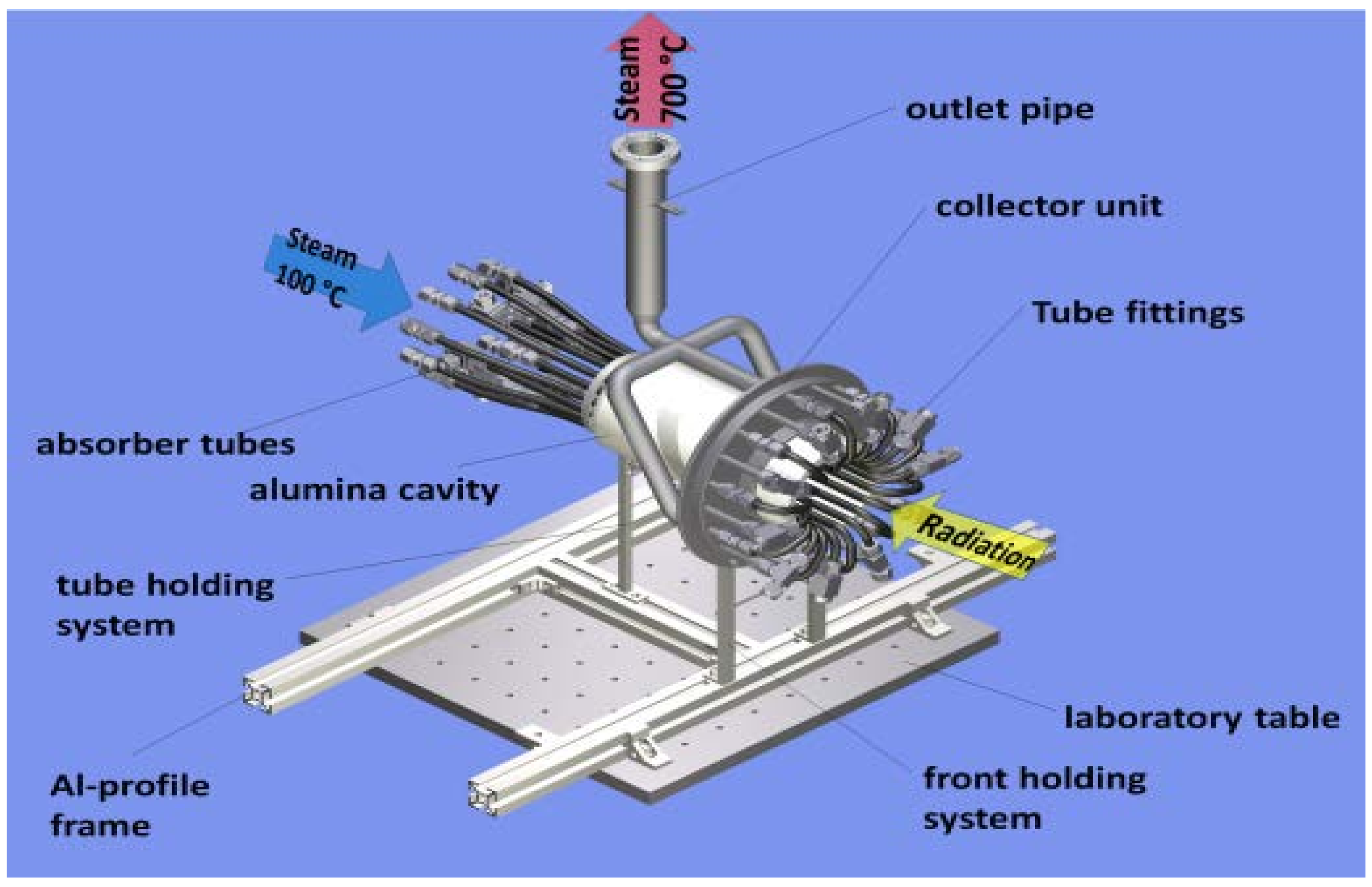

Fig. 2 CAD model of solar receiver

Fig. 3 Irradiated solar receiver in DLR's high flux simulator

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