

PROJECT 16 – A HYBRID SOLAR-GAS SYSTEM FOR NATURAL STEAM REFORMING

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Research Centre
for Gas Innovation

cleaner energy for a sustainable future

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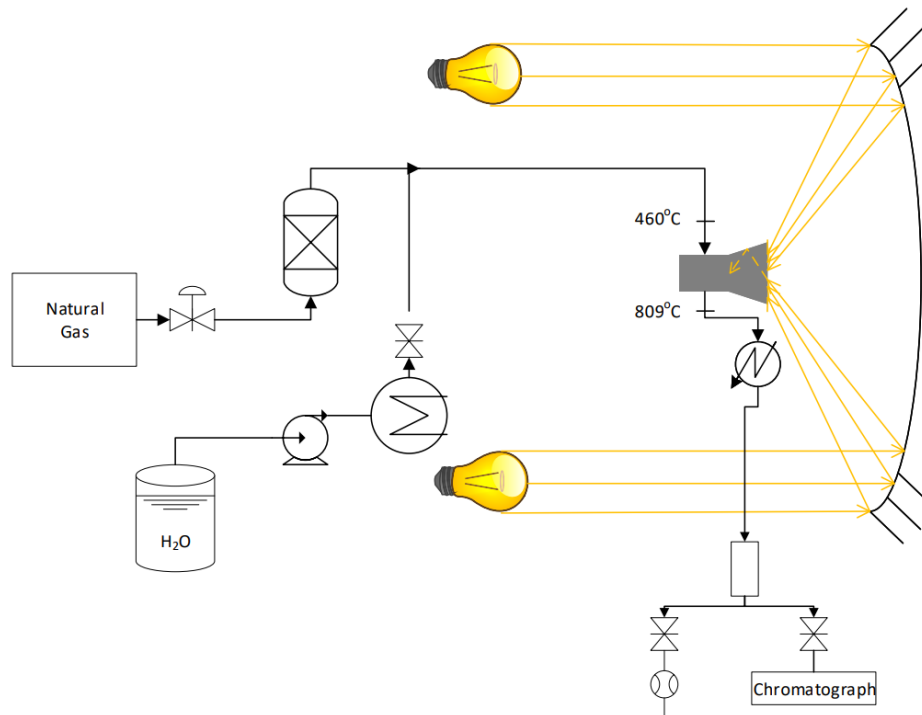
20 August 2018

Introduction - Main Objectives

- To carry out an up-to-date study on natural gas steam reforming using solar energy;
- To build an indoor solar simulator for laboratory studies;
- Thermal design of the black cavity reactor.
- To carry out an experimental and numerical work of thermochemical reactions powered by solar energy.

Introduction - Main Objectives

This project is developing a solar-powered steam-methane reformer (SMR). The reformer sits at the focal point of a parabolic dish concentrator, with the concentrated solar energy providing the endothermic heat of reaction. The result is a syngas comprising mostly H₂ and CO with a heating value approximately 27% higher than the entering natural gas.



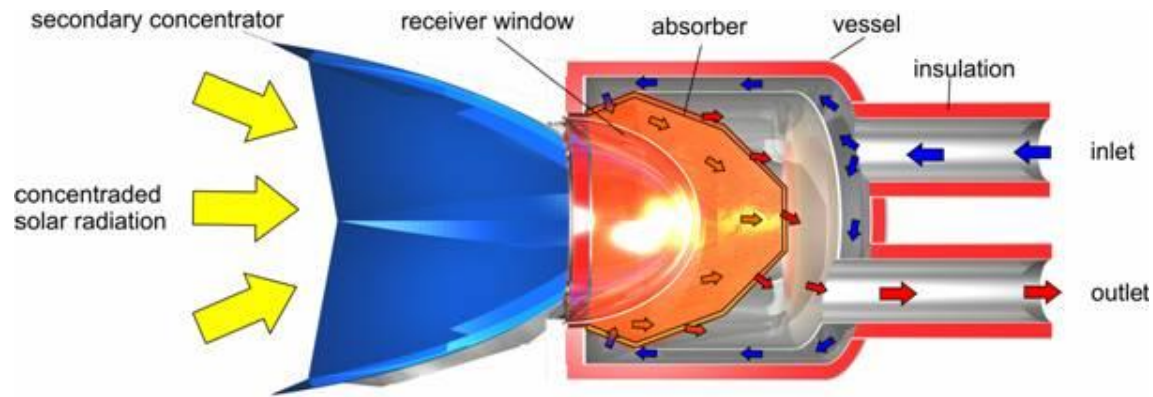
Introduction - A hybrid solar-gas system for natural gas steam reforming

Main Research Areas: Concentrator - Receiver/ Reactor .



Concentrator

- ✓ Reflectivity of materials
- ✓ Equilibrium temperature
- ✓ Heat flow
- ✓ Design and construction



Scheme of a solar reactor concept for the reforming of natural gas (Epstein, 2011)

Receiver/ Reactor

Design and construction of:

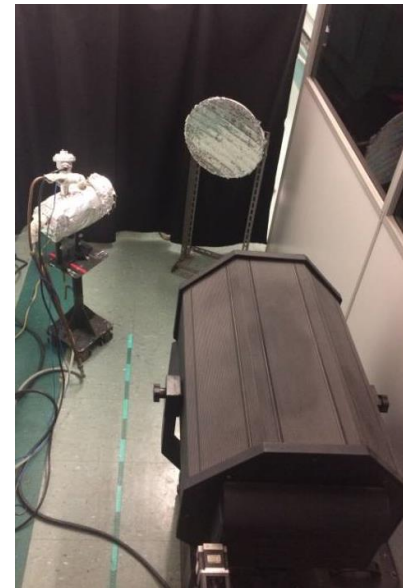
- ✓ Concentrator
- ✓ Catalyzer
- ✓ Reactor

Experimental - A hybrid solar-gas system for natural gas steam reforming

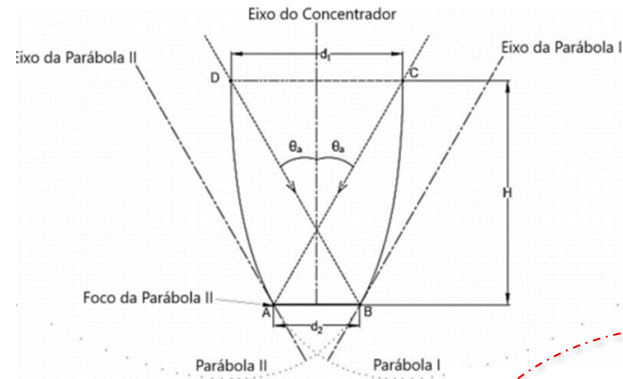
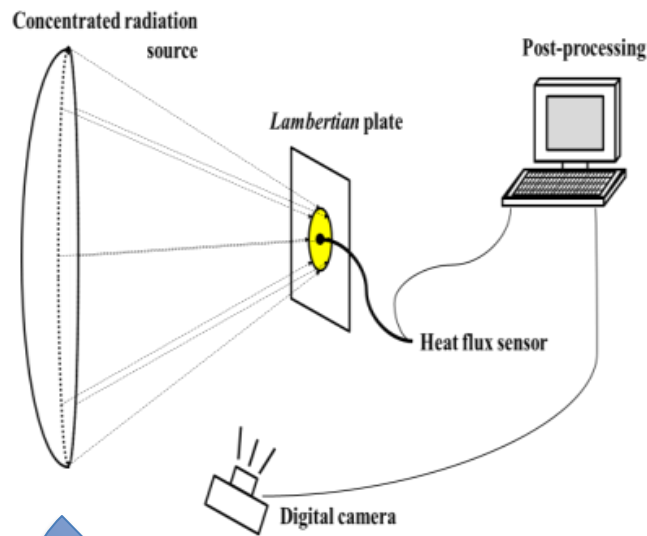


Concentrator

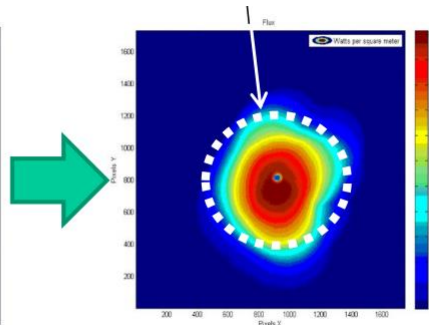
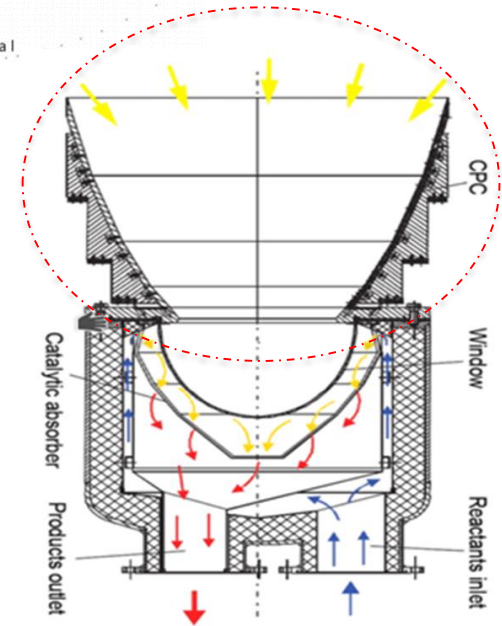
- ✓ Reflectivity of materials
- ✓ Equilibrium temperature
- ✓ Heat flow
- ✓ Design and construction



Experimental - A hybrid solar-gas system for natural gas steam reforming

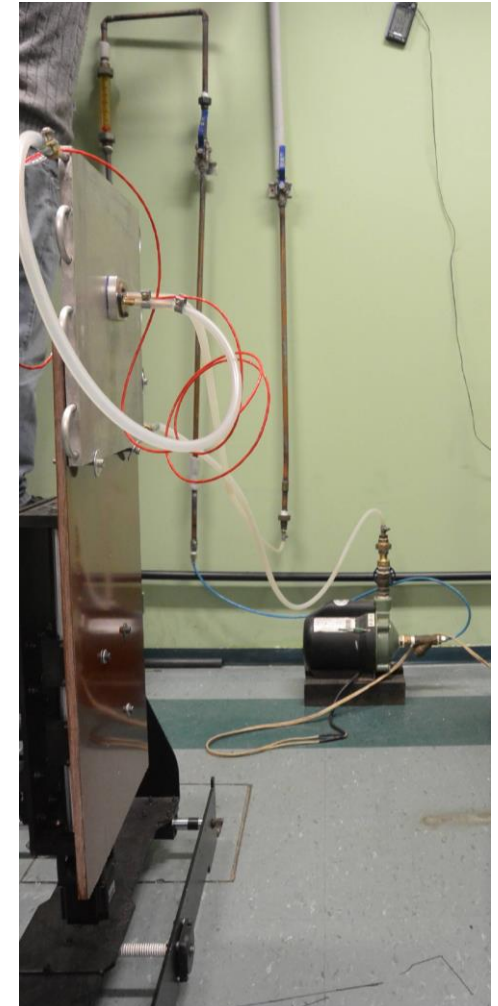
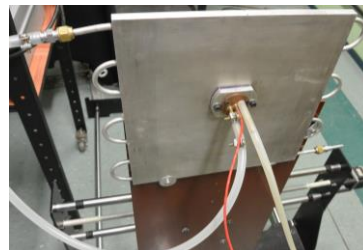


It will define the cavity aperture size



Experimental - A hybrid solar-gas system for natural gas steam reforming

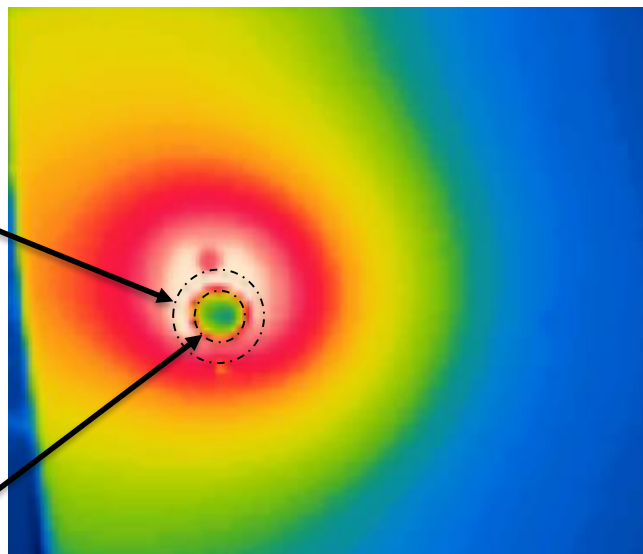
Lambertian plate construction



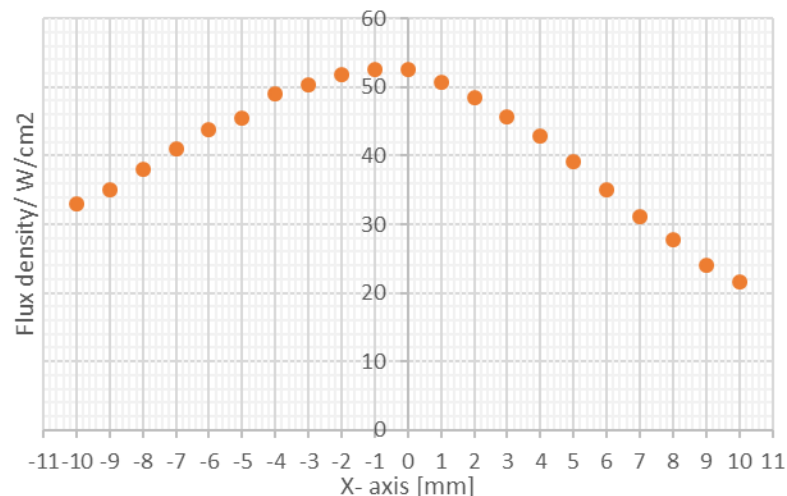
Results and discussion - A hybrid solar-gas system for natural gas steam reforming

Lambertian plate provisional:

$$\begin{aligned} \varnothing &= 3,5 \text{ cm} \\ \text{HF} &= \pm 32,59 \frac{\text{W}}{\text{cm}^2} \end{aligned}$$

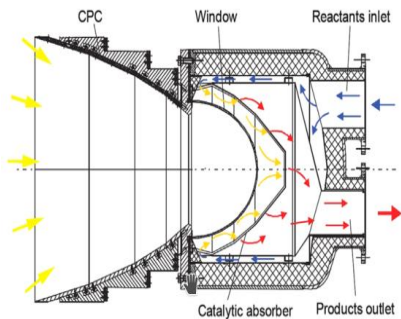


$$\begin{aligned} \varnothing &= 2,5 \text{ cm} \\ \text{HF} &= 52,5 \frac{\text{W}}{\text{cm}^2} \end{aligned}$$

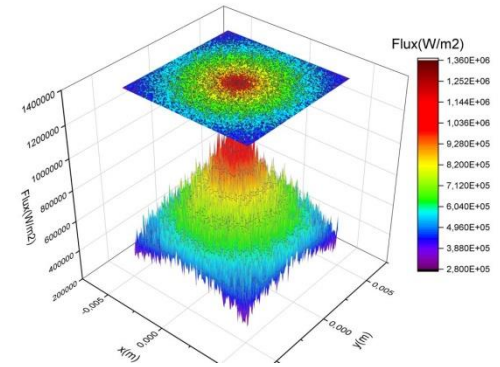
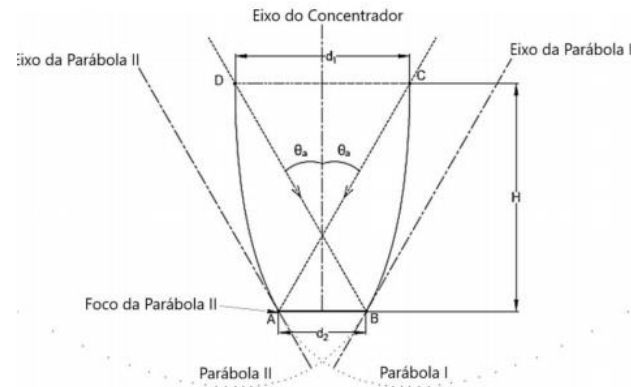


Results and discussion - A hybrid solar-gas system for natural gas steam reforming

Scheme of a solar reactor concept for the reforming of natural gas (Epstein, 2011)



Schematic diagram of a CPC collector

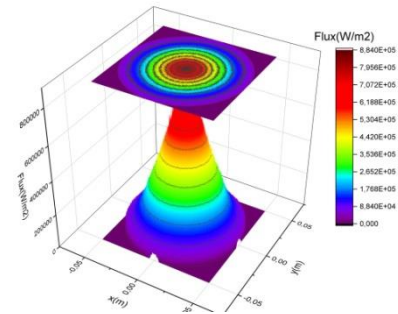


Receiver/ Reactor

Design and construction of:

- ✓ Concentrator
- ✓ Catalyzer
- ✓ Reactor

❖ The Tonatiuh project aims to create an open source, cutting-edge, accurate, and easy to use Monte Carlo ray tracer for the optical simulation of solar concentrating systems.



Results and discussion - A hybrid solar-gas system for natural gas steam reforming

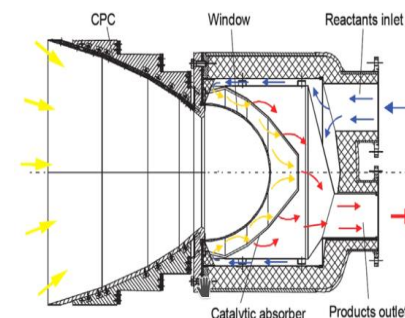
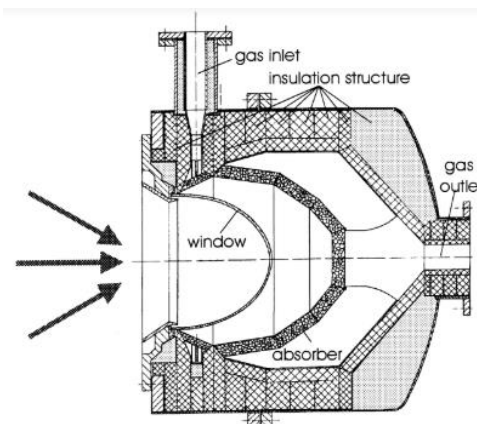
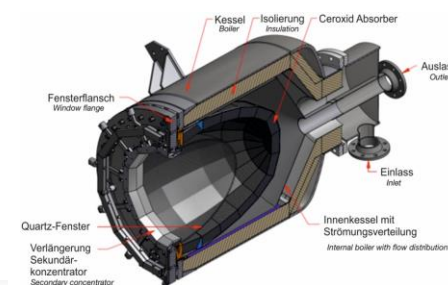
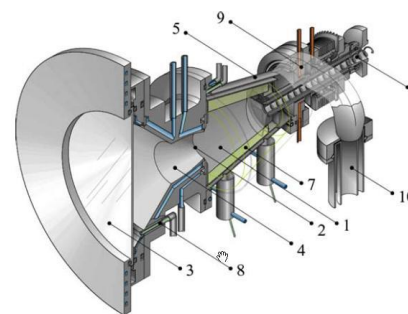
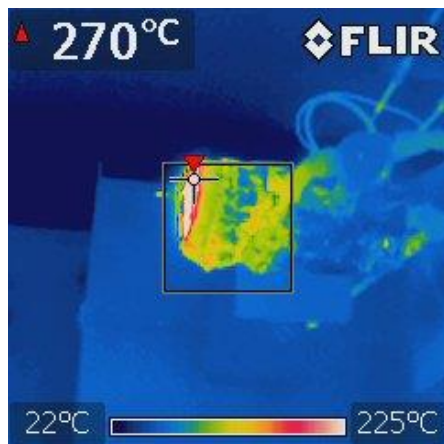
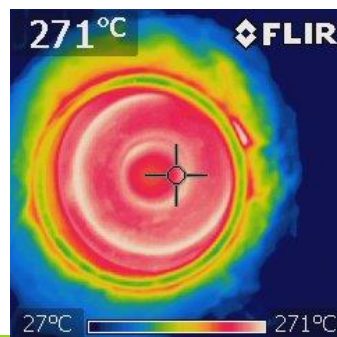


Fig. 1. Schematic of the solar chemical receiver-reactor.



Receiver/ Reactor

Design and construction of:

- ✓ Concentrator
- ✓ Catalyzer
- ✓ Reactor

Conclusions

- Increasing the equilibrium temperature up to 470 ° C.
- Higher rise in equilibrium temperature: mirror tape and resin reflector
 - construction of a new concentrator.
- Next Steps:
 - Characterization of Solar Simulator Spectrum;
 - Reactor Design

Results and discussion - A hybrid solar-gas system for natural gas steam reforming

- ✓ Master's degree qualification of Luma
- ✓ **COBEM** – International Congress of Mechanical Engineering
- ✓ World Hydrogen Energy Conference (WHEC)
- ✓ São Paulo School of Advance Science on Renewable Energies

References

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