Interview with Clarisse Lorreyte, German Aerospace Center, Institute of Future Fuels. Clarisse is part of Work Package 3 (WP3) of the PYSOLO project, which focusses on the development of the solar receiver for solar pyrolysis.

PYSOLO – Making Use of Concentrated Solar Power for Biomass Pyrolysis

PYSOLO (PYrolysis of biomass by concentrated SOLar pOwer) offers a solution for both decarbonisation and defossilisation by preparing the ground for a fully renewable process combining concentrated solar power and biomass pyrolysis. Thanks to the use of solar heat in the pyrolysis process, the production of valuable products bio-oil, biochar and pyrogas can be maximised and the associated CO_2 emission minimised. This offers both economic and environmental benefits compared to conventional pyrolysis.

Please shortly describe the concentrated solar power (CSP) technology developed in PYSOLO. Why is this a ground-breaking technology?

The CSP technology developed in PYSOLO includes a solar tower system to convert solar energy into thermal energy, which is stored in Particle Heat Carriers (PHC). Storing thermal energy in PHC allows the use of high temperature heat for continuous operation, even when the solar conditions are not the best for CSP. The component in which the solar energy transformation process takes place is the solar receiver. In PYSOLO, the design concept of the solar receiver is a rotary kiln. Here, PHC are inserted and irradiated with solar flux, which enters from an aperture. The cavity effect inside and the geometry of the receiver allow the PHC to reach temperatures between 700 and 800°C. The PHC are brought to a pyrolizer unit, where the thermochemical conversion of the biomass is driven by the thermal heat provided by the PHC. The revolutionary aspect of this technology is that it does not require fossil fuels for the pyrolysis reaction and avoids burning the biochar produced, which can then be used for much more useful purposes (for example, as a fertilizer).

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Which part of the CSP-technology are you improving and refining at DLR in frame of the project?

In the frame of the project, we are working extensively on optimising both the receiver design and the PHC material selection, drawing on our past experience in solar receiver design and material characterisation. The material selected as the PHC affects both the performance of the heat collection process in the solar receiver and the heat release during the pyrolysis process; therefore, it is critical to consider various material properties that impact the performance of these individual processes and the PYSOLO process as a whole. We are conducting a comprehensive characterization study, considering mechanical, thermal, optical, and chemical properties, and utilizing the results to guide our PHC material selection.

With respect to the solar receiver, we are focusing on adapting a rotary kiln design that we have past experience with and modifying it to improve the heat transfer to the PHCs (by improving particle mixing) while also allowing the kiln to operate at steeper inclination angles that are desirable for improving the optical efficiency in concentrated solar power tower systems. Our receiver will also be able to operate in two configurations: open for

Solar Tower Jülich – Image: DLR

testing with an inert PHC or closed with a window for testing PHC in inert atmosphere conditions, as would be required if the biochar produced in the pyrolysis reactor were used as PHC.

How did you determine the most promising particle heat carrier (PHC) and what specific properties (optical, mechanical, handling, compatibility) are prioritised for solar receiver applications?

Each particle heat carrier (PHC) was analyzed at room temperature, and at the intended receiver operating temperature (approximately 900°C) where possible, using a suite of tests. Based on the results, we attributed a score for each specific property and each PHC to determine a ranking for the most promising PHCs. Since we are working with the solar receiver, optical properties were prioritized for the selection.

How do you monitor the sustainability of your technology during its development?

From the early design phase, we consider for the solar receiver the use of non-critical materials where possible. Minimizing waste and providing a long lifetime for the receiver are key aspects that are also considered. The design is also thought to be easily assembled/disassembled, enabling the recycling of materials after the end of its lifetime. For the commissioning phase, we try to work with companies in the region whenever possible, in order to reduce the environmental impact of long transport distances, but also to promote their development.

Beyond pyrolysis, how and for which other high temperature industrial process could CSP be adapted?

CSP can be adapted for many industrial processes, in which middle and high temperature heat is required. For the high temperature range, two good examples are the calcination process in the cement industry and the production of hydrogen using technologies such as water splitting or membranes for oxygen transport. In the middle temperature range, and since high temperature steam can be easily produced with CSP, the list of industrial processes is quite big.