next-CSP

High Temperature concentrated solar thermal power plant with particle receiver and direct thermal storage

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Deliverable D5.3

WP5 – Testing of the complete high temperature solar and heat conversion loops including a gas turbine

Deliverable D5.3. Report on the heat conversion loop performances

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Introduction and objectives of D5.3

WP5 of Next-CSP project deals with the testing of the complete prototype, the particle solar loop and the heat conversion loop that share the same component, the heat exchanger. T5.3 aims to characterize the heat conversion loop with particle circulation in closed circuit.
Nevertheless, Due to the delay of the last work of WEL on site (finish end of the first week, July 2021) to connect the piping of the gas turbine to the heat exchanger, we (CNRS) had no time to perform the necessary tests. It is important to notice that WEL makes all the necessary efforts to finish the prototype assembly as soon as possible but the travel of the workers was delayed because of the travel limitation during the Covid19 pandemic.
Consequently, this deliverable describes the work made on the solar particle loop and the heat conversion loop to identify the technical issues and the necessary measures to overcome them.
In the heat conversion loop, the particles from the hot storage flow inside the heat exchanger in order to heat the pressurized air flowing out from the compression stage of the gas turbine. The heat exchanger and the gas turbine constitute the “heat conversion loop”. The bucket elevator, which is included in the particle solar loop is an important component to close the complete loop by carrying the particles from the heat exchanger outlet to the cold storage tank. These three components are described and characterized. Moreover, the mass flow of solid particles between the cold store and dispenser (bottom of the solar receiver), and between the hot store and the heat exchanger is controlled by L-valves. This type of valves avoid using mechanical feeders, nevertheless they are more complex to operate, in particular with particles containing fines. Difficulties experienced with L-valves are also discussed.

Recommendation for further development

This section lists a series of recommendations for the next steps. Most of them are compulsory to operate safely the facility:

- Pressure equilibrium:
    - Add differential pressure sensor between the cold L-valve and the cold storage in order to equal the pressure between the dispenser and the particle inlet.
- L-valves design:
    - Change air injection with a wider range of flowrate (0-50 sm^3/h)
    - Change pressure controller of the valve placed before piloted valves (0-3 bar)
    - Change the location of the air injector, it must be placed above the elbow.

- Bucket elevator:
    - Change the outlet collector with a steep plate.
    - Change the slope of the collector tube between the bucket elevator and the cold storage.
    - Add a dedusting plug at the bottom of the bucket elevator
    - Fluidize particles at the bottom of the bucket elevator.