Next-CSP

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

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Deliverable D5.1

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

Deliverable D5.1. Report on operating conditions for stable particle flow in the solar loop

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Introduction and objectives of D5.1

WP5 is the core of the Next-CSP project. In this WP, T5.1 aims at commissioning the complete loop without solar heating (cold regime) and defining the experimental conditions, particularly the pressure distribution, that results in stable solid flow inside the solar loop. It is crucial to maintain a constant solid flow rate in the solar receiver tubes to avoid overheating of the solar receiver when the concentrating solar field focuses on it. The solid mass flow rate can also be modified to control the solid outlet temperature as a function of the input solar power. Consequently, the solid mass flow rate will be varied in the range 2-20 tons/h.

This deliverable presents the results obtained during the "cold" experimental campaign. First, filling the system with 20 tons of olivine particle is described. Then the pressure distribution is detailed for each element of the loop. The measurement of the fluidized bed's pressure drop is explained for each element. Correlated to the component volume occupied by the fluidized particles it allows calculating the particle mass variation with time and consequently the particle mass flowrate. Since the particle loop is not equipped with a mechanical feeding system for controlling the particle mass flow rate, this latter parameter is measured by the variation of the pressure loss with time (and this is the only solution to do it). A simple relation between the pressure loss and the mass of particle in the fluidization state leads to the key data, the particle mass flow rate at the inlet or the outlet of the vessel. If there is no variation of the pressure loss in any of the component an equilibrium regime is reached. . After the complete description of pressure distribution, particle circulation in the 40 tubes receiver is described. Several particle mass flowrates have been tested. The last part of this deliverable concerns the problems that we faced with the L-valves and the bucket elevator and the modification that we implemented to solve it.

Figure 1 shows a schematic of the particle loop for identification of the main components involved.

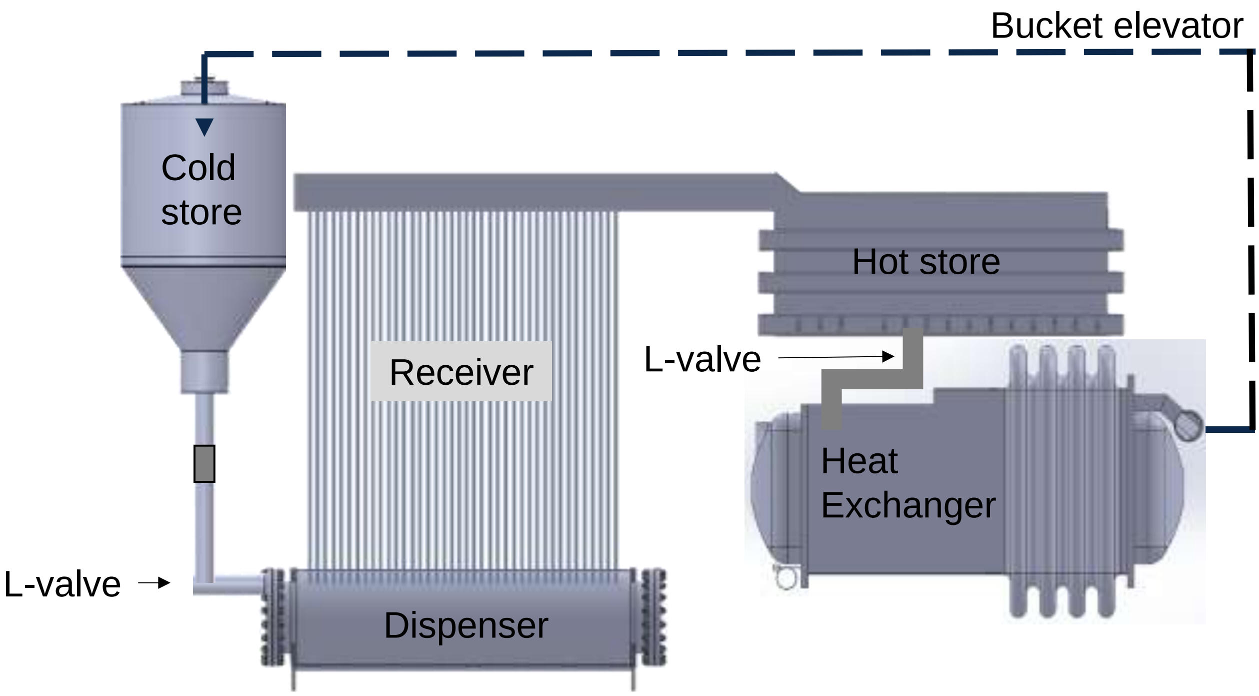

***Figure 1**. Schematic layout of the Next-CSP particle loop*

Conclusion

This deliverable summarizes the various steps perform to fill the particle loop components with olivine and the problems identified.

The particle loop was completely filled with approximately 20 tons particles as follows: cold bin → dispenser → receiver tubes → hot bin → heat exchanger → bucket elevator → cold bin. Pressure drop variation with time was used to determine the mass flow rate of solid entering or leaving the dispenser, the hot store and the heat exchanger.

The main problems identified were, (1) lack of pressure drop equilibrium between the dispenser and the cold store stand pipe resulting in the impossibility to feed the dispenser when pressurized; (2) defect of L-valves manufacturing; (3) mechanical issues with the bucket elevator. Fortunately, the WEL team that arrived mid-June 21 on site to achieve the complete loop assembly have made the mechanical changes that will allow performing the on-sun tests in satisfactory conditions.

References

[1] Kang Q., Flamant G., Dewill R., Baeyens J., Zhang H.L. Deng Y.M., *Particles in a circulation loop for solar energy capture and storage,* Particuology, 43:149-156, 2019