Innovative Direct Solar Receiver-Storage Systems for Heat Production (Inno-DSS)

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Solar thermal technology encounters some challenges specially when it is compared with its main competitor (i.e., PV) such as:

- Solar thermal collector always requires storage system
- There is limited space in a normal house for a storage unit

In Inno-DSS we addressed these challenges by introducing a new solar thermal collector in which both storage system and collector are combined in one unit without increasing the size of the collector. To achieve a compact unit, a suitable storage material with high energy density is required. For this purpose, a PCM has been developed based on SAT (Sodium acetate trihydrate) which offers a high laten heat. However, to have a stable martial over many charging and discharging cycles with suitable thermal properties, some material modifications have been done [1]. As the developed PCM has very good light absorption characteristics, therefore it can be used as a light absorber material in the solar thermal collector. This reduces the heat transfer resistance between the absorber plate and the heat transfer fluid which exists in a conventional solar thermal collector.

A suitable solar thermal collector has been designed [2] and fabricated to test the performance of the developed PCM in practice. It was observed, that with irradiance of 1000 W/m2 (in the lab condition), the PCM can be fully charged within couple of hours. As a next step, the collector must be tested outside to check it performance under real conditions.

Beside promising results we achieved in this project, there are still some challenges which require more investigations such as:

- Airgap formation between heat exchanged and PCM after several changing and discharging cycles.
- Volume expansion of the PCM and the mechanical force acting to the wall of the collector
- Permanent change in PCM characteristics in case of overheating

Above mentioned challenges can be addressed by modifying the design of the heat exchanger inside the collector. And this the main technical goal of the follow up research.

[1] M. Mehrali et al. Simultaneous solar-thermal energy harvesting and storage via shape stabilized salt hydrate phase change material, Chemical Engineering Journal, Volume 405, 1 February 2021, 126624

[2] C. Yeh et al. Experimental and numerical analysis of thermal performance of shape stabilized PCM in a solar thermal collector, Case Studies in Thermal Engineering 30 (2022) 101706