Design and integration of a solar heat system based on the SunDial for industrial processes

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1. Introduction

The use of solar thermal technologies to provide thermal energy required by an industrial process, also known as Solar Heat for Industrial Processes (SHIP), is one of the solutions proposed to promote the decarbonization of productive industries. The European Project ASTEP (Application of Solar Thermal Energy to Processes) has the main objective of demonstrating the viability of applying solar thermal energy to partially cover heating and cooling demands on two different relevant industrial demo sites located on two different climate regions. The main focus in this project is the decrease of cost, modularity of systems and thermal supply manageability for industrial heat above 150 ºC. The ASTEP concept is based on the modular and flexible integration of two innovative designs for the solar collector (SunDial) and the Thermal Energy Storage (TES), based on Phase Change Materials (PCM). This concept will be tested and validated in two industrial sites.

The objective of this work is the design and feasibility study of the integration of the ASTEP concept in two industrial processes, including parameter definition of both the solar collector and the whole system

2. ASTEP System description

2.1. Industrial processes

The two industrial sites where the ASTEP system is to be tested are a dairy industry located in Corinth, Greece, and a pipe manufacturing industry located in Iasi, Romania.

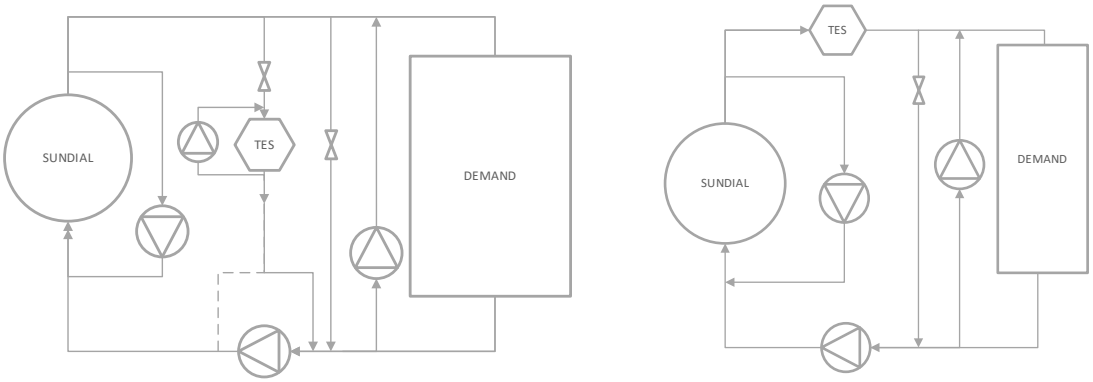
In the case of a dairy industry, the system has to provide energy to a boiler, for steam production (8 bar and 175 ºC) for the pasteurization process and to an absorption chiller, to provide cold water (- 5ºC) for the refrigeration of the products. The contribution is 6 kW_{th} boiler demand (working during 8 hours) and 13 kW_{th} chiller demand (1 hour every 4 hours, fed by an absorption chiller demanding 17 kW_{th}).

In the case of the steel industry, the ASTEP project has to provide thermal energy to preheat the manufactured pipes up to 180-220 ºC before their coating process. Hence, ASTEP system needs to provide thermal oil up to 240 ºC to heat up the preheating furnace.

2.2. Solar system description and integration

The solar system consists of the SunDial and a thermal storage system. One of the main innovations of the ASTEP project is the use of the SunDial Collector [1], a rotary Fresnel collector, where 8 mirrors are built on a platform with an azimuthal sun tracking system. The collector works with thermal oil as heat transfer fluid and the outlet temperature of the collector is 240 ºC. The receiver of the SunDial can be a standard evacuated monotube or a multitube [2] one. The thermal energy storage (TES) is based on a PCM with shell-side inserts with optimized geometry for the heat transfer during the charging/discharging.

The connection between these two systems can be done both in parallel or in series, as it is shown in Fig. 1, where the industrial demand is represented by a boiler and a chiller. The demand (boiler and chiller) can also be connected in parallel, as shown in Fig 1(a) or in series, as shown in Fig 1(b).



a) b)

Fig. 1: TES Layouts analyzed: a) SunDial-TES in parallel b) SunDial-TES in series.

3. Results and discussion

This study proposed and analyzed the design of the ASTEP concept required for providing solar heat for two different industries, in the two locations. The selected systems are shown in Table 1.

Code	**Location**	**Receiver**	**# semi-fields**	**Tracking mirrors**	**HTF**	**TES Layout**
MAND	Corinth, Greece	2 Evacuated tubes connected in series	2	1-axis	Therminol 55	series
AMTP	Iasi, Rumania	1 Multitube	1	2-axis	Therminol 55	parallel

Table 1: Selected designs.

The present work analyzed the integration concept's feasibility and evaluated the variables that most affected the performance of the systems on design.

References

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