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Control optimization through simulations of large scale solar plants for industrial heat applications

Ilyes Ben Hassine[a], Mariela Cotrado Sehgelmeble.[a], Robert Söll[b], Dirk Pietruschka[a]*,

[a]zafh.net Research Center on Sustainable Energy Technology, Schellingstraße 24, 70174 Stuttgart, Germany
[b]S.O.L.I.D. Solarinstallationen und Design GmbH, Puchstrasse 85, 8020 Graz, Austria

Abstract

The European FP7 Project InSun; which started in April 2012; aims to demonstrate the reliability and efficiency of three different collector technologies suitable for heat production employed in diverse industrial processes in different climatic regions. These collectors are installed and will be monitored in detail over a period of almost two years.
One of the plants is installed at Fleischwaren Berger GmbH located in Sieghartskirchen, Austria, a company which produces meat and sausage products. The second solar plant is installed at the company Laterizi Gambettola SRL (SOLTIGUA) located in Gambettola, Italy, which produces highly insulating hollow brick blocks for external walls of buildings. The control optimization and commissioning of the two solar plants has been carried out as a part of the InSun project. Considering measurements and results of simulations developed with dynamic models, potential improvements of the low-level control algorithms are presented for the two solar plants.

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Keywords: Control optimization; solar thermal collectors, large scale solar plant; solar industrial heat applications

1. Introduction

The present work describes some improvements developed in the solar plants installed at Berger and SOLTIGUA as a part of the European FP7 Project InSun. The control optimization and commissioning of the two solar plants has been carried out considering measurements and results of simulations using the programs OptiCAd and Matlab.

* Corresponding author. Tel.: +49 (0)711-8926-2674 ; fax: +49 (0)711-8926-2698
E-mail address: dirk.pietruschka@hft-stuttgart.de

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2. Control optimization of the flat plate collector field installed at BERGER in Austria

In the first part of the project a simplified model of the entire solar system is developed with the program Trnsys 16.1. This model considers technical information of the installed solar system and it includes the entire flat plate collector area of 1067.5 m² in one field as described in [1] and shown in Fig. 1.

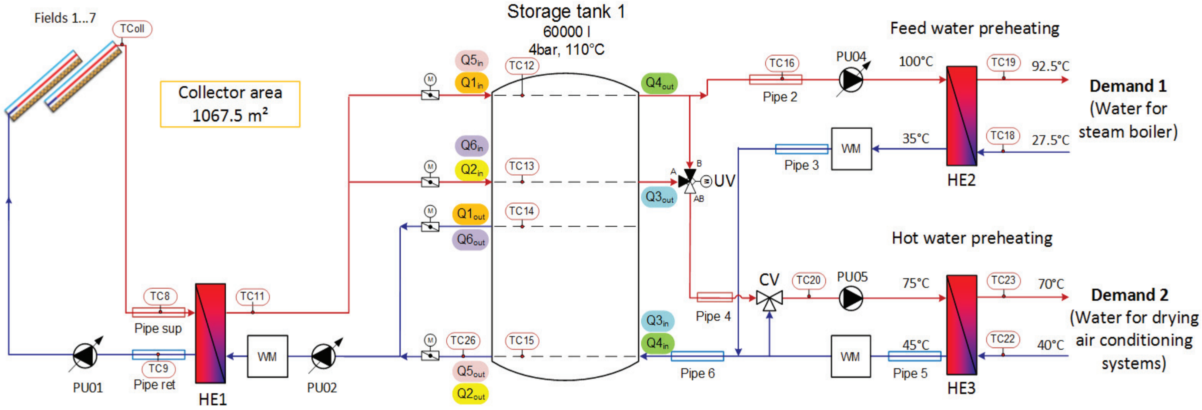

Fig. 1. Simplified hydraulic scheme of the solar system integration at the company Berger

The produced thermal energy is mainly used to preheat feed water for steam boiler and the surplus heat is used to increase the supply temperature within the heating water system up to 70°C. The feed water (HE2) of the steam vessel shall be preheated from approx. 27.5°C up to 92.5°C. The steam is internally required for process heating – specifically for ham cooking. The hot water (HE3) is required for several heat sinks within the plant (cleaning, ageing etc.).

To investigate the fluctuating temperature and flow rate values in the primary collector loop, a more detailed model was built using the program Matlab. In this second model, the collector field is divided into three sub fields. Also additional components and heat capacitances such as pipe diverters, heat capacity of pipe walls, dead time of pump and sensors are considered. This model was used to analyze and improve the implemented PI controller regulating the collector mass flow to reach a constant outlet temperature.

The following Fig. 2 shows a daily course of global irradiance, medium flow and supply temperature as measured in the solar field. The supply temperature is considerably fluctuating within the medium flow (e.g. medium irradiance) range due to the fluctuating pump flow in the collector field. The applied controller is obviously unable to cope with the changing dynamic of the field within this range.

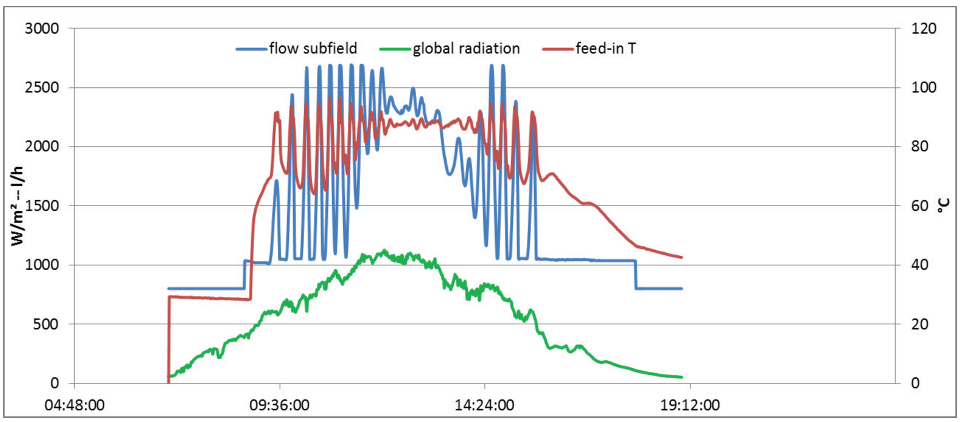

Fig. 2. Measurement data of the solar loop at the company Berger