

Multi-objective dynamic integration of a solar thermal system in the agro-industry processes: Methodology and case study

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Abstract

The agro-industry sector requires a large share of thermal energy for low-temperature applications in order to comply with the actual sustainability roadmaps and decarbonisation targets. It is desirable that heat demands are supplied by different energy sources depending on the temperature level. As a consequence, there is a huge potential to substitute ordinary fossil fuel energy sources with those from renewable sources. One of the challenges that hinders its application consists of the dynamic operation and the matching between the solar system and the industrial process. The main objective is to foster the solar heating integration in both new and existing industrial and agro-industrial plants. This work presents a methodology to evaluate the dynamic integration of a solar thermal system applied to a production site of winemaking industry. Although several research papers have been developed to evaluate the integration between a solar system and the processes, this work intends to extend the current framework for wider integration. Unlike the conventional stationary analysis, this methodology considers the transient behaviour of the solar thermal source. For this purpose, a transient simulation software (TRNSYS) coupled to a Java Application (JEPlus) was used to evaluate different process configurations and requirements and a post-processing algorithm was developed in Python in order to collect and analyze data from the resulting simulations. In this way, a combination of schedules, process temperatures, heat demands and storage systems is considered. The study novelty lies in a transient state solution, which takes into account the fluctuations of solar energy and the seasonality in the production processes, using multi-optimization solutions to assess the best integration process according to the balance between energy and exergy variables. Therefore, this fact implies a high potential for replicability in a wide range of industrial and agro-industrial sectors, solar technologies and geographical locations.

Keywords: Solar integration, Agro-industry, Dynamic operation, Exergy, Multi-objective optimization

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