Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 91 (2016) 650 – 660

Energy Procedia

SHC 2015, International Conference on Solar Heating and Cooling for Buildings and Industry

Classification of industrial heat consumers for integration of solar heat

Dr.-Ing. Bastian Schmitt

IdE Institute decentralised Energy Technologies gGmbH, Ständeplatz 15, 34117 Kassel, Germany

Abstract

In spite of the large potential, the market development of solar heat for industrial or commercial applications is rather slow so far. An important barrier for the market development is the large effort to carry out a feasibility assessment including the pre-dimensioning of a suitable solar process heat system. Especially to facilitate the identification of suitable integration points for solar heat in Industry, tools and guidelines are required. To reduce the effort for identification of a suitable integration point within Industry, comprehensive research on the food and beverages sector was performed to highlight the possibilities for integrating solar heat. The analysis shows that the utilized process installations and especially the current equipment for heating are of particular importance for the integration of solar heat.

Based on the results of the analysis of several sectors of the food and beverage industry and conventional process heating technologies, a classification for the integration of solar heat in industrial processes and heat supply systems was developed. This classification is sector independent and contains concepts for the hydraulic integration of solar heat for the majority of all industrial processes and operations. Finally, an approach is presented to simplify the choice of a suitable integration point for solar heat in industry. This approach includes the identification and assessment of possible integration points as well as the utilization of the developed classification and other important steps within the feasibility assessment.

Peer-review by the scientific conference committee of SHC 2015 under responsibility of PSE AG

Keywords: Solar process heat; integration concepts; processes; classification; industrial heat loads; approach for feasibility assessment

Nomenclature

P	Process	Q_{conv}	Conventional heat
PL	Process level	Q_{sol}	Solar heat
PM	Process medium	SL	Supply level

Peer-review by the scientific conference committee of SHC 2015 under responsibility of PSE AG
doi:10.1016/j.egypro.2016.06.225

1. Introduction

Industry represents a very promising application area for solar thermal technology, since it has a very high heat demand with a significant share below 150 °C [1], [2]. Additionally, Industry and Commerce usually have a very constant heat demand, both during working days and over the year. This is a significant advantage compared to standard applications of solar energy in the residential sector. Often very large solar heating systems can be applied in Industry due to the constant and high heating loads, which can yield in very low solar heat generation costs. In spite of the large potential that was estimated within several studies worldwide and the beneficial boundary conditions in Industry for the utilization of solar process heat, the market development is rather slow. The share of solar process heat systems on the global installation rate of solar heating systems is in the range of only one percent [3].

One important reason for the slow market development is the complexity of Industry as a new field of application for solar thermal energy. Based on the company size and applied processes, it can be very time-consuming to identify a suitable integration point for solar heat and to estimate the effort to integrate solar heat into the existing infrastructure of the production site. Additionally, different possibilities to integrate solar heat might be applicable based on the multitude of industrial heat loads, leading to different suitable hydraulic concepts for solar heating systems. However, there are no standardized system configurations for solar process heat so far which leads to very high costs for feasibility assessment and planning of these systems.

For a better market development and a reduced effort for feasibility assessment, different sectors or applications have been analyzed in more detail within the past. Partially, guidelines for a specific sector or application have been developed and published to reduce the effort for project development and realization of solar process heat systems [4], [5], [6]. However, a generalized methodology was still missing to transfer the findings of specific industry sectors or applications to others, that haven't been analyzed so far.

Within the past, the research priorities in the field of solar process heat were mainly focused on collector developments, identification of suitable industries and processes, as well as the implementation of case studies and initiation of pilot and demonstration plants. Approaches to simplify the integration of solar heat in industrial processes are rarely found. [7] identified widely-used unit operations, which seems to be suitable for the application of solar energy due to their low-temperature heat demand. The identified unit operations are supply of hot water or steam, drying and dehydration processes, preheating of input- and raw material, concentration processes, pasteurization and sterilization, washing and cleaning, chemical reactions, and industrial space heating. The identification and description of typical low temperature processes by Schnitzer et al. can be used to identify suitable applications for solar process heat. However, relating to the integration of solar heat this approach cannot make any general statement. This can be shown for example for the category washing and cleaning. The detailed analysis of the Brewing sector and additional sectors of the food and beverage industry by [8] show the wide variety of washing and cleaning processes. The applied installations for these processes can vary according to the product that has to be cleaned or the technique that is applied. Therefore, the method and installation for washing crates in a brewery is completely different compared to the washing of returnable bottles or the cleaning of a meat production facility. This leads to three totally different integration concepts for the utilization of solar heat. Thus, the presented approach does not result in any simplification of the integration of solar heat.

A similar approach is presented by [9]. Based on several screenings in companies of varying industry sectors, the authors identified promising applications for the integration of solar heat that frequently occurred within the screenings. These applications are as follows: heating of fresh water for cleaning processes, preheating of make-up water for steam boilers, heating of industrial baths, and convective drying with hot air. Due to their wide distribution, the significant energy demand and relatively low temperature level, these applications were determined to have a high potential for the integration of solar thermal energy. With regard to the temperature levels, energy demand and diffusion rate this selection seems reasonable, as it summarizes a large quantity of industrial processes. However, except for the preheating of make-up water for steam boilers a large variety of possible solar heating system configurations can be applied for the identified applications. As example, hot water supply for cleaning purposes can be realized continuously by a heat exchanger or with a storage that is heated by an internal heat exchanger. The heating of industrial baths gives even more options. Therefore, the approach of promising applications is not able to simplify the integration issue. However, the general distinction of heating fresh water and