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Energy saving study on a large steel plant by total site based pinch technology

Kazuo Matsuda [a,*], Shigeki Tanaka [a], Masaru Endou [b], Tsutomu Iiyoshi [c]

[a] Chiyoda Corporation, Energy Frontier Business Development Office, 2-12-1, Tsurumichuo, Tsurumi-ku, Yokohama 230-8601, Japan
[b] Sumikin Management Co., Ltd., 3, Hikari, Kashima 314-0014, Japan
[c] Sumitomo Metal Industries, Ltd., 8-11, Harumi 1-chome, Chuo-ku, Tokyo 104-6111, Japan

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ABSTRACT

The total site approach using a "Total Site Profile (TSP) analysis" (based on pinch technology) was applied to a large scale steel plant. And it was confirmed, despite the very high efficiency of the individual process systems of the plant, that there would be a huge energy saving potential by adopting this approach. It became apparent that the available pinch technology tools and techniques lend themselves very well to the analysis of a steel plant. The heat (thermal energy) under 300 °C has previously not been well utilized in steel plants. But TSP analysis was able to identify the distribution and the quantity of such heat, from which energy saving plans could be developed.

1. Introduction

A steel plant consumes a huge amount of energy. Energy saving has been studied for long years by many well-respected, professional engineers and a great deal of equipment has also been introduced to significantly improve energy efficiency (Bisio and Rubatto [1], Chan et al. [2], XU and Cang [3]). These approaches concentrated on the study of individual process systems (Worrell et al. [4]) but a total site approach has previously not been considered.

Pinch technology (Kemp [5]), an analytical methodology, has however been applied in heavy chemical complexes, such as refineries and petrochemical plants, to analyze the heat recovery system with the objective of reducing energy consumption in a plant or a complex of plants. It is well known that engineers in heavy chemical complexes study energy saving, not only by using a single process system approach but also by a total site approach of TSP analysis based on pinch technology. Tian et al. [6] studied the integration approach in a steel plant from the aspect of industrial water saving.

Pinch technology needs and makes use of the data obtained from many heat exchangers in the pressurized system of a heavy chemical complex. However, most of the process systems in a steel plant are operated under atmospheric pressure and originally the concept of using heat exchangers for heat recovery in the steel plant was hardly recognized, despite improved heat recovery systems. On the contrary pinch technology is based on the data obtained from heat exchangers. In order to analyze the heat recovery systems in a steel plant by total site approach, the data equivalent to that obtained for heat exchangers was essentially required. A procedure for the preparation of such data was newly established. It was important for the procedure to analyze and understand how the heat was utilized in each process system. Firstly all the process systems that consumed and recovered the heat were extracted. And then it was confirmed how the heat was transferred to heat and cool the process streams, even without any heat exchanger. After confirmation of the heat balance, each fluid was identified as to whether it was a utility fluid or a process fluid. For TSP analysis, the data of the utility/process fluids in heat exchanging are used, but not the process/process fluids. Thus the procedure was developed to extract adequate heat data for pinch technology analysis. A large steel plant was then studied with the extracted heat data by using the total site approach of TSP analysis.

2. TSP analysis and data

2.1. TSP analysis

In the context of a total site consisting of a number of process plants, the utility system must be understood and optimized. A graphical method, so called site profiles, was first introduced by Dhole and Linnhoff [7] and later Raissi [8]. Klemes et al. [9] considerably extended this methodology to site-wide applications. Heat recovery data for individual processes are firstly converted to grand composite curves (GCCs). GCCs are combined to form a site heat source profile and a site sink profile. These two profiles form total site profiles (TSP) analogous to the composite

* Corresponding author. Tel.: +81 45 506 7182; fax: +81 45 506 7376.
E-mail address: kmatsuda@ykh.chiyoda.co.jp (K. Matsuda).

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