Pinch Analysis for the Application in Steel Plants

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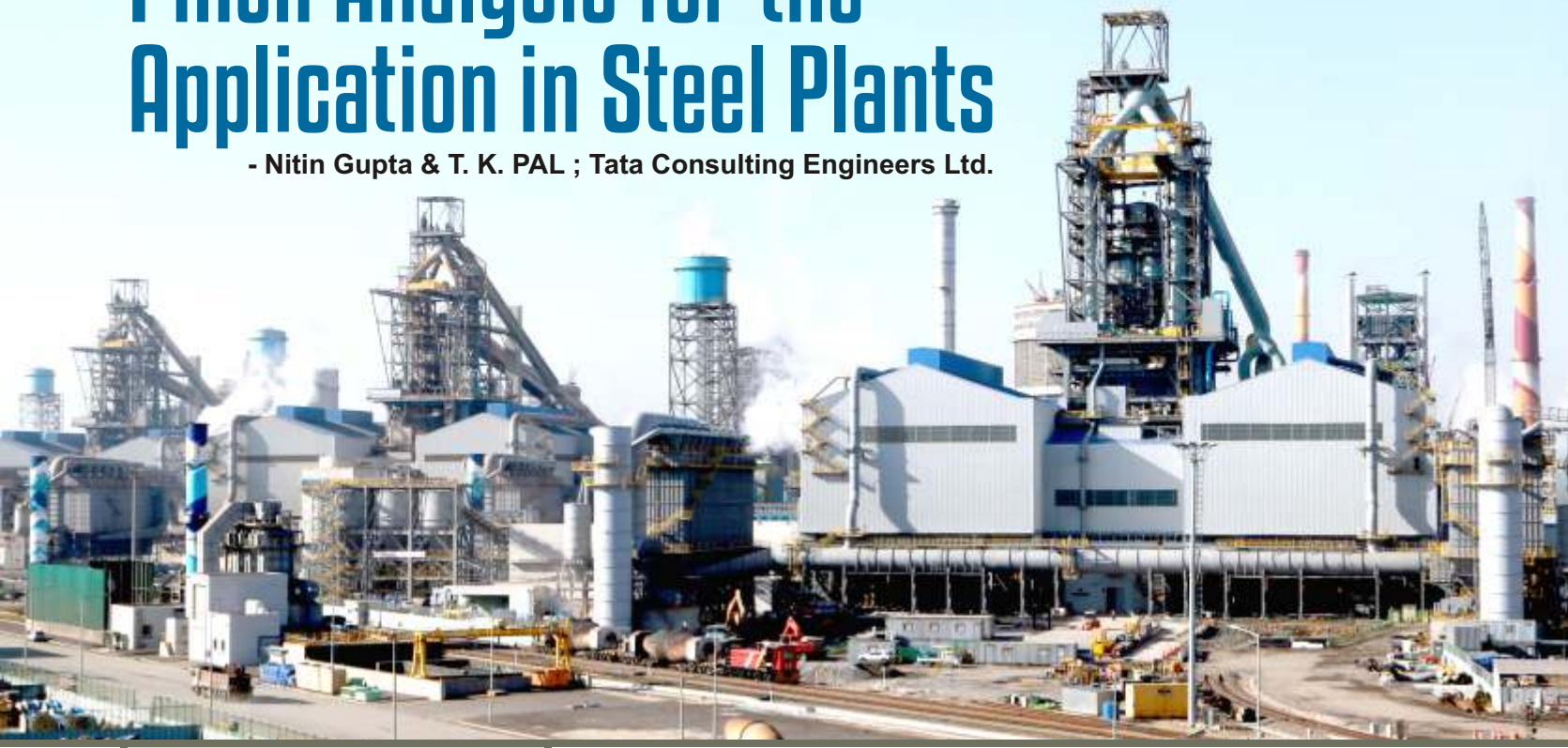


The term 'Pinch Technology' is a new set of thermodynamically based methods that guarantee the design of heat exchanging networks with minimum energy levels. The equations are mainly based on the First Law and the direction of heat flow is determined by the Second Law of Thermodynamics. This method is very useful for the large and complex industrial facilities and identifies the best energy saving opportunities. Pinch analysis is used in complex processes with extensive exchange of thermal energy. This article outlines the process of Pinch Analysis and study the applicability of pinch analysis in steel plants along with its advantages.

Introduction

Adaption of green technology and methods has gained momentum in the present industrial scenario. R&D teams in many plants are more concerned about the developing new greener technology or modifying the existing system parameters to reduce the energy consumption and CO2 emission. Some time it needs holistic approach to further reduce the energy consumption and CO2 emission when already the best technology is adopted for the plant.

It was generally believed that there was no further potential for energy saving in a steel plant because almost all energy saving measures thought to be possible had already been developed and introduced. The concept for energy saving studies had been limited only to the individual processes in the plant.

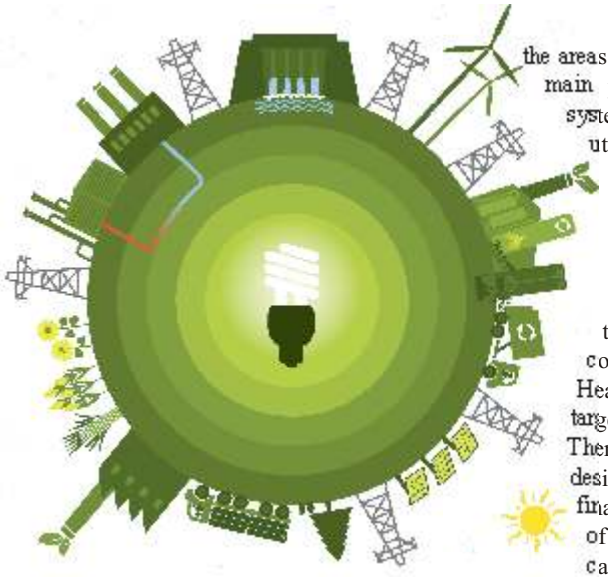
Pinch analysis is a technique for Process integration (PI). Among various PI methodologies, pinch analysis is widely used in the industry for the simplicity of its concepts and the satisfactory results it offers for many applications worldwide. The plant OPEX can be reduced substantially by optimum use of utilities, water and energy by applying PI, which helps in reducing carbon footprint and Industrial waste generation.

In an integrated steel plant various networks of units exchange energy and matter with each other. System studies using Process Integration (PI) tools are important for the optimization of energy balance of the steel plant and Pinch analysis is an ideal tool considering its simplicity and systematic approach.

Pinch analysis is recommended to be used in complex processes with extensive exchange of thermal energy, such as the coke oven gas cleaning area, sinter plant, waste gas utilization for preheating in sinteringprocess while blast furnace and steel melt shop are less suitable. As conditions can be different for different plant areas and problems a toolbox of diverse methods is probably preferable, i.e., pinch analysis should be used together with the other tools, not instead of them. Though the analysis needs more expertise to perform but the concept of pinch analysis is simple. The complexity of pinch analysis increases with the increase in number of heat exchanging units and their interaction.

Process Integration techniques provide advantages in the following areas :

- Minimization of Waste
- Optimization of Utility system



- Reduction in Investment cost
- Operational cost reduction
- Reduction in carbon footprint
- Energy saving
- Optimized interaction between various industrial processes
- Minimization of water consumption
- Better Heat Exchanger network design
- Optimization of separation sequences

It is more systematic approach, compared to other traditional approaches. PI is very useful for the large and complex industrial facilities which identify the best saving opportunities using these systematic approaches.

Traditional Design Approach Vs Pinch Analysis Approach

Traditional Design Approach

In traditional plant design, the design of main process along with the heat recovery system is engineered separately from the utility system which lacks the integrated approach of utilizing the available heat and mass within the system.

Pinch Technology Approach

Pinch Technology which is a part of Process Integration (PI) first estimates the minimum energy targets before the design of actual heat recovery network. The pinch analysis considers all processes with multiple streams as a single integrated system which helps in optimized selection of heat transfer equipments during the design of the system.

The practical constraints for implementing the concepts of Pinch Technology for heat recovery from main process and utility system are reviewed. Pinch design approach suggests the areas of possible improvements in the main process as well as its utility system, which may improve the heat utilization by integration of available heat.

Objectives of Pinch Analysis

Pinch Analysis is used to identify minimum energy targets, cost of energy and capital cost for improvements in a process, Heat Exchanger Network (HEN) targets and pinch point selection. Then a heat exchanger network is designed satisfying these targets. The final optimization of HEN, the cost of present energy expenses and capital cost for implementing the suggested modification are compared to arrive at the best compromise between energy expenses and investments which provide better return on Investment. Basically Pinch Analysis investigates the energy flows within a process, and identifies the most economical ways of maximizing heat recovery and ways to minimize the demand for external utilities (e.g., steam and cooling water) and also reduces energy loss from the system. This approach is also useful in identifying energy-saving areas within a process or utility systems.

Pinch analysis is a well established method in the following industry sectors:

- Steel & metallurgy
- Petrochemicals
- Chemical
- Pulp & paper
- Oil refining
- Food & Beverages

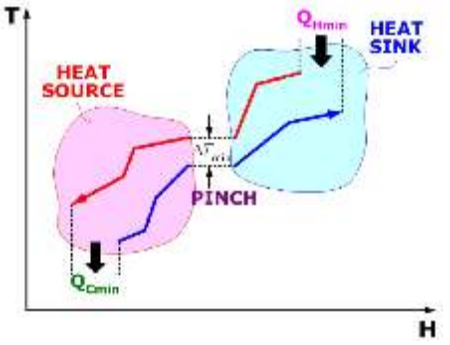
The Pinch Analysis is generally performed with the help of specialized software's to increase the speed of analyzing the large amount of data. The selection of right software based on the requirement and complexities of the problem in hand is very important. Some software applications also offer tools to rapidly design or modify heat exchanger networks.

Basic Concepts of Pinch Analysis

The principle of pinch is to group individual process streams together and regards them as two flows with common energy content, one composite cold streams and one composite hot streams. The location where temperature difference (ΔT) for heat exchange between hot and cold stream is minimum is called pinch point.

The pinch analysis starts with the collection of data from the target process. Each hot/ cold stream is considered separately. The data for each stream are tabulated which requires the initial and final temperature of each stream, specific heat and quantity of media. Based on the hot and cold stream data collected for existing process the hot and cold composite curve can be developed with vertical axis as temperature and horizontal axis as enthalpy (refer figure 1). These curves help the process experts to visualize the possible areas of improvements and implement the right solutions.

FIG. 1 : THE CONCEPT OF PINCH ANALYSIS



Relevance to Present Industrial Situation

As the saying goes the "A penny saved is a penny earned", pinch technology stands for the same in the current market scenario where the investment is tough and demand is low. The best the industry can do is to save as much energy to increase its profitability and provide sustainable solutions. The return on investments depends on the type of solutions implemented in a plant. The review and recommendations of the independent engineering consultant can be applied in phase wise manner also based on the priority of the customer. With Systematic Pinch Analysis the expected savings in the water and energy is

- **Saving in energy consumption :** 10% to 35 %
- **Saving in water consumption :** 25% to 40 %

These savings are very lucrative considering total energy and water expenditure of a steel plant.