Energy Integration and Cost Analysis of Ethyl Benzene Production Plant using Pinch Technology

Saket Kumar[1], Subhajit Majumder[2*]

[1]*Under-Graduate Student, Department of Chemical Engineering*
Birla Institute of Technology and Science (BITS), Pilani- 333031, Rajasthan, India
Email: sktkumar8@gmail.com

[2]*Lecturer, Department of Chemical Engineering*
Birla Institute of Technology and Science (BITS), Pilani- 333031, Rajasthan, India
Email: subhajit@pilani.bits-pilani.ac.in; subh.jit@gmail.com

EXTENDED ABSTRACT

The petro-chemical industries are facing great challenges in terms of energy conservation and cost reduction. While fuel prices continue to climb, energy conservation remains a prime concern for these industries. It is always a common approach to install a feed-effluent heat exchangers around a reactors and distillation columns to integrate the energy in the overall process. For last few decades, pinch technology has been gaining significant importance to improve the efficient energy usage in process industries. Pinch technology follows a systematic procedure for energy saving in processes. At a starting point, thermodynamic concepts are invoked while calculating the minimum heating and cooling requirements in the process. Minimum number of heat exchangers required for the process is calculated to obtain the minimum energy requirements. These calculations can be performed without finalizing any heat exchanger network (HEN). The minimum energy requirements and minimum number of heat exchangers provide targets for the subsequent design of complete heat exchanger network which helps to determine the total annual cost of heat exchangers involved in the process.

Present study deals with the minimizing the total annual cost required for an ethyl benzene (EB) process plant using Pinch Technology. In production process, EB is produced by alkylation of ethylene and benzene, and the product is used to produce styrene monomer. Aspen Plus (V8.4) is used to simulate the entire process. HEN for the process is specified using Aspen Energy Analyzer (V8.4). Analysis of the HEN reveals that there is a possibility to improve energy usage in the process and to reduce the load on utilities, thereby reducing the operating costs. A modified HEN is proposed by adding three new heat exchangers. It reduces the annual energy cost by 25.5%. It decreases the overall utility requirement, thereby saving energy and capital requirements. In order to implement the modified network, cost analysis of the process is done using both *Guthrie's correlation* and *Aspen correlation*. A trade-off is considered between new capital investment and operating cost savings. The base case has a return on investment of 17.76% and payout period of the initial investment 3.33 yrs. Considering the modification, the

new return on investment comes out to be 24% and a payout period of 2.7 yrs. The modification shows a huge rise in profits and most importantly energy savings by reducing utility load. This retrofitted model, if implemented can be a benchmark for industries towards an efficient energy usage.

Keywords: *Heat exchanger network, Pinch analysis, Annual energy cost, Guthrie's correlation, Aspen correlation, Payout period, Return on investment.*

* Corresponding author. Tel.: +91-1596-515872; Fax: +91-01596-244183
E-mail address: *subhajit@pilani.bits-pilani.ac.in; subh.jit@gmail.*