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Modification of the heat exchangers around the reactors of the isomerization unit in order to reduce energy consumption

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1. ABSTRACT
The light naphtha isomerization process is very important in increasing the octane number of gasoline and reducing environmental problems such as benzene and sulfur. The reactors of the isomerization unit play a significant role in increasing the octane number of the final product and reducing the environmental problems, so the energy optimization of the heat exchangers around the reactors was studied in the Persian Gulf Star Oil Company (PGSOC) using by pinch technology. The cross pinch the heat exchangers around the reactor is 50% of the total cross pinch of the unit's heat exchangers, and in order to reduce it, a corrective case was investigated. The results of this project show that by adding two new heat exchangers, in addition to removing 7 Ton/hr of medium pressure steam in the E-13 heat exchanger, also 9 Ton/hr of low pressure steam is produced in the E-28-R2 heat exchanger, that causes to reduction of 10.7 MW in the consumption of utility services. This case saved energy 3 million dollars per years and with the purchase of two heat exchangers, the investment return of this case is less than 1 month.

Keywords: Isomerization Process, Pinch Technology, Heat Exchangers, Optimization, Utility Services.

2. INTRODUCTION
An isomerization unit is a process to increase the gasoline quality and decrease environmental issues. The interest in the isomerization process has grown to limit the amount of benzene, aromatic, and olefin in gasoline to decrease the amount of gasoline benzene with the benzene saturation. Process Integration (PI) improved energy recovery and reduced loss of energy in chemical processes [1, 2]. PA can be used to reduce energy costs and increase the efficiency of Heat Exchanger Network (HEN) design through innovation and creativity in an energy-based industry [3]. The exergy and PA were carried out to optimize heat integration and recycling heat flow by Yu-Hsuan et al. The results show that utility energy efficiency is saved at 81.97%, and the total exergy efficiency for products in the process was 92.24% [4]. Recently used a new algorithm and methodology to analyze HEN and reduced cost. Jan et al. suggested a two-level algorithm for HEN retrofit: 1) a Genetic algorithm for to determine optimization and 2) a differential algorithm for heat loads. They achieved, this algorithm applied to industry and reduced the total annual cost by about 66% [5]. In this research a retrofitting case have been studied on the HEN of Isomerization unit at PGSOC[1] and compared with the base case (the design process), using Aspen HYSYS and Aspen Energy Analyzer V9.

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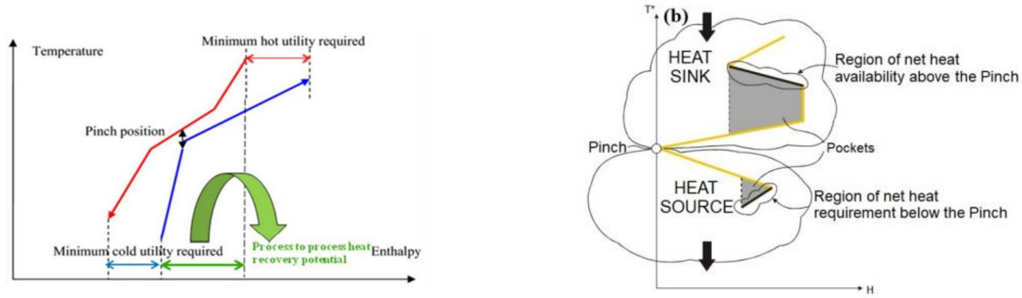
3. MATERIALS AND METHODS

The basic methodology for general Pinch Analysis (PA) is explain by linnhoff, and here are not repeated. Using the same terminology and principal here, one could the CC in the PA tool (Fig. 1a) as a simple but powerful enthalpy-temperature diagram which illustrate the minimum hot QH_{min} and cold utilities QC_{min} [6, 2]. Fig. 1b is also referred as the GCC when the overlapping by cold and hot CC are carried out by ½ ΔT_{min} on each of them. Here the two curves touch each other at pinch temperature [7]. In this research, the same methodology in the PA is used to analyses the Heat Exchanger Network HEN at Isomerization unit.



a b

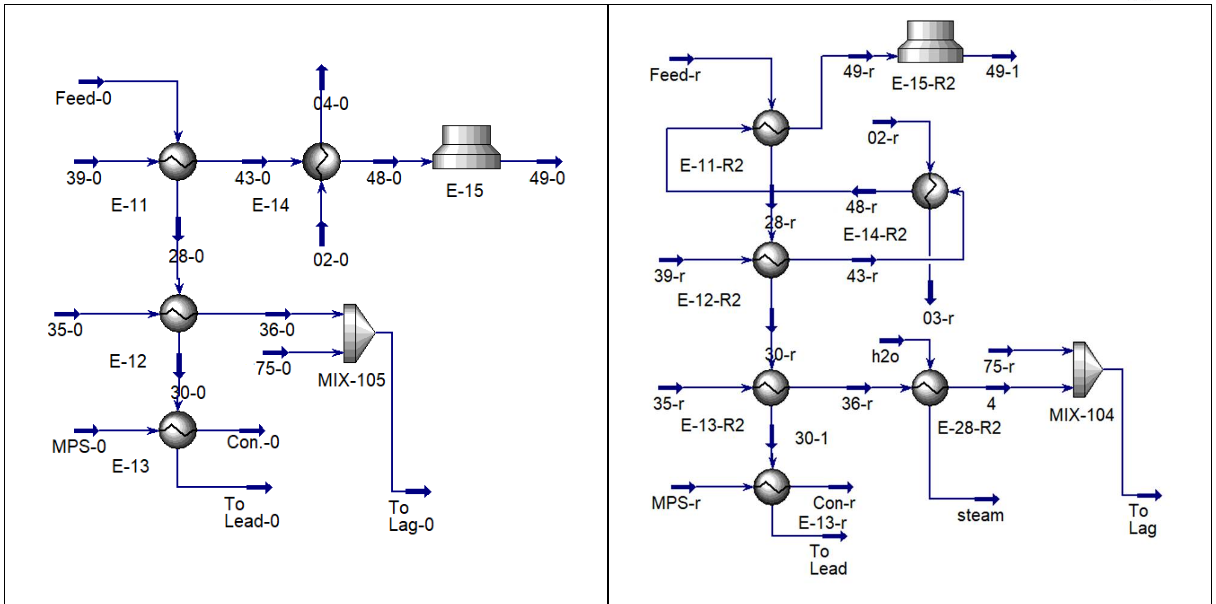
Fig. 1 a) Diagram of CC, b) Diagram GCC [7, 8].

4. RESULTS AND DISCUSSION

Process data collected from the PFD[2] and then imported into the Aspen Energy Analyzer software. The Isomerization unit has 6 process-to-process heat exchangers, 14 cold utility heat exchangers (air cooler & sea water), 7 hot utility heat exchangers (High Pressure Steam, Medium Pressure Steam and Low Pressure Steam), and one electrical heat exchanger., The ΔT_{min} was calculated at 10 ˚C and the pinch point was located at 92-102˚C. Cross-Pinch tools showed 18.35 MW in the base case. The heat exchangers E-11, E-12, E-24, E-25, E-10 and E-08 are inappropriately placed in the existing network as indicated by the oblique lines crossing the pinch point. The retrofitting cases were propose based on the pinch rules procedures outline in the PA approach. In this study, one retrofitting case were consider.

The retrofitting case were studied on Reactor section. The base case design shows that E-11, E-12 and E-14 have cross pinch. In the E-11, the stream 27 (cold) reaches from 49°C to 89°C, and the stream 39 (hot) reaches from 147°C to 122°C (Fig. 2a). The E-12, reaches the 28 (cold) stream from 89 ˚C to 135 ˚C by the stream 35 (hot), and the stream 35 reaches from 186 ˚C to 138 °C. In the retrofitted case, (Fig. 2b), the stream number 39 exchanges with the stream number 28 in the E-12-R2 and reaches from 147°C to 117°C. Then stream 43 enters to the E-14-R2 and reaches to 99°C. Finally, the stream 48, sent to the E-11-R2, and decreases to 53°C and stream 27 (cold) increases from 49 ˚C to 96.8 ˚C. In this case, by adding two new heat exchangers, in addition to removing 7 Ton/hr of medium pressure steam in the E-13 heat exchanger, also 9 Ton/hr of low pressure steam is produced in the E-28-R2 heat exchanger, that causes to reduction of 10.7 MW in the consumption of utility services. The cross pinch reduced from 18.35 MW to 9 MW, or 51%. Also the consumption of the utility was reduced by 10.7MW. This case saved energy 3 million dollars per years and with the purchase of two heat exchangers, the investment return of this case is less than 1 month.

[2] Process Flow Diagram



a	b

Fig.2 a) The base case b) The retroffited case.

5. CONCLUSION

The energy optimization of the heat exchangers around the reactors was studied in the Persian Gulf Star Oil Company (PGSOC) using by pinch technology. The results of this project show that by adding two new heat exchangers, in addition to removing 7 Ton/hr of medium pressure steam in the E-13 heat exchanger, also 9 Ton/hr of low pressure steam is produced in the E-28-R2 heat exchanger, that causes to reduction of 10.7 MW in the consumption of utility services. This case saved energy 3 million dollars per years and the investment return of this case is less than 1 month.

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