# CHAPTER VII

# CONCLUSION

Synthesis of an energy-efficient process system using the concepts of pinch and exergy have been reported to be highly successful. The present study has demonstrated without doubt the effectiveness and usefullness of such concepts when applied to an actual large-scale refinery plant.

The design method adopted here may be categorized into 4 stages, i.e., pre-analysis, generation of an initial heat exchanger network and its evolution, design evaluations, and economic analysis.

At the starting point of the pre-analysis stage, we first selected the Bangchak Petroleum Industry, a large-scale refinery plant, to be our case study. The data are first checked for credibility and consistency by material and energy balance calculations. Once the data are accepted as reliable, the existing energy consumption around the Topping Unit were subsequently determined. Then the complex process flow was simplified to the grid diagram form, and the basis stream were extracted.

In the second stage, generation of an initial network and its evolution, cascading principle was used to determine the pinch location, minimum heating and minimum cooling requirements for a process with the aid of our developed Energy Targetting Software. Also the composite curves (Temperature - Enthalpy diagram) for a given $\triangle$ Tmin was constructed. The results reveal whether the possibility exists to significantly reduce those energy requirements of the existing process. In the present study the MER design was shown to have potential reduction of 25 % and 22 % of hot utilities (as fuel) and cold utilities (as cooling water), respectively.

A simple and practical general pinch design algorithm was developed to aid in the synthesis of a heat exchanger network that accomplished maximum heat recovery and correct placement of heaters and coolers. The initial MER network was further improved by simple heuristic evolutionary rules involving stream-splitting to simultaneously increase the heat duties of the units and reduce the required number of exchanger units. In short, the MER design and one or more relaxed designs, which are more practical and economical, were obtained in the design evaluations stage. In addition, exergy analysis was carried out in this stage. The exergy loss reductions of 28.12 % and 16.73 % , compared to the existing design, were found to be possible with the MER and relaxed designs, respectively.

In the course of the present investigation, Bangchak Petroleum Industries had embarked upon and finish a major revamp of the No.3 refinery plant. The project was implemented by a consortium led by Toyo Engineering Corp. and was started up in the middle of 1989. Interesting the utility consumptions of the revamped and expanded plant was found to be comparable to our MER design even though the plant capacity was raised from 50,000 to 65,000 barrels of crude oil per day. This was possible because of not only improvement in the heat recovery area but also improvement in process equipment, especially the topping column, as well as optimization of operating conditions.

Economical evaluation of all competing retrofit designs was carried out in the final stage. The payback periods of the relaxed design was estimated to be 1.55 years, whereas the MER design required a little bit longer,i.e., 1.58 years. Based on the reasons mentioned in Chapter VI, the relaxed design was recommended over the MER design.

Table 7.1 summarized the results obtained in the present study. It compares the utility consumption, exergy losses and econcmic evaluation among the various cases.

Finally, the present work clearly demonstrates the effectiveness and usefulness of pinch technology and exergy concept as a tool of process integration. Anyway, the other features of the network configuration that should also be taken into account are good controllability, plant layout, intrinsic safety, process flexibility, and so on. However, they are beyond the scope of the present study.

TABLE 7.1 Summary of the Design Evaluation

| Scheme | Energy Consumption (MBtu/hr) | | | % Saving | | Exergy (MBtu/hr) | | Heat Exchanger | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hot Utility | Cold Utility | Total | Fuel | Cooling Water | Exergy Losses | Reduction (%) | No. of Unit | Additional Area (ft^2) | Payback Periods |
| 1. Based Case (Existing) | 149.4 | 167.31 | 316.71 | 0 | 0 | 63.79 | 0 | 14 | - | - |
| 2. Relaxed | 126.18 | 144.0 | 270.18 | 15.54 | 13.39 | 53.12 | 16.73 | 21 | 17,895 | 1.55 |
| 3. MER | 112.88 | 130.99 | 243.87 | 24.44 | 21.71 | 45.58 | 28.21 | 25 | 25,840 | 1.58 |