CHAPTER III
OPTIMAL DESIGN OF CRUDE UNITS

Design of a multipurpose energy efficient atmospheric column can be used by following technique. First, the Watkins design method is used to obtain an initial scheme without pump-around circuits. Then a heat demand-supply diagram is constructed and the direction of heat shifting needed for maximum energy efficiency is determined. This procedure is applied with the lightest crude and the heaviest crude.Therefore, the design procedure is classified into two parts, the targeting procedure and the multipurpose heat exchanger network design. First, the targeting procedure is focused on that the flexibility of changing the pump-around circuits loads in applications to crude fractionation. After this, the goals of the heat exchanger network design procedure are summarized.

3.1 Targeting Procedure

Step 1: Begin with the lightest crude to be processed. As the lightest crude has the highest yields of light distillates, the supply of heat is the largest. Then, the major design parameters such as the number of trays in each section, the pressure drop, and the amount of stripping steam are chosen using the guidelines offered by Watkins with one exception: *No pump-around circuits are included at this point.*

Step 2: The simulation is performed next by using a commercial simulation software (PROVISION II). Usually the simulation result of the column is not difficult to converge, with the large liquid reflux ratio.

Step 3: The heat demand-supply diagram is constructed.

Step 4: The maximum amount of heat is transferred to pump-around circuit located in the region between the top tray and the first product withdrawal tray. The location of the pump-around circuit withdrawal and the return temperature are conveniently chosen so that the energy recovery is maximized. This step will be discussed further.

Step 5: If the product gap becomes smaller than specification (off spec), the stripping steam flow rate is be increased to fix the gap. On condition that the steam added has a lower cost than the energy saved, one can continue shifting loads. Otherwise, stop when a trade-off has been reached.

Step 6: If there is heat surplus from the pump-around circuit just added, transfer the heat to the next pump-around circuit above all of the side-withdrawal product lines in the same way as in step 4. If not, stop.

At this step, once this procedure is repeated for different crudes which are intermediate and heavy crudes. One is left with heat removal targets from the condenser, the products, and several pump-around circuit streams. In general, the light crude is the one that needs a larger reflux; it exhibits a larger amount of pump-around circuit duties. After these targets are determined, it is shown that there is still some flexibility to shift heat from one pump-around to another, a feature that may be helpful in the final design of the heat exchanger network or for retrofit. The results of targeting procedure are used as motivating material for the goals of the multiperiod heat exchanger network.

3.2 Multipurpose/Multiperiod HEN Model Procedure

Step 1: The temperatures for the different types of crudes are checked and seen if one set of heat exchangers can satisfy the criterion that the crude is in contact with hot streams having increasing temperatures. Therefore the flowsheet is made better by making the crude get in contact with hot streams hotter.

Step 2: The areas of these heat exchangers are optimized. Basically, the set of areas of each crudes are chosen for making the minimum annual cost (Furnace energy cost + Cooling Utility cost + The area depreciation cost of heat exchanger) by using optimizer in PROVISION II. Then, the best area for each crudes are achieved. Next, the largest areas of three types of crudes are reached.

Step 3: Simulating the heat exchanger network for each crudes with the same area which the largest areas for all. This step, a bypass is necessary for handling variable heat loads.

Step 4: Proposing the following retrofit method: By looking at the heat demand-supply diagram, and comparing with the real heat exchanger. First, adding one heat exchanger at the time in different locations and optimizing the area to maximize the Net Present Value (NPV). Then, repeating this step for adding two heat exchangers at the time. Finally, the best solution can be obtained by using optimization.