CHAPTER VI

CONCLUSIONS AND RECOMENDATIONS

6.1 Conclusions

The design procedure for a resilient HEN used in this research can be describe as follows:

1. The *minimum heat load condition* is selected as the design condition. Then only the *positive disturbances* of process streams are considered.
2. Prefer a match at an upstream position. This will leave down stream of a larger stream as a residual.
3. Resiliency is satisfied if a disturbance of a smaller stream is less than the minimum of the heat exchanger resiliency parameter or the difference between the heat loads of the two streams in a match.
4. The disturbance of the residual stream is the sum of the disturbances of stream in a match, i.e. the heat load variations of a residual stream will be increased by the heat load of a smaller stream. According to the design condition, the new inlet temperature of the residual stream is shifted in proportion to the propagated disturbance.
5. Prefer a match where a larger heat load stream has larger heat capacity flowrate a smaller stream.

Matching a hot and cold stream at an upstream position and leaving the downstream portion of a larger stream as a residual follows the causal logic i.e., the disturbance will affect only that part of a stream that lies below the point of the disturbance. However, our strategy for resiliency prefers the upstream match approach which matching evolving toward the pinch will be equally as good. After all, the design objective is not just the identification of a cost optimal structure but one, which maintains MER and temperature targets when the inlet temperatures and flowrates of process streams vary from their nominal design points.

In HDA Process there are six alternatives but 4 ways of selected streams in all alternatives.

Alternative 1 have only two streams to matched and exchanged. So, this network can be design only one kind of heat exchanger network. The resilient network for this alternative is the same as in Conceptual Design (Douglas, 1988).

Alternative 2 have four streams to matched and exchanged but divided into 2 subnetwork. Each two streams were matched and exchanged by using each pinch temperature and can be the resilient one. That means alternative 2 doesn't reach MER because consideration of integration in exchanger is separated. We can see these four streams matched and reach MER in alternative 4. The resilient network for this alternative is the same as in Conceptual Design (Douglas, 1988).

Alternative 3 have five streams to matched and exchanged but divided into 2 subnetwork. Both subnetworks were matched and exchanged by using each pinch temperature and can be the resilient one by installed the auxiliary reboiler in stream C2. That means alternative 3 doesn't reach MER because consideration of integration in exchanger is separated. We can see these five streams matched and reach MER in alternative 5. The resilient network for this alternative is resemble as Conceptual Design (Douglas, 1988) but added auxiliary unit to be resilient network.

Alternative 4 have four streams to matched and exchanged as describe above in alternative 2. But this alternative can reach MER and we can design and received 2 resilient heat exchanger networks by installed the auxiliary reboiler in stream C2. The first resilient network must be more useful network than another. Because the size of auxiliary reboiler is less than one and cheap cost to install the auxiliary unit which can managed variations in stream C2. The resilient network 4.2 for this alternative is resemble as Conceptual Design (Douglas, 1988) but added auxiliary unit to be resilient network.

Alternative 5 have five streams to matched and exchanged as describe above in alternative 3. But this alternative can reach MER and we can design and received 4 resilient heat exchanger networks by installed the auxiliary reboiler in stream C2 and

C3 in each network. The first resilient network must be more useful network than another. Because the size of auxiliary reboiler is less than others and cheap cost to install the unit which can tolerate disturbance in stream C2. The resilient network 5.4 for this alternative is resemble as Conceptual Design (Douglas, 1988) but added auxiliary unit to be resilient network.

Alternative 6 have six streams to matched and exchanged. This alternative can reach MER and we can design and received 6 resilient heat exchanger networks by installed the auxiliary reboiler in stream C2 and C3 in each network. The first and the third resilient network are look about the same but different only sequence in exchanger of stream H1 by C3 and C4. They must be more useful networks than another. Because the size of auxiliary reboiler is less and cheaper cost to install the unit which can managed variations in stream C2. The third resilient network is more reasonable than one because of stream C4 have higher temperature than C3. So the third network is better. There are no resilient network which resemble as Conceptual Design (Douglas, 1988).

We can summarize that in case of resilient network design for HDA process, the match pattern class C, which is non-resilient class, must be use in each alternative to avoided temperature constraint. But lead to installed some extra unit which is auxiliary reboiler at the end of the cold streams to increased the performance in disturbance propagation and can take easy in controlled the resilient network. But the *trade-off* for the resiliency and cost would be considered. Because of the objective of this research needs the best resilient network, we need auxiliary unit installed to be the resilient networks. This will caused expenses increased, so the resilient network which use the less size or cost of installation in the same variation condition should be selected and use the design control structure to managed the disturbance load path. If engineers chose to not install the auxiliary unit, he or she needs to use feed forward control with feedback control and upstream unit to maintain target temperature. Installing auxiliary unit to the HDA Process will be the better choice which safe and non-risk by take effect to another target temperatures in upstream units. In case of same RI, which occurred in some networks because of RI concept is catching up on all the stream that can handled the same boundary of variation and not separated into each streams. So, we can use resiliency of each stream and cost estimation to be the decision of the best network depend on the priority of each stream that interesting. The last contribution of this research is known as the resilient network design method provided by Wongsri (1990) is the heuristics approached to design not only optimum network but also resilient network which can managed the variation or unwanted change to maintain the target temperature be the design point. While optimization technique may gives only optimum network but not the resilient network.

6.2 Recommendations

This research have design the resilient networks for HDA process and present the better choice of networks that can tolerates the disturbance to utilities. We only interested only target temperature. In the future works. the design control structure to resilient networks should be applied in control of product quality.