# CHAPTER V

# DISCUSSION, CONCLUSION AND RECOMMENDATION

## 5.1 Conclusion

The simulation results can be concluded in Table 5.1, the control performance indices are the IAE values and ITAE values.

| Case | Change | IAE | | ITAE | |
|---|---|---|---|---|---|
| | | PI-NN | PI-P | PI-NN | PI-P |
| 1 | -30% $C_{Bsp}$ | 268 | 268 | 25593 | 24467 |
| 2 | -20% $C_{Bin}$ | 99 | 283 | 11508 | 84324 |
| 3 | +20% $C_{Bin}$ | 94 | 139 | 10216 | 20054 |
| 4 | -20K $T_F$ | 39 | 118 | 3612 | 19144 |
| 5 | +20K $T_F$ | 39 | 273 | 3819 | 87584 |
| 6 | -30% $k_1$ | 19 | 61 | 1417 | 11935 |
| 7 | +30% $k_1$ | 13 | 54 | 988 | 12104 |
| 8 | -30% $k_2$ | 0.37 | 1.38 | 31 | 292 |
| 9 | +30% $k_2$ | 0.31 | 1.37 | 31 | 304 |

Table 5.1: IAE and ITAE Values

All results shown in Table 5.1 were simulated using PI-NN of which Kc = -34, $\tau_I$ = 80 with filtering of $\tau_F$ = 70, and the retuned PI-P of which Kc1 = -1.94, $\tau_{I1}$ = 80, Kc2 = 2,200 and $\tau_{I2}$ = 100,000.

Case 1 is the nominal case. PI-P was retuned to achieve the same value of IAE given by PI-NN. The ITAE value given by PI-P is slightly less than that of PI-NN.

In cases 2 to 9, PI-NN gave smaller IAE and ITAE values than PI-P did. Moreover, the responses of PI-NN are more stable than those of PI-P. It can be concluded from this research that PI-NN cascade strategy is more robust and stable than the conventional PID control.

The reason why PI-NN is better than PI-P is that the neural networks can detect any change occurring in the system indirectly from the measured reactant concentration, reactor temperatures and jacket temperatures. Nevertheless, the conventional PID cascade control utilizes only the errors between the desired set points and the process outputs to generate the magnitude of manipulated variable. Furthermore, PID control performance depends on the tuning parameters chosen, which can be a sluggish affair for a rebellious system such as this.

## 5.2 Recommendation

For the future direction, the neural network control strategy will be applied to the highly non-linear and complex systems which lack of the knowledge about the relations between inputs and outputs such as the polymer plants, the petrochemical plants and the multi-products plants. The neural network control strategy which requires only the inputs and outputs data should be the appropriate strategy for modeling and control of those processes.

Furthermore, some controlled variables are not available for the on-line measurement, such as the concentrations which are widely used as the controlled variables. For the hybrid process in this research, the neural network has done a good prediction for the concentration without knowing any past value of that concentration only in the nominal case, in cases of disturbances change and plant-model mismatches, it still requires the past values of the concentration to generate a good prediction value. Thus, it would be useful for the capability to predict the concentrations well without knowing any past value of it, even in cases of disturbances change and plant-model mismatches. The "soft sensor" would be the advantageous invention to cover this.