CHAPTER VI

CONCLUSION AND RECOMMENDATION

In this work, a pervaporative membrane reactor carried out an exothermic and reversible esterification reaction of acetic acid and butanol has been studied. Neural network based inverse model control (NNIC) has been designed and implemented to control an optimal reactor temperature of the pervaporative membrane reactor at 363 K by manipulating a jacket temperature. Furthermore, a neural network based estimator (NNE) has been designed to estimate unmeasurable heat release of chemical reactions and incorporated with the controller. This work has come up with the following conclusion.

1. <u>Neural network configuration, designed for a neural network based estimator.</u>

A multilayered feedforward network (5 input-nodes with 2 hidden layers, 7 and 5 nodes) is trained by the Levenberg-Marquardt technique which is one of methods for improving the rate and stability of the backpropagation algorithm. For the NIMC, the configuration consists of 5 input-nodes, 11 1^{st} hidden-nodes, 9 2^{nd} hidden-nodes and 1 output-node network. In both NNE and NIMC, the hyperbolic tangent function is used as activation function in the hidden layer because a neuron with hyperbolic tangent activation function outputs values in the interval (-1,1) as its input can goes from $-\infty$ to $+\infty$. The linear activation function is considered in output layer to avoid the problem of overflow of log sigmoid function

2. Control Performance

The simulation results have shown that the NIMC is able to control the reactor temperature at its desired set point without overshoot and provides the concentration of C_E at 5.2016 mol/l at the end of batch time which takes up 8 hours. When IAE is observed, it is found that performances of NIMC and GMC controller are more or less equivalent. For the robustness test, both controllers have been investigated with respect to changes in heat transfer coefficient, rate constant and heat of reaction. The simulation results have shown that the NNE is able to provide good estimates of the unmeasurable heat release. Consequently, the NIMC is found that it is still able to control the reactor temperature to achieve the desired set point with very slightly overshoot in all plant/model mismatch cases. In addition, the performance of the NIMC with the NNE is equivalent to that of the GMC with the Kalman filter.

3. In case of increasing the heat release by chemical reaction and of decreasing the heat transfer coefficient, the performance of the NIMC with NNE is poorer than that of the GMC coupled with Kalman Filter. This is due to improper training data for the NIMC and NNE and this can be improved by re-training with a wider range of training data set.

4. For application of the neural network for advance control, the neural network techniques are preferred when

- The problem is difficult to pose mathematically,
- The process is quite nonlinear,

- Mathematical models interpreting in term of first principles are rarely available.
- Sufficient data are available for training.

Recommendation

For the future direction, the proposed neural network based estimator and controller will be applied in real plants, which have complexity and lack of first principle models such as the polymer plants, petrochemical plants and multi-products plants. Furthermore, the neural network based estimator and controller for controlling multiple-input and multiple-output (MIMO) can be also considered in the future research.