PREFACE

This work is directed towards betterment of control in highly nonlinear processes: Continuously Stirred Tank Reactor (CSTR) pH process and Inline-pH process. The goal of this study was to establish the effectiveness of the artificial neural network for efficient modeling and control of these processes. The Internal Model Control (IMC) scheme is used as a basic control strategy. The thesis presents the details of the study undertaken with the following objectives in mind:

- To study the different approaches to advanced pH control.
- To study the system identification and control using artificial neural networks.
- To study the usefulness of IMC scheme in the control system.
- To identify the forward and inverse model of the plants with using the multilayer perceptron neural network.
- To analyze the results obtained by applying the proposed artificial neural network based Internal Model Control Scheme (ANN-IMC) to control the CSTR-pH and in-line pH process. This also includes study on the additive Internal Model Control (AIMC) scheme.
- To study the effectiveness of proposed control scheme using laboratory setup test plant.

The thesis is organized as follows:

Chapter-I presents a brief survey of the existing literature in the field of pH control. Various approaches developed in the pH control over the past two decades and current trends in advanced pH control are particularly highlighted. This chapter discusses the need of neural network in pH process modeling and control. Different issues involved in the nonlinear system identification using neural networks are discussed. The usefulness of IMC scheme in the control system is discussed by highlighting its suitability for the nonlinear process control.

Chapter-II is devoted to use of neural network for the identification of CSTR-pH process and Inline-pH process. Initially, the mathematical modeling of both processes is presented. Further, the identification of forward model and inverse model of the plant using neural network is highlighted. This discussion also involves the selection of input signal, selection of model structures, estimation and validation of the models. Results on the study of the different parameters like training data, choice of model order, data sample time etc. are presented. This chapter concludes with the one step-ahead prediction accuracy results of forward and inverse models of both processes.

Chapter-III analyzes the results obtained by applying the proposed ANN-IMC control scheme to both processes on the basis of regulatory and servo performances. Two standard benchmark controllers are developed for the performance comparison viz. PID controller and Feed forward-Feedback Controller. Based on the analysis and supporting experiments, a qualitative discussion is presented on the disturbance rejection performance of the controllers.

Further, the implementation of ANN-IMC controller in the additive form is discussed in the context of In-line pH process. The results of the proposed controller are analyzed. This chapter also includes the studies on the performance of AIMC controller for non-constant disturbance and controller contribution.

Chapter-IV discusses the results of proposed control scheme when applied to laboratory pH processes. Experimental results using the test plant are discussed in comparison with feed forward- feedback controller. This chapter concludes with the performance evaluation of ANN-AIMC controller in the absence of the existing controller.

Chapter-V summarizes the salient observations and conclusions from the present study. It also outlines the related areas of future research.