An Adaptive Neuro-Fuzzy Sliding Mode Controller for MIMO Systems with Disturbance

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An Adaptive Neuro-Fuzzy Sliding Mode Controller for MIMO Systems with Disturbance.

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Abstract

This paper introduces the mathematical model of ammonia and urea reactors and suggested three methods for designing special propose controller. The first proposed method is Adaptive model predictive controller, the second is Adaptive Neural Network Model Predictive Control, and the third is Adaptive neuro-fuzzy sliding mode controller. These methods are applied to a multivariable nonlinear system as Ammonia-Urea reactors system. The main target of these controller is to achieve stabilization of the outlet concentration of ammonia and urea, stable reactions rate, increase the conversion of carbon monoxide (CO) into carbon dioxide (carbon dioxide (CO_2) to reduce the pollution effect, increasing the ammonia and urea productions, keeping the NH_3/CO_2 ratio equal to 3 to reduce the unreacted CO_2 and NH_3, and the two reactors temperature in the suitable operating ranges due to the change in reactors parameters or external disturbance. Simulation results of the three controllers are compared. Comparative analysis proves the effectiveness of the suggested Adaptive neuro-fuzzy sliding mode controller than the two other controllers according to external disturbance and the change of parameters. Moreover, the suggested methods when compared with other controllers in the literature show great success in overcoming the external disturbance and the change of parameters.

Keywords: Ammonia reactor, urea reactor, Process Control, Chemical Industry, Adaptive model predictive controller, Adaptive Neural Network Model Predictive Control, Adaptive neuro-fuzzy sliding mode controller, Nonlinearity.

1- Introduction

Ammonia (NH_3) is one of the most chemical processes in industry. NH_3 is produced from the reaction between nitrogen gas (N_2) and hydrogen gas (H_2). The reaction for ammonia production is described as [1-8]:

$$N_2 + 3H_2 \Leftrightarrow 2NH_3 \qquad (1)$$

There are six steps for ammonia synthesis process. Hydrogen production stage, Nitrogen addition stage, Removal of carbon monoxide Stage, Water removal stage, Remove of carbon oxides, and finally, synthesis of ammonia stage. The flow chart of ammonia process as shown in Fig.1. Ammonia reactor with quenching cooling and Beds is shown in Fig.2. [7].

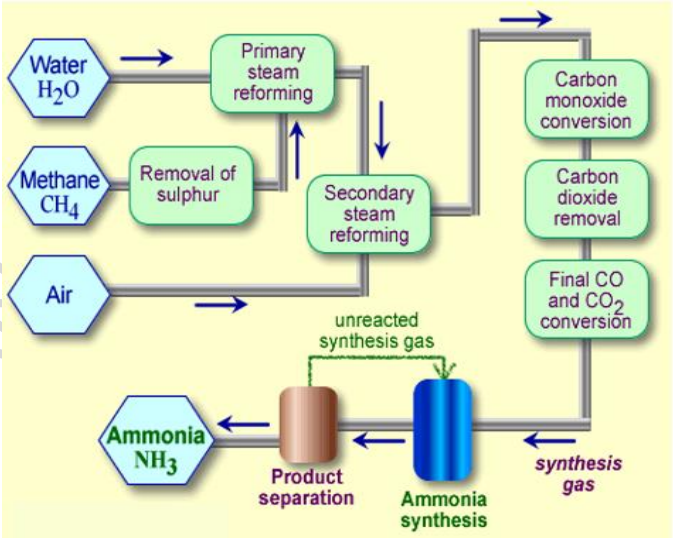

Fig. 1. Flow chart of Ammonia synthesis process.

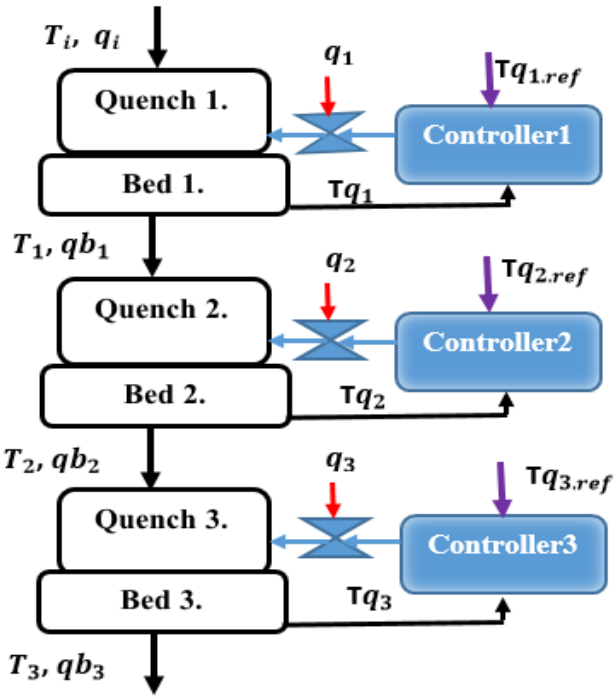

Fig.2. Ammonia reactor with Quenching and Bed sections.