Applied Mechanics and Materials Vol. 573 (2014) pp 217-222
Online available since 2014/Jun/18 at www.scientific.net

doi:10.4028/www.scientific.net/AMM.573.217

Comparative Study of Controller Design by Intelligent Techniques on Nonlinear Process Control Reactor - Continuous Stirred Tank Reactor (CSTR)

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KEYWORDS: CSTR, Nonlinear modeling, MIMO System, Controller Design, Intelligent Technique

ABSTRACT
In recent scenario of research area is towards the modeling of the system with nonlinearities, controller design is becoming an intentional necessity as a result of increasing economic, environmental demands associated with an increasing demand for high performance as well as for more safety and reliability of dynamic systems. Continuous Stirred Tank Reactor (CSTR) is one of the universal reactors in chemical plant and also it is complex in nonlinear behavior which causes the identification problem and controller design is always a challenging task for the researchers. This paper focuses the nonlinear modeling and the comparison study of various intelligent techniques for dynamic controller design.

INTRODUCTION
Many common process control problems exhibit nonlinear behavior, in that the relationship between the controlled and manipulated variables depends on the operating conditions. A major reason to rely on linear control is the relative simplicity and computational feasibility of linear control schemes. But the linear process control can't be competitive in the nonlinear effects. In recent days, there has been a growing interest in nonlinear process control, especially with the advent of new techniques to address nonlinear control design problems. Nonlinear, time varying behavior is common in chemical process. When a change occurs in the process parameters, the controller frequently needs to be retuned in order to maintain satisfactory performance. Retuning the controller is time consuming, requiring a combination of operational experience and trial-and-error. So the Intelligent Technique is focused in this paper.

CSTR MODELING
The reaction inside the reactor is called *van der Vusse reaction.* This reaction can be described by the following scheme

$$A \xrightarrow{k1} B \xrightarrow{k2} C \tag{1}$$

$$2A \xrightarrow{k3} D \tag{2}$$

The mathematical model of this reactor comes from balance inside the reactor. The equation 1 and 2 comes from material balances of compounds A and B:

$$\frac{dC_A}{dt} = \frac{q_r}{V_r}(C_{A0} - C_A) - k_1 C_A - k_3 C_A^2 \tag{3}$$

$$\frac{dC_B}{dt} = -\frac{q_r}{V_r} C_B + k_1 C_A - k_2 C_B \tag{4}$$

$$\frac{dT_r}{dt} = \frac{q_r}{V_r}(T_{r0} - T_r) - \frac{h_r}{\rho_r c_{pr}} + \frac{A_r U}{V_r \rho_r c_{pr}}(T_c - T_r) \tag{5}$$

$$\frac{dT_c}{dt} = \frac{1}{m_c c_{pc}}(Q_c + A_r U(T_r - T_c)) \tag{6}$$