Comparative Study of Temperature Control in a Heat Exchanger Process

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ABSTRACT

In the present work the dynamic behavior of a plate heat exchanger (PHE) (single pass counter current consists of 24 plates) studied experimentally and theoretically to control the system. Different control strategies; conventional feedback control, classical fuzzy logic control, artificial neural network (NARMA-L2) control and PID fuzzy logic control were implemented to control the outlet cold water temperature. A step change was carried in the hot water flow rate which was considered as a manipulated variable. The experimental heat transfer measurements of the PHE showed that the overall heat transfer coefficient (U) is related to the hot water flow rate (m_h) by a correlation having the form:

$$U = 11045\ m_h^{0.7158}$$

In this work the PHE model was found theoretically as a first order lead and second order overdamped lag while the experimental PHE represented dynamically (by PRC method) as a first order with negligible dead time value. A comparison between the experimental and the theoretical model is carried out and good agreement is obtained. The performance criteria used for different control modes are the integral square error (ISE) and integral time-weighted absolute error (ITAE) where the ITAE gave better performance. As well as the parameters of the step performance of the system such as overshoot value, settling time and rise time are used to evaluate the performance of different control strategies. The PID fuzzy controller gave better control results of temperature rather than PI, PID and artificial neural network controller since PID fuzzy controller combines the advantages of a fuzzy logic controller and a PID controller. MATLAB program version 7.10 was used as a tool of simulation for all the studies mentioned in this work.

Keywords: plate heat exchanger, dynamic behavior, model, PI controller, PID controller, fuzzy logic controller, artificial neural network controller.