A back-propagation (BP) neural network is a multi-layer feed-forward neural network. The BP is typical and most frequently used in current learning models. An on-line learning neural network controller based on a back-propagation neural network has been used in this simulation. This controller can breakthrough the bottleneck of a traditional neuro-controller, which can learn on-line and take a control action at the same time. Furthermore, the controller can merge the learning process with a real control, eliminating the need to training it before use. The weights of a neural network are obtained from a random number generator. Thus, setting weights is not a problem. In this study, the on-line learning neural network controller has been applied to a CSTR system. The effect of learning rates on controllability of an on-line learning neuro-controller has been studied in this simulation. The computer simulation of a CSTR system with two control loops has been carried out. The interaction between the two loops is also discussed. Simulation results show that the neuro-controller with fixed learning rates cannot control the CSTR at satisfactory standards. Therefore, a linear expansion method and Newton likely method are then used to obtain optimal, dynamic learning rates. Simulation results show that good control performance is obtained if an on-line learning neuro-controllers combined with optimal, dynamic learning rates. A neural network needs to be trained before use. Training a neural network takes a lot of time, and therefore limits the application of the neural network. If a neural network can take training and perform a control action at the same time, then the application of a neural network becomes more convenient. Today’s personal computers have improved calculation ability, which can be used to train neuro-controllers to predict a near future process state. This ability is very important to a real-time simulation. Actually, the neuro-controllers play two roles, including feed-forward (prediction) and feed-back (control).