Neural Network Predictive Controller Design for Counter-Current Tubular Heat Exchangers in Series

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Abstract

This paper aims at showing the application of neural network predictive control (NNPC) to counter-current heat exchangers (HEs) in series for water savings. The controlled process unit is composed of five counter-current shell-and-tube heat exchangers in series in which petroleum, coming from a distillation unit in a refinery is cooled.

Neural network predictive control (NNPC) of the HEs for water savings was studied by simulations. The neural network (NN) plant model of the heat exchangers in series was obtained off-line. The two-layer network with sigmoid transfer functions in the hidden layer and linear transfer functions in the output layer was trained using the Levenberg-Marquardt (LM) algorithm. The neural network predictive control (NNPC) combines the advantages of neural-network-based modelling and model-based predictive control (MPC). Neural-network modelling is suitable for modelling non-linear processes, processes with asymmetric dynamics and processes with uncertainty. MPC is a model-based strategy and usually linear models of controlled processes are used. This fact can cause problems when strongly non-linear processes, processes with asymmetric dynamics or uncertainty have to be controlled. Using neural-network plant model in MPC is one of the ways to overcome these problems. Moreover, MPC can handle boundaries on control inputs and controlled outputs. As the calculated control inputs are obtained as a result of an optimisation procedure, MPC can lead to water savings.

Results obtained using NNPC for the HEs were compared with those by the classical PID control. They confirm that using the advanced control strategy leads to water savings.