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A Simulated Evaluation of Model Predictive Control

Authors : Ahmed AlNouss, Salim Ahmed

Abstract : Process control refers to the techniques to control the variables in a process in order to maintain them at their desired values. Advanced process control (APC) is a broad term within the domain of control where it refers to different kinds of process control and control related tools, for example, model predictive control (MPC), statistical process control (SPC), fault detection and classification (FDC) and performance assessment. APC is often used for solving multivariable control problems and model predictive control (MPC) is one of only a few advanced control methods used successfully in industrial control applications. Advanced control is expected to bring many benefits to the plant operation; however, the extent of the benefits is plant specific and the application needs a large investment. This requires an analysis of the expected benefits before the implementation of the control. In a real plant simulation studies are carried out along with some experimentation to determine the improvement in the performance of the plant due to advanced control. In this research, such an exercise is undertaken to realize the needs of APC application. The main objectives of the paper are as follows: (1) To apply MPC to a number of simulations set up to realize the need of MPC by comparing its performance with that of proportional integral derivatives (PID) controllers. (2) To study the effect of controller parameters on control performance. (3) To develop appropriate performance index (PI) to compare the performance of different controller and develop novel idea to present tuning map of a controller. These objectives were achieved by applying PID controller and a special type of MPC which is dynamic matrix control (DMC) on the multi-tanks process simulated in loop-pro. Then the controller performance has been evaluated by changing the controller parameters. This performance was based on special indices related to the difference between set point and process variable in order to compare the both controllers. The same principle was applied for continuous stirred tank heater (CSTH) and continuous stirred tank reactor (CSTR) processes simulated in Matlab. However, in these processes some developed programs were written to evaluate the performance of the PID and MPC controllers. Finally these performance indices along with their controller parameters were plotted using special program called Sigmaplot. As a result, the improvement in the performance of the control loops was quantified using relevant indices to justify the need and importance of advanced process control. Also, it has been approved that, by using appropriate indices, predictive controller can improve the performance of the control loop significantly.

Keywords : advanced process control (APC), control loop, model predictive control (MPC), proportional integral derivatives (PID), performance indices (PI)
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