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Performance estimation of Different controller for the Industrial Based Process

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Abstract: Most of the processes used in the industry are First Order plus Dead Time process. Blending Process is chosen and FOPDT model is designed for the process, Different controller technique is tuned for the given process. The controllers are compared with time domain specification and Performance indices. The optimal controller for the process is chosen with minimum time domain specification and minimum performance indices.

Keywords: FOPDT, Dead-time, Time domain specification, Performance indices.

I. INTRODUCTION

Many industries are comprised of first order plus dead time. The process taken here is blended process, which a process of combing materials, in which solid-solid or mixing of bulk solids with small quantity of liquid are taken place. This blending process is used in many chemical industries. In chemical industries the process of mixing two components with equal percentage is taking place, where higher order model are obtained during this process. This was a tedious process in controlling process model, Therefore this higher order process model is modelled as a linear first order process with dead time. In real time world first order process with dead time is controlled using PID controller, because we get minimum time delay and minimum overshoot. Various methods have been established for PID controller, As a result the Different PID control tuning is compared with Model Predictive Controller (MPC) and the best controller is chosen with minimum time domain specification and minimum performance indices.

II. PROCESS SETUP

A. Description of Process

Chemical industry uses blending process as one of the main process. Blending process is taken as process and the process modelling for the blending process is designed.

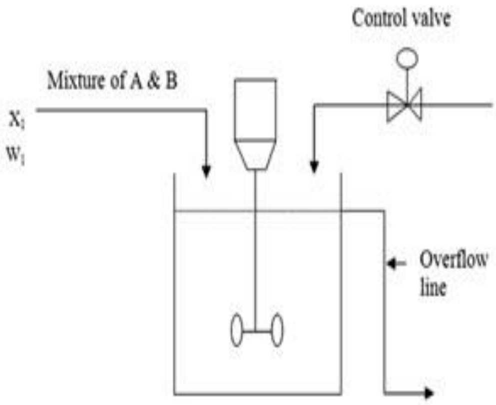

Fig 1. Process setup

The main objective of the blending process is to synthesis or blend two input inlet stream to make a final output, the final product should meet customer satisfaction.

A stirred tank blending is chosen for the process which has Stream 1 , which is a mixture of two chemical components A and B, the mass flow rate of stream 1 is w_1 which is constant and the mass fraction of stream 1 is x_1 which varies with time. Stream 2 is a pure form of mixture A which is a mass flow rate of w_2 and mass fraction of stream 2 is $x_2=1$. The mass fraction of the final output is denoted by x and the desired value is reached.

III. CONTROLLER DESIGN

In many industries PID controller is implemented for controlling the real time process. In this process different types of PID controller are implemented and compared with MPC, in terms of Performance indices and Time domain specification. First order plus dead time process modelling is obtained by using Process Reaction Curve method. The transfer function for the process is obtained.

The PID controllers implemented in the process are defined below.

A. Connell et al

It was invented by Connell in the year 1996, in which the overshoot of the process is reduced using this Connell PID controller.

Controller	K_p	τ_I	τ_d
PID	$\frac{1.6T_m}{K_m\tau_m}$	$1.6667\tau_m$	$0.4\tau_m$

Table 1. Connell et al formula

B. Callender et al

It was invented in the year 1935, which was the first PID controller invented by Callender. It reduces 0.3 % of overshoot from the desired output.

Controller	K_p	τ_I	τ_d
PID	$\frac{1.6T_m}{K_m\tau_m}$	$1.418\tau_m$	$0.353\tau_m$(or)$0.47\tau_m$

Table 2. Callender et al formula

C. Chinn et al

It was introduced by Chinn in the year 1952, which is used to reduce the regulatory problem in the Process, it has 0% Overshoot and it is most widely used in many processes

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Controller	K_p	τ_I	τ_d
PID	$\frac{0.95T_m}{K_m \tau_m}$	$2.387\tau_m$	$0.42\tau_m$

Table 4. Chinn et al formula

D. Astrom & Hugg

Astrom & Hugg invented a new method to tune PID controller,In which the oveshoot is minimum when compared other PID controllers

Controller	K_p	τ_I	τ_d
PID	$\frac{3}{K_m}$	$T_{90\%}$	$0.5\tau_m$

Table 5. Amstrong & Hugg formula

E. Modern Predictive Controller (MPC)

(MPC) is an superior method of process control that has been in use in the process industries in chemical plants and oil refineries etc. It is used to predict the future evolution of the process to optimize the control signal. The main advantage of MPC is the fact that it allows the current timeslot to be optimized, while keeping future timeslots in account. This is achieved by optimizing a finite time-horizon, but only implementing the current timeslot.

It is based on iterative based technique, in which the current state is sampled and a cost minimizing control strategy is computed, for a relatively short time horizon (t, t+T), Then the plant is sampled again and the new state for the plant is identified, obtaining a new control and new prediction state path.

The reason for MPC having receding horizon is that the prediction horizon keeps on shifting forwarding.

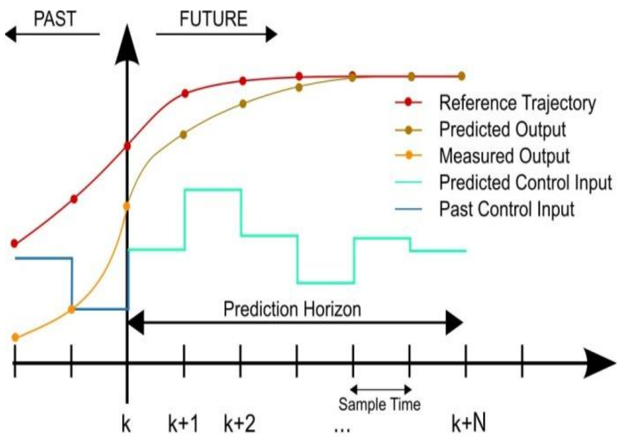

Fig 2. Modern predictive control

IV. RESULT AND DISCUSSION

The process chosen here is blending process, in which FOPDT process is obtained. A different type of PID controller is tuned for the given process with MPC controller. The controller that has minimum time domain specification & minimum performance indices is selected as the best controller for the process.

The time domain specification & performance indices are tabulated in Table 1 & Table 2.

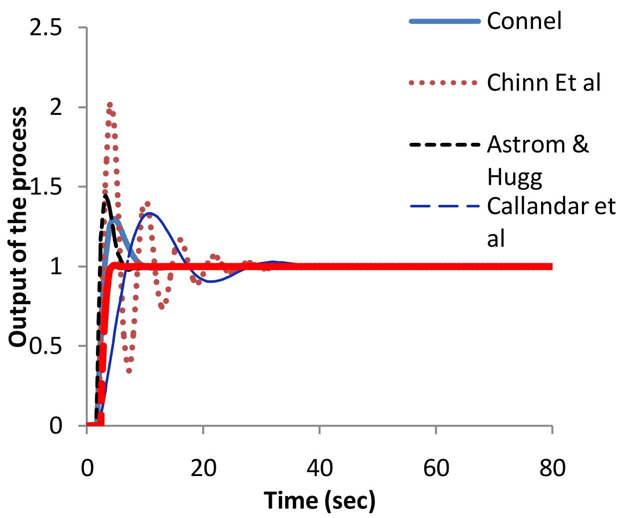

Fig 3. Comparison of Different controller for a stirred tank blending process

Controller	Rise Time	Settling Time	Peak Overshoot
Astrom & Hugg	3.7	18	0.29
Chinn et al	2.7	45	1
Connel et al	2.4	25	0.4
Callender et al	6.8	60	0.35
MPC	2	5	0

Table 6. Time domain specification for the blending process

Controller	IAE	ISE	ITAE	MSE
Astrom & Hugg	19.28	13.59	36.67	0.1346
Chinn et al	51.20	36.10	467.69	0.3575
Connel et al	16.91	18.92	19.384	0.1874
Callender et al	42.82	28.08	490.37	0.2761
MPC	23.91	20.08	23.96	0.1011

Table 7. Performance indices for the blending process

V. CONCLUSION

It is evident that from Table 1 & Table 2, MPC controller has better performance when compared to all other controller in terms of Time domain specification & Performance indices. Therefore MPC is the better chosen controller for the process. In future Neutral Network, ANFIS, Fuzzy Logic Controller is implemented for the process.

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BIOGRAPHIES

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