Tuning of PID controller using multiple dominant poleplacement technique for stable third order processes

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Abstract

The current study proposes PID controller tuning for stable Third Order plus Time Delay (TOPTD) and Third Order plus Time Delay with a Zero (TOPTDZ) systems. The Multiple Dominant Pole Placement (MDP) Method is used to build the PID Controller. The performance of the suggested Controller is evaluated utilising errors such as Integral Square Error (ISE), Integral Absolute Error (IAE), and Integral Time Absolute Error (ITAE) on linear models of TOPTD and TOPTDZ and non-linear models such as isothermal CSTR and bio-reactor (ITAE). Using Kharitonov's theorem, the performance under model uncertainty is also seen when one parameter is perturbed at a time. The proposed MDPPID controller is compared to controllers built using performance specifications such as Overshoot (Shamsuzzoha 2013), IMC technique (Zhi-cheng et al., 2010; Shamsuzzoha and Lee, 2007), and Direct Synthesis Method (DSM) for stable TOPTD/TOPTDZ systems (Chidambaram, 1998; Chen and Seborg, 2002; Seshagiri rao Chidambaram,2006) and for model uncertainty. The efficiency of the suggested technique is demonstrated by simulation results on a variety of case studies of stable TOPTD, TOPTDZ, and non-linear models, which indicate that the proposed MDP-PID controller outperforms the other methods.

For decades, the omnipresent PID controller has been the most frequently used process control method. Although sophisticated control approaches such as model predictive control can give substantial benefits, for the great majority of industrial control loops, a well-designed and tuned PID controller has shown to be sufficient. The vast literature on PID controllers covers a wide range of design and tuning techniques based on various performance criteria. 3-6 Ziegler and Nichols (ZN)7 and Cohen and Coon (CC)7 described two early and well-known design approaches. 8 Both techniques were created to offer a quarter decay ratio closed-loop response. Design relations based on integral error criteria9-11, as well as gain and phase margin formulas, are other well-known formulae for PI controller design. 12 PID controllers are commonly designed using a time-domain or frequency-domain performance criterion. The relationships between the closed-loop system's dynamic behaviour and these performance indices, on the other hand, are not straightforward. The controller design in the direct synthesis (DS) approach13-15, on the other hand, is based on a desired closed-loop transfer function. The controller is then analytically computed so that the closed-loop set-point response is identical to the desired response. The direct synthesis technique has the apparent benefit of including performance criteria directly through the design of the closed-loop transfer function. Choosing closed-loop poles is one approach to specify the closed-loop transfer function. It's based on a first-order plus time delay model with a significant time delay. The resultant controller is a timedelay compensated PI controller. 4 Furthermore, the well-known internal model control (IMC) design method1,18-20 is very similar to the DS technique and provides equivalent PID controllers for a wide range of situations. To synthesise PID controllers for higherorder systems, a model reduction method and IMC can be utilised. 21 A high-order controller may also be created and then reduced to PID form via a series expansion. 22 The required closed-loop transfer function for set-point changes is generally specified using DS design approaches. As a result, the DS controllers that result function well for set-point adjustments, but their disturbance response may be inadequate. For processes with a modest time-delay/time-constant ratio, the IMC-PID controller, for example, provides effective setpoint tracking but slow disturbance reactions. This innovative control method can outperform traditional IMC controllers in terms of dynamic performance, but the design process is more difficult and might result in unstable controllers. It's remarkable how little attention has been paid to the development of direct synthesis design approaches for disturbance rejection. The z transform of the desired closed-loop response to a given disturbance was specified in the early design approaches for sampled-data systems. 14 This method, however, is sensitive to the presumed disturbance and does not always result in a PID controller. Szita and Sanathanan have presented a more viable strategy. 24-26 They define the desired disturbance rejection properties in terms of a disturbance closed-loop transfer function. The resultant controller is seldom a PI or PID controller, and it might be of high order. The authors suggest utilising frequency domain error reduction to approximate a high-order controller with a low-order controller. The direct synthesis approach and disturbance rejection are used to develop analytical formulations for PI and PID controllers for typical process models in this work. The required closed-loop time constant, c, is the only design parameter in the proposed approach. The tradeoff between speed and robustness in defining c is examined. To enhance controller performance for setpoint changes without compromising the reaction to disturbances, a simple set-point weighting factor is utilised. The suggested design technique produces robust PID controllers that work well for both disturbance and set-point changes, as demonstrated by simulation results for nine instances.

Biography

Sowjanya have expertise in indentifying and solving the problem using new techniques. Her solving technique based on reducing the errors obtain by the parameters in PID Controller when compared with the other techniques her technique obtain better results. The technique is based on Multiple Dominant Ploeplacement where the Controller is tuned with a compensator. Their results are useful to all Chemical Industries because there is no Chemical Industry without a Controller. Her technique reduces the maintaining cost of the equipment and increases the purity of the product. Her approach is responsive to all Chemical Industries.

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