A MULTIPLE INTEGRATION TUNING METHOD FOR FILTERED PID CONTROLLER

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Abstract: The magnitude optimum (MO) technique provides non-oscillatory closed-loop response for a large class of process models. However, this technique is based on a transfer function model that requires precise process identification and extensive computations. In the present paper, it is shown that a close relation exists between multiple integrations of the process step response and the MO criterion. Due to this relation, the MO criterion can be more simply achieved by using filtered PID controller.

Keywords: PI controllers; PID controllers; step function responses; moment method; set-point control

1. INTRODUCTION

The Ziegler-Nichols tuning rules (Ziegler and Nichols, 1942) were the very first tuning rules for PID controllers, and it is perhaps surprising that they are still widely used today. Their popularity lies in their simplicity and efficiency.

Following the work of Ziegler and Nichols, a variety of PID tuning methods have been developed. In general, these methods can be divided into two main groups: *direct* and *indirect* tuning methods (Åström et al., 1993; Gorez, 1997).

The direct tuning methods do not require a process model, while the indirect methods calculate controller parameters from an identified model of the process.

One of the indirect tuning methods is the magnitude optimum (hereafter "MO") method (Kessler, 1955), which results in a relatively fast and non-oscillatory system closed-loop response. However, practical implementation of this method is comparatively difficult due to its quite demanding requirements, including the explicit identification of 12 process model parameters to calculate three parameters of the PID controller.

However, it was shown (Vrančić et al., 1996; 1999) that the MO settings can also be achieved by using the multiple (successive) integration method proposed by Strejc (1960). By combining these two very well- known tuning and identification methods, it is shown that the MO criterion can be met merely by measuring the process open-loop step response without the need for additional "fine" tuning, by using the PI and a "schoolbook" PID controller (with unfiltered derivative term).

The purpose of this paper is to show that the same principle can be applied also for the PID controller with filtered derivative term.

2. DERIVATION OF PID CONTROLLER PARAMETERS

One possible objective when designing a control system is that the system's output instantaneously follow the reference. In other words, the closed-loop system should have an infinite bandwidth and zero