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A PRACTICAL DECENTRALIZED PID AUTO-TUNING METHOD FOR TITO SYSTEMS UNDER CLOSED-LOOP CONTROL

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Abstract. *In this paper, a decentralized PID auto-tuning method for two-input two-output (TITO) processes is presented. By only two on-line closed-loop step tests, the equivalent process inputs and outputs are derived. Based on the information of equivalent inputs and outputs, four transfer functions of the sub-systems or two transfer functions of decentralized equivalent single-loop processes of second order plus dead time (SOPDT) models can be directly identified by a modified step identification method. Then the single loop tuning approaches can be applied to tune the decentralized controllers based on either relative gain array (RGA) detuning or independent design of ideal control loop approximation. Some typical processes have been employed to compare the two tuning procedures and illustrate the effectiveness of the proposed method.*
Keywords: TITO systems, Decentralized identification, Least squares, Decentralized control, Gain and phase margins, Detuning, Auto-tuning

1. **Introduction.** Most large and complex industrial processes are naturally multi-input multi-output (MIMO) systems. Compared with single-input single-output (SISO) counterparts, MIMO systems are more difficult to control due to the existence of interactions between input and output variables. Although considerable effort has been dedicated to this problem and many design techniques have been proposed over the years, MIMO control system design and implementation is still very difficult to deal with for control engineers due to the lack of systematic approach.

The interactive multivariable systems can be controlled by either 1) a multivariable or centralized MIMO controller or 2) a set of SISO decentralized controllers. Algebraic decoupling methods or optimal multivariable control theory are usually applied to obtain centralized MIMO controllers. In the first case, additional transfer function blocks are introduced between the single-loop controllers and the process to decouple each loop, such that techniques for single loop controller design can be applied. In the second case, the optimal control action is derived by minimizing a quadratic control cost function. While centralized multivariable controllers are complex and lack integrity, the decentralized control system enjoys certain advantages: 1) it requires fewer parameters to tune which are easier to be understood and implemented; and 2) loop failure tolerance of the resulting control system can be assured. Therefore, they are more often used in process control applications.