A COMPARISON OF EMPIRICAL CONTROLLER TUNING METHODS FOR THIRD ORDER INVERSE RESPONSE PROCESSES.

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Abstract

Until recently the two most commonly used empirical methods for choosing feedback controller tuning constants were the Cohen - Coon (CC) method (based on the open loop 'process reaction curve'), and the Ziegler - Nichols (ZN) method (based on ultimate response of the closed loop process). Both of these methods have substantial limitations: the CC method is unsuitable for processes which are open loop unstable, and the ZN method generally produces closed - loop responses which are not sufficiently damped, particularly for chemical engineering processes. Recently a new empirical method was developed by Tyreus and Luyben (1992). The method is also based on the ultimate response of the closed - loop system, however instead of being optimized in terms of simple performance criteria it aims to produce a closed - loop response which has a maximum log modulus of ± 2 dB. The objective of the current research was to compare these three empirical tuning methods on third order inverse response processes obtained as a result of competing first and second order processes in parallel. It was determined that the ZN method gave consistently better tuning constants than the other methods, based on both simple and integral performance criteria. The CC method suffered from the obvious inability for inverse response processes (particularly third order processes which may be oscillatory) to be approximated by a first order plus dead time response. The Tyreus - Luyben (TL) method did not achieve the stated objective of having a maximum closed - loop log modulus of ± 2 dB in any case studied: in fact the ZN method appeared to follow this criteria more closely for these processes. It appears a major drawback of the TL method is that the tuning equations meet the ± 2 dB criteria mainly for the processes the method was initially tested for, rather than in general. An improvement of the method would be to set equations for the integral and derivative time constants, and vary the controller gain in order to achieve the ± 2 dB criteria for each process: however this method would greatly increase the difficulty of tuning, especially in the process plant.

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