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Computers and Chemical Engineering 29 (2005) 1153–1154
Computers & Chemical Engineering
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Letter to the Editor

Dear Sir,

PID controllers and their variants are, by far, the most widely employed control algorithms in the manufacturing industries. Over six decades of research and development, numerous tuning relations have been developed for these controllers (Astrom & Hagglund, 1995; Padma Sree, Srinivas, & Chidambaram 2004). Among the most popular are those developed by Ziegler and Nichols (1942) and Cohen and Coon (1953). These two methods seek to achieve closed-loop oscillation with a quarter decay ratio in the amplitude of successive peaks in response to step changes in the set point or load. For many processes, such a transient response is too oscillatory. In addition, the actual response may be quite different from that desired. Abbas (1997) proposed controller-tuning expressions to overcome such disadvantages. These expressions relate the controller settings to the parameters of a first-order plus time delay (FOPTD) model of the plant as well as the desired overshoot of the closed-loop response to a step change in the setpoint. Alexander and Trahan (2001) compared the Abbas tuning method to an adaptive Smith Predictor strategy. They considered the robustness of each method for parametric and structural modeling errors. Two second-order plus time delay (SOPTD) plant transfer functions were used for the comparison. It is interesting to note that their results have shown that, for reasonably small modeling errors, the simple static tuning method of Abbas leads to comparable, and in some cases superior performance than the relatively complex adaptive Smith Predictor strategy. As is the case with any static tuning method, the Abbas method was found to be sensitive to large modeling errors in the time delay.

Recently, following a similar approach to that used by Abbas, Padma Sree et al. (2004) developed tuning relations for PI/PID controllers and FOPTD plants. The method seeks to provide a closed-loop response which is the same as the change in the setpoint (a step input) shifted by the unavoidable time delay. As expected, the obtained tuning relations, Eqs. (12)–(14), were found to lead to closed-loop responses, which were too oscillatory. New sets of controller-tuning relations were then obtained by using an additional tuning parameter, α, followed by simulation of the closed-loop behavior and curve fitting of the results. The authors stated that suitable values were used for the tuning parameter, α, without explaining what they considered as suitable values or good closed-loop behavior. The tuning equations relate the parameters of PI/PID controllers to the gain, k_p, and time delay to time constant ratio, ε, of stable and unstable. FOPTD plant transfers functions. Simulation examples were then used to compare the proposed method to other existing tuning rules.

Padma Sree et al. used a PI controller and the plant transfer function $e^{-s}/(s+1)$ to compare the proposed method, Eq. (35), with that of Abbas and the open-loop technique of Ziegler–Nichols. Based on an incorrect application of the Abbas method, they concluded that the proposed tuning rules give the best performance when compared to the other two techniques. Note that the Abbas equations relates the controller settings to the plant parameters k_p and ε, and the desired fractional overshoot of the closed-loop step response, V. It applies for the following parameters' ranges: $0.1 \le \varepsilon \le 5$ and $0 \le V \le 0.2$. Padma Sree et al. gave the following PI settings for the Abbas method without mentioning the value selected for the overshoot: $k_c = 0.4182$ and $\tau_1 = 1.5$. Note that the limiting overshoot values of 0 and 0.2 produce controller gains of 0.672 and 1.052, respectively. This means that the k_c value of 0.4182 used by the authors is outside the range of application of the Abbas method.

For a 10% overshoot, $V = 0.1$, the Abbas PI controller settings are $k_c = 0.884$ and $\tau_1 = 1.5$. Figs. 1 and 2 show the closed-loop unit-step responses corresponding to these settings, together with the responses of the other two techniques, for servo and regulatory problems, respectively. These two figures correspond to Figs. 15 and 16 of Padma Sree et al. Fig. 1 shows that the performance of the Abbas method is the best for a servo problem. For a regulatory problem, the Padma Sree–Srinivas–Chidambaram and Abbas methods yield comparable performances. Note that both of these two techniques were developed based on step changes in the set point. The ISE, IAE and ITAE value comparisons are given in Table 1. For a 20% increase in the time delay, the servo unit-step responses and the ISE values are shown in Fig. 3 and Table 2, respectively. The performance of the

0098-1354/$ – see front matter
doi:10.1016/j.compchemeng.2004.11.012

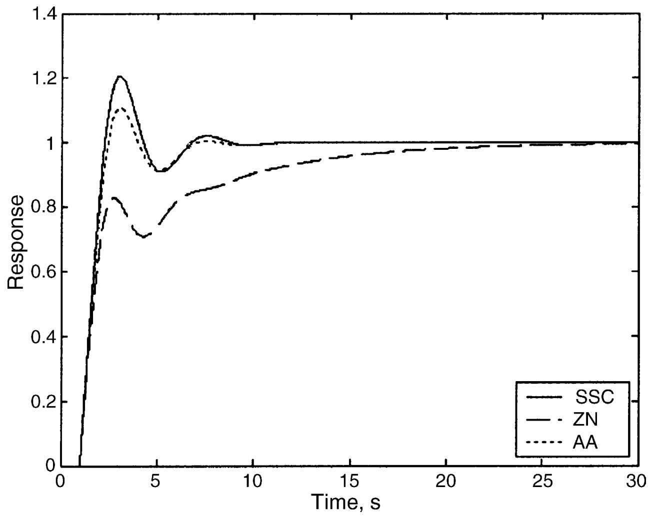

Fig. 1. Servo step response for nominal plant parameters. Padma Sree et al. (SSC), Ziegler–Nichols (ZN) and Abbas (AA).

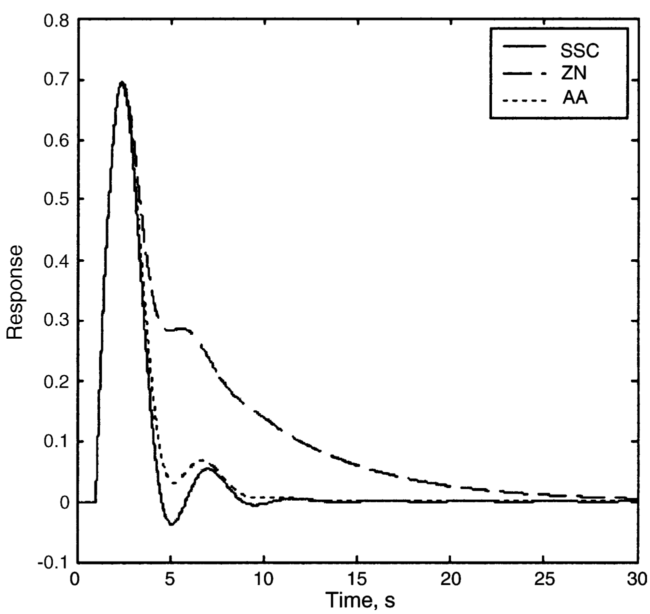

Fig. 2. Regulatory step response for nominal plant parameters.

Abbas method remains the best. Finally, it is to be stressed that the ability to specify the overshoot of the closed-loop response a priori is the main advantage of the Abbas tuning rules.

Table 1
Performances of the three considered methods: Padma Sree et al. (SSC), Abbas (AA) and Ziegler–Nichols (ZN)

Method	Servo problem			Regulatory problem		
	ISE	IAE	ITAE	ISE	IAE	ITAE
SSC	1.445	2.037	3.268	0.734	1.534	4.528
AA	1.437	1.926	2.778	0.777	1.696	5.422
ZN	1.779	3.672	17.943	1.229	3.676	25.049

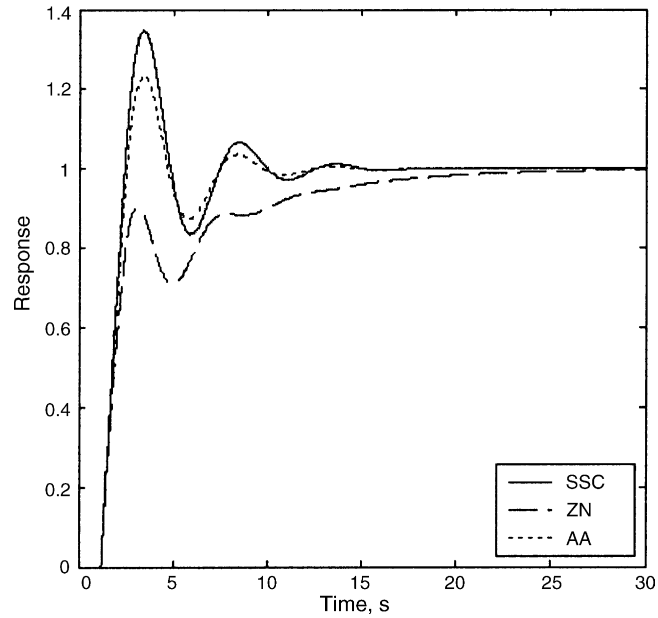

Fig. 3. Servo response for 20% error in the time delay.

Table 2
ISE values corresponding to 20% error in the time delay

Method	Servo problem			Regulatory problem		
	k_p	τ	L	k_p	τ	L
SSC	1.507	1.502	1.780	0.965	0.708	0.919
AA	1.435	1.495	1.700	0.984	0.755	0.928
ZN	1.588	1.826	1.928	1.427	1.211	1.319

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10 April 2004
Available online 1 February 2005