

SINTONIA USANDO MÉTODOS HEURÍSTICOS

TABELA I
MÉTODO DE SINTONIA DE COHEN E COON

controlador	k_c	τ_i	τ_d
P	$\frac{1}{K_P} \frac{\tau}{t_d} \left(1 + \frac{t_d}{3\tau} \right)$	-	-
PI	$\frac{1}{K_P} \frac{\tau}{t_d} \left(0.9 + \frac{t_d}{12\tau} \right)$	$t_d \frac{\left(30 + 3 \frac{t_d}{\tau} \right)}{\left(9 + 20 \frac{t_d}{\tau} \right)}$	-
PID	$\frac{1}{K_P} \frac{\tau}{t_d} \left(\frac{4}{3} + \frac{t_d}{4\tau} \right)$	$t_d \frac{\left(32 + 6 \frac{t_d}{\tau} \right)}{\left(13 + 8 \frac{t_d}{\tau} \right)}$	$t_d \frac{4}{\left(11 + 2 \frac{t_d}{\tau} \right)}$

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TABELA II
MÉTODO DE SINTONIA DE ZIEGLER E NICHOLS
(MALHA ABERTA)

controlador	k_c	τ_i	τ_d
P	$\frac{1}{K_p} \frac{\tau}{t_d}$	-	-
PI	$\frac{0.9}{K_p} \frac{\tau}{t_d}$	$3.33t_d$	-
PID	$\frac{12}{K_p} \frac{\tau}{t_d}$	$2t_d$	$\frac{t_d}{2}$

Limitação:
 $0,1 < T_{aud} / T_{aup} < 1,0$

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On-Line Tuning of PID Controllers

▪ *Ziegler-Nichols Test (1942)*

1. Set the controller gain K_c at a low value, perhaps 0.2.
2. Put the controller in the automatic mode.
3. Make a small change in the set point or load variable and observe the response. If the gain is low, then the response will be sluggish.
4. Increase the gain by a factor of two and make another set point or load change.
5. Repeat step 4 until the loop becomes oscillatory and continuous cycling is observed. The gain at which this occurs is the ultimate gain K_u , and the period of oscillation is the ultimate period P_u .

***MÉTODO DE SINTONIA DE ZIEGLER E NICHOLS
(MALHA FECHADA).***

controlador	k_c	τ_i	τ_d
P	$\frac{k_u}{2}$	-	-
PI	$\frac{k_u}{2.2}$	$\frac{P_u}{1.2}$	-
PID	$\frac{k_u}{1.7}$	$\frac{P_u}{2}$	$\frac{P_u}{8}$

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Tuning of PID Controllers

2. Tyreus-Luyben(1992): Recommended for time-constant

dominant processes ($D/\tau < 0.1$)

Tyreus-Luyben	K_c	τ_I	τ_D
PI	$K_u / 3.2$	$P_u / 0.45$	-
PID	$K_u / 2.2$	$P_u / 0.45$	$P_u / 6.3$

3. Ciancone-Marlin(1992): Recommended for dead-time

dominant processes ($D/\tau > 2.0$)

Ciancone-Marlin	K_c	τ_I	τ_D
PI	$K_u / 3.3$	$P_u / 4$	-
PID	$K_u / 3.3$	$P_u / 4.4$	$P_u / 8.1$

* "Series" form of PID

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Recommended Tuning Formulas

The following formulas are recommended by Luyben and Yu for tuning of PI controllers:

Table 4.4 Tuning rules for FOPDT processes with different D/τ ratios

Method	$D/\tau < 0.1$	$0.1 \leq D/\tau \leq 1$	$D/\tau > 1$
TL		ITAE	IMC
			$\lambda = \max(1.7D, 0.2\tau)$
$K_c = \frac{K_u}{3.2}$	$K_c = \frac{0.586}{K_p} \left(\frac{\tau}{D} \right)^{0.916}$		$\tau + \frac{D}{2}$
$\tau_I = 2.2P_u$	$\tau_I = \frac{\tau}{1.03 - 0.165 \left(\frac{D}{\tau} \right)}$		$K_c = \frac{\tau + \frac{D}{2}}{K_p \lambda}$
			$\tau_I = \tau + \frac{D}{2}$

