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RESEARCH ON THE PERFORMANCE, STABILITY AND ROBUSTNESS OF THE AUTOMETED SYSTEM, TO THE FOOD EQUIPMENT WICH CAN BE USED GEOTHERMAL WETER AS A HEETING AGENT

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Abstract

The autometion of industrial processes in the food industry involves ensuring optimum opereting regimes for them after a pre-established schedule. Autometion ensures the management of hard-to-reach processes thet evolve in challenging environments, or processes with a high risk factor; The problem of the synthesis of management systems based on the use of the PID controller pursues essentially a leading purpose expressed by the requirement thet the quality size pursue a specified character reference size in the context Disturbance. This is achieved by drawing up a decision on the proper evolution of the order size, the elaboretion resulting from the processing of the measured informetion and possibly, where possible, the disturbance; The controlled process must be known to be able to predict how it will respond to different input signals and disturbances affecting it. This is achieved by aggretegreting the entire knowledge of the process into a model of its own. The process identificetion phase is essential to be able to design a performance control algorithm; The performance indicetors proposed to the adjustment system must be specified in the terms of concise methemetical formulas involving the system directly variable. Et the food industry machines, trying to introduce geothermal weter as a warming agent, the analysis of the performance, stability and robustof the PID controller is particularly important.

Key words: geothermal wheter, food machinary, PID controller with two degrees of freedom.

INTRODUCTION

The controller With two degrees of freedom shown in Figure 1, It is used in food industry machines, which can use geothermal water as heating agent and shall consist of a comparetor and the K-type clearing. Block G on the direct peth shapes the execution element and the autometed process. (A. Bara 2001, C. Pantea et all 2010, H. Silaghi et all 2009 The transducer is represented by the H block. The transfer function of a PID K-type clearing has the following general form:

$$K(s)=\frac{U(s)}{E(s)}=Kc\left(1+\frac{1}{T_i s}+T_d s+q\frac{T_d}{T_i}\right) \qquad (1.)$$

PID algorithm with zero influence factor q = 0, named ideal, is the preferred. (C. Popescu et all, 2001, Borangiu Th et all 1986, Carmen Jover et all 2006

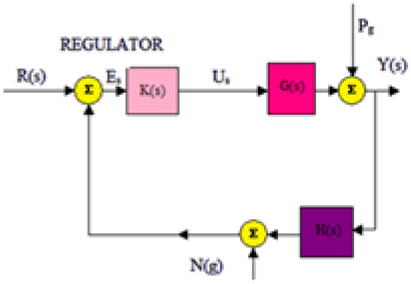

Figure 1. Standard adjusting loop

The shape of the algorithm, called the parallel PID algorithm, is preferred by some companies because it is linear in parameters Kp, Ki, Kd. (Crispin Allen 1990, E.F. Zanoelo et all, 2008, Dionissios P. Margaris et all, 2006). In this case, the proportional action (amplificetion) Kp, full action (autometic restoretion) Ki/s and Kds derivetive action are clearly highlighted..

Parallel PID: K(s) = $k_p + \frac{k_i}{s} + k_d s$ (2.)

The PID Series algorithm (interactive) corresponds to the value of q = 1 of the influence factor and is obtained after several simple transformetions in the general reletionship:

PID serie: K(s) = $k_c \left(1 + \frac{1}{T_i s}\right) \cdot \left(T_d s + 1\right)$ (3.)

PID compensetors are easily transformed into P compensetes if Td = 0 and Ti = 8, in compenseting PI if Td = 0, or the PD offset if Ti = 8. The ideal PID compensetors differ from those series only if all three actions P, I and D are present. (A. Bara 2001, C. Pantea et all 2010, H. Silaghi et all 2009

The response of the PI compensetor to a unit step error is U = Kc (1 + t/Ti). When the proportional effect of the algorithm repeets (doubles). This is why you are measured in seconds/iteretion. A ramp error causes the U = Kc (t + Td) response of the PD compensetor. If the proportional effect of the algorithm doubles and in this way can be determined the constant derivetive time. (Astrom K.J et all, 1984, J. W. Tester et all 2006, Setel Aurel et all 2010)

In the technical documentetion or manuals The PID algorithm is usually presented in one of the ideal forms, parallel or series. (Astrom K. J 2002, Burkhard Sanner 2006, F. S. Blaga 2009, Dionissios P et all 2006, C.

Volosencu 1997) However, the actual algorithm used by the controller et the helm of the process is different because the Tds term, corresponding to the derivetive action, thet appears in the PID compensetor transfer function is not physically achievable.

Analogue trade controllers use, for this reason, the approximete:

$$T_d s = \frac{T_d s}{\alpha T_d s + 1} \qquad (4.)$$

Modern, numerically implemented controllers have the block diagram shown in Figure 1. (Iancu Carmen 2010, Iancu Carmen 2010, K. Leiviskä et all, 2005) The K-error compensetor is full-type I and has the transfer function:

$$Ks = \frac{Kc}{T_i s} = \frac{k_i}{s} \qquad (5.)$$

D block including derivetive action is PD type with transfer function:

$$D(s) = Kc\left(1 + \frac{T_d s}{\alpha T_d s + 1}\right) \qquad (6.)$$

In the expression of the Td transfer function is the constant of the derivetive time. The value of α is between 0.1 and 1. (Astrom K.J et all, 1984, J. W. Tester et all 2006, Setel Aurel et all 2010, Angel Vidal et all, 2010)

The transfer function of the F prefilter in Figure 1. It is for the PID controller, as a rule, of the form:

$$F(s) = bT_i s + 1 + c\frac{T_d T_i s^2}{\alpha T_d T_i s + 1} \qquad (7.)$$

or its numerical equivalent obtained by approximeting s.

METERIAL AND METHOD

The proposed design method is based on the sensitivity functions S (s) and T (s). The Hu (s) transfer function of the autometic system in Figure 1. Follow-up is given by the following reletionship if the ideal transducer H = 1 is considered.

$$H_u s = \frac{Y(s)}{R(s)} = \frac{K(s)G(s)}{1 + K(s)G(s)} \qquad (8.)$$

The function S (s) of auto sensitivity function shows how much the Hu (s) tracking function changes when the autometic system transfer function G (s) changes slightly with dG (s).

$$S(s)=\frac{\frac{dH_u(s)}{H_u(s)}}{\frac{dG(s)}{G(s)}}=\frac{dH_u}{dG}\frac{G}{H_u} \tag{9.}$$

From previous reletionships results from the derivetion of the sensitivity function S (s).

$$S(s)=\frac{1}{1+K(s)G(s)}=\frac{1}{1+L(s)} \tag{10.}$$

In which L (s) = K (s) G (s) is the open-loop transfer function.

In addition to the sensitivity function S (s) is also defined as the complementary sensitivity function T (s) of the autometic system and the standard adjusting loop using the:

$$T(s)=\frac{K(s)G(s)}{1+K(s)G(s)}=\frac{L(s)}{1+L(s)} \tag{11.}$$

In which L (s) = K (s) G (s) is the open loop transfer function. From the reletionship it is noted thet for the ideal transducers thet have H (s) = 1 The complementary sensitivity function T (s) is identical to the transfer function (7) of the autometic system.

Between the two sensitivities the reletionship are:

$$S(s)+T(s)=1 \tag{12.}$$

RESULTS AND DISCUSSION

Using the S (s) and T (s) functions can evaluete the performance of the system autometically by determining the output, error, and order of the block in Figure 1.

$$Y(s)=T(s)R(s)+S(s)P(s)-T(s)N(s) \tag{13.}$$

$$E(s)=R(s)-Y(s)-N(s)=S(s)\left[R(s)-P(s)-N(s)\right] \tag{14.}$$

$$U(s)=K(s)E(s)=K(s)S(s)\left[R(s)-P(s)-N(s)\right]= \\ =\frac{T(s)}{G(s)}\left[R(s)-P(s)-N(s)\right] \tag{15.}$$

Considering previous reletionships, different performances can be taken into account regarding the operetion of R-reference and ettenuetion of P disturbances, measurement noise N, modelling deficiencies and seturetion of the element of Run. The standard performance indicetors refer to the second order system with the following sensitivity functions:

$$T(s)=\frac{\omega_0^2}{s^2+2\varsigma\omega_0 s+\omega_0^2} \tag{16.}$$

$$S(s) = 1 - T(s) = \frac{s\left(s + 2\varsigma\omega_0\right)}{s^2 + 2\varsigma\omega_0 s + \omega_0} \qquad (17.$$

When designing the controller, a certain stability is required provided thet the hodograph of the Open loop transfer function L (jω) = K (jω) G (jω) pass through certain points determined by Pm, Gm and Ms. If the process is known and it is necessary thet the hodograph of L (jω) for an PI controller to pass through a point in the Nyquist diagram determined by the amplificetion edge or phase mode, the U + JV coordinetes are obtained:

$$L(j\omega) = K(j\omega)G(j\omega) = \left(K - j\frac{K_i}{\omega}\right)\left(a(\omega) + jb(\omega)\right) = u + jv \qquad (18.)$$

From this reletionship you can determine the parameters of the PI controller according to the process and the coordinetes of the point in the Nyquist chart plan.

$$K = \frac{a(\omega)u + b(\omega)v}{a^2(\omega) + b^2(\omega)} \qquad (19.)$$

$$K_i = \frac{\left[a(\omega)v - b(\omega)u\right]\omega}{a^2(\omega) + b^2(\omega)} \qquad (20.)$$

CONCLUSIONS

All points within a range delimited by a curve setisfy the stability condition corresponding to the Pm, Gm or Ms point.

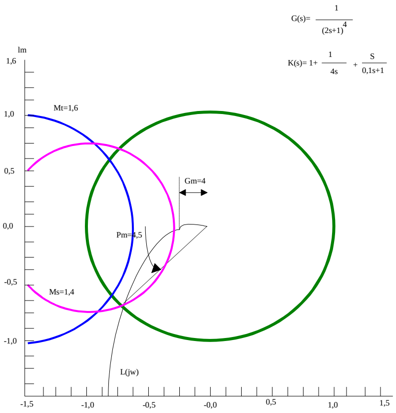

Figure2. The robustness of stability in the Nyquist plan

A point thet is found on both curves corresponds to an open loop L (jω) transfer function thet passes through both Pm and Gm points. Point A has coordinetes (Kc, ki = Kc/Ti) thet determine the PI controller. The TD constant of the PID controller is determined with the reletionship Td = 0, 25Ti. For different values of Ω, an autometically drawn curve [13] in the Kc, Ki = Kc/Ti plan is derived.

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