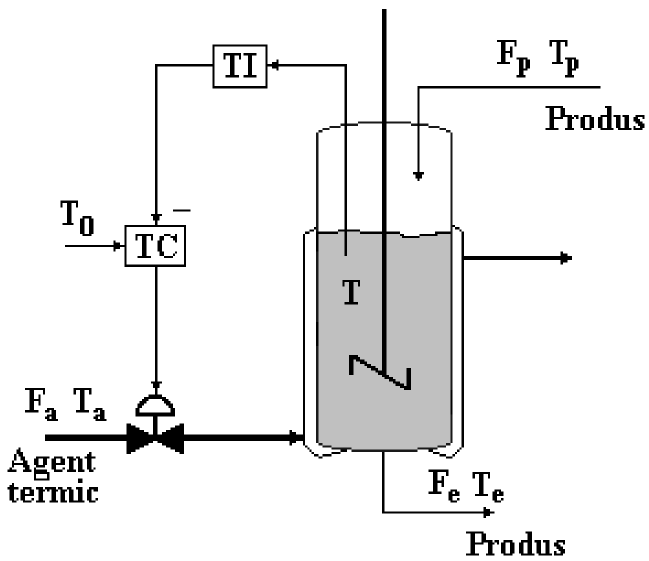
ROBUST PROCESS CONTROL FOR A SYSTEMS WITH TEMPERATURE CONTROL IN A TANK

1. Introduction

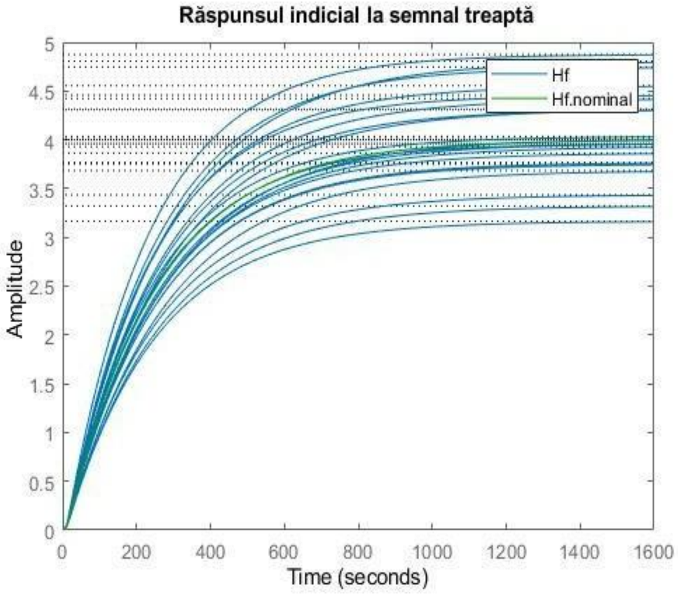
Temperature control refers to the processes that aim to maintain the temperature in a given area at a certain level, maximum/minimum or within a certain range.

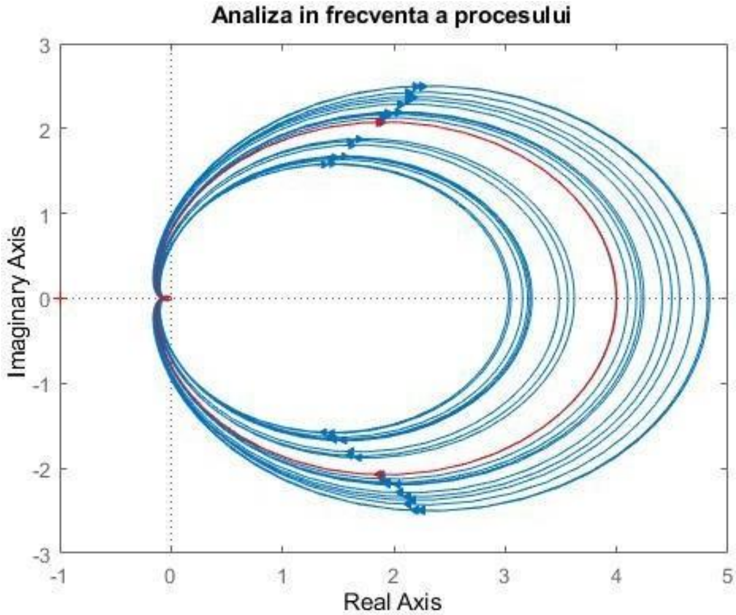
Temperature regulation systems are implemented in fault regulation structures, but in most cases in cascade or disturbance regulation structures. The figure below (Fig.1) shows the temperature control scheme in a reactor. If the temperature T in the reactor decreases compared to the reference value T0, the temperature controller TC commands the opening of the valve for regulating the flow of the heat agent, so Fa increases (the temperature Ta of the heat agent being higher than the reference T0).



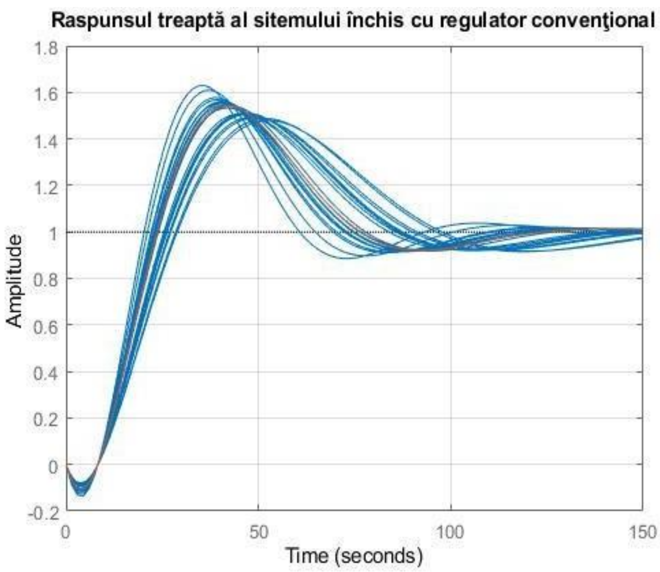
Previously, the first-order transfer function was derived for a process with temperature regulation, namely: $Hp(s)=kp/Tp(s)+1$

Using the Matlab environment this process to which the dead time is added (implemented with the help of the pade function), and follows an approach that concerns systems with uncertainties. For these systems, the modeling errors are given by the differences between the actual plant and the nominal model. With the help of the ureal function in the Matlab Toolbox, Robust Control, it is possible to create uncertain elements or physical parameters whose value is not known exactly. This function taken in the form below creates an uncertain real parameter, where the uncertainty, the deviation from the nominal value, is described as the percentage of the deviation from the nominal value. The image below (Fig.3) represents the step input signal response of the fixed part transfer function and its nominal for the process with dead time and affected by uncertainties, developed applicatively in the paper. For these, a frequency analysis of the process is also built using the Nyquist diagram.

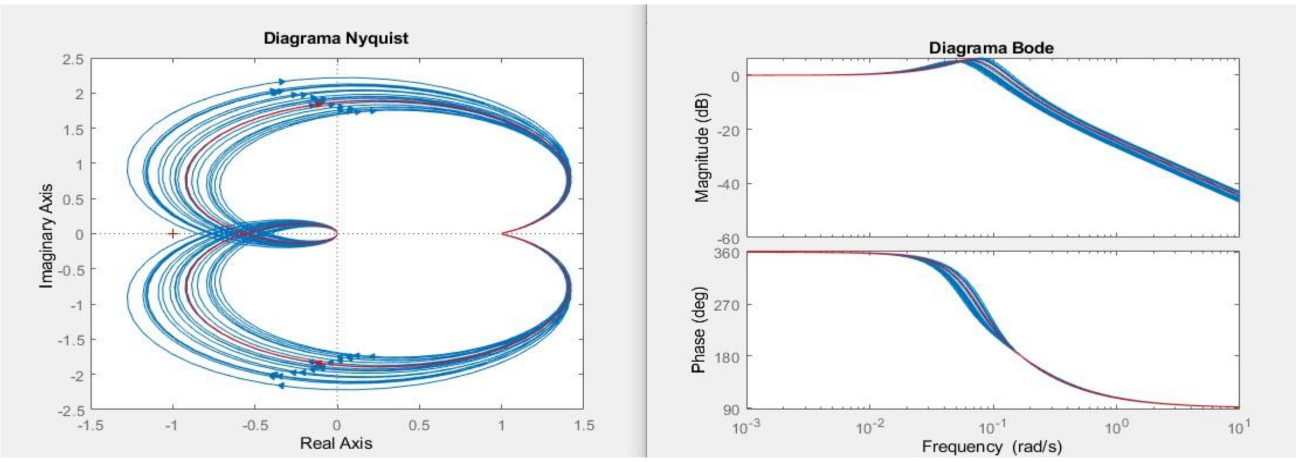




The choice and tuning of the regulator with a conventional proportional-integrative (PI) type regulator is thus done by the Kapelovici method that establishes the optimal tuning parameters that ensure an aperiodic transient response with minimal duration, respectively a response with a maximum overshoot of 20%.

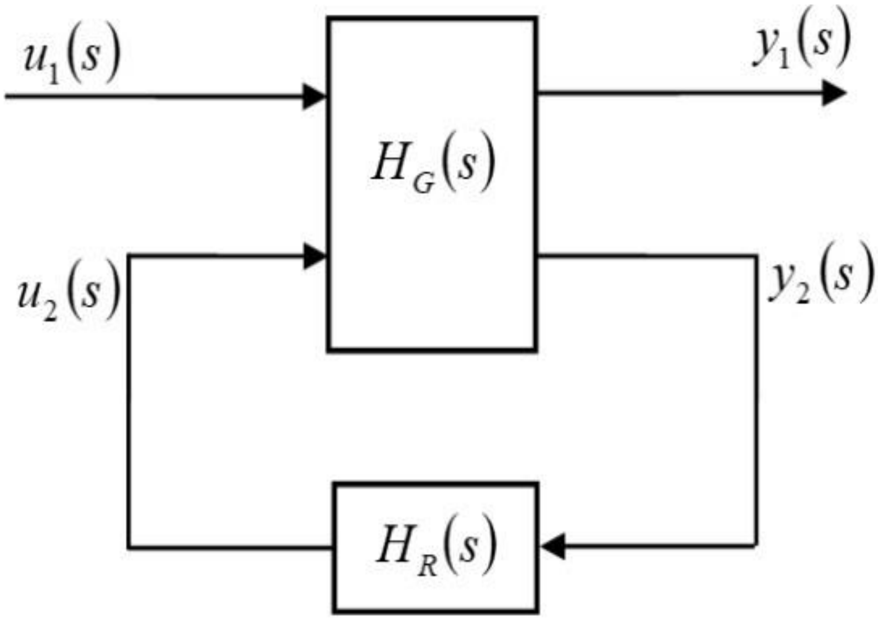


To assess the stability and performance of the system with uncertainties using a conventional (fixed) regulator, it is considered to plot the amplitude-phase and pulsation amplitude characteristics, respectively the creation of the Nyquist and Bode diagrams.



2. Designing a regulator using certain robust synthesis methods

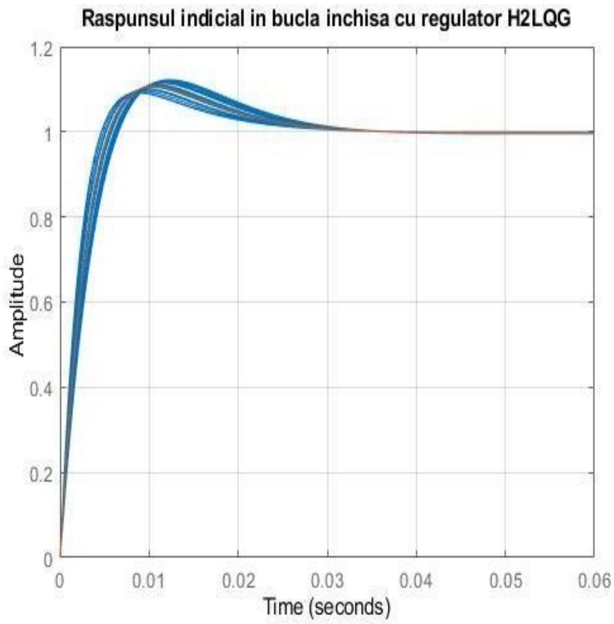
In the practice of robust design, the aim is to build a controller that issues a command $u2(s)$ = $HR(s)$ + $y2(s)$ for which the system is stable in the presence of uncertainties, disturbances and which provides certain robustness performances.

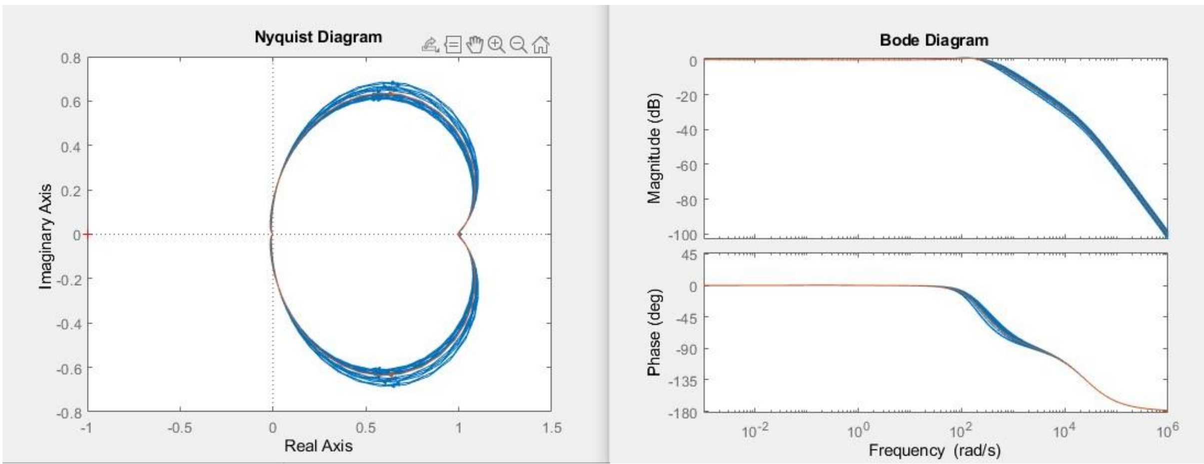


The standard design by the H2 method involves finding an HR regulator, for the augmented HG system, so as to minimize the 2nd norm of the fractional linear transformation H2.

$$\left\|T_{y1u1}(s)\right\|_2 = \left\|H_{11}(s)+H_{12}(s)H_R(s)[I-H_{22}(s)H_R(s)]^{-1}H_{21}(s)\right\|_2 < 1.$$

The controller by the H2 method is implemented in Matlab by using the function h2lqg applied to the augmented HG system which is calculated again based on the weights and the transfer function of the process with dead time.





3. Analysis of the possibilities to reduce the order of the robust regulator

One of the problems with designing using robust regulators is that the order of the controller becomes high. This causes the regulator to have a higher cost, low reliability and maintenance problems [3]. As a solution to this problem, certain techniques have been developed to obtain low-order regulators from high-order regulators. In the Matlab environment, the syntax [HRred,INFO]=reduce(HR,r) is used like this; with the help of which the reduced-order regulator HRred, of order r>n, obtained from the initial regulator HR of order n is determined.