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Parametric Methods in Analysis and Synthesis of Controlled Time Delay System- – Circulating Reservoir for Mixing Liquids

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***Abstract**: Synthesis of time delay systems in parametric plane is based on the D-decomposition method, developed from Neimark [8]. In this case this method has a lot of specifics regarding to the eneeds of extraction the region in parametric plane which ensures the system having predefined damping factor [1], [2].This paper presents and investigates the further expansion of last obtained results and develops the methods for synthesis and analysis of closed-loop system with proportional regulator for circulating reservoir for mixing liquids. Now it would be possible to separate the region in three-dimensional space(undamped frequency ω_n (Hz), loop gain (K=1/α) and time delay constant (τ)) which adjustable parameters guarantee damping factor of controlled system will have a priori defined value .*

***Keywords** : time delay system , relative stability , parametric plane, damping factor, circulating reservoir for mixing liquids*

I. INTRODUCTION

The first methods for testing stability of time delay system in the parametric plane, came from a Russian scientist Neimark [7],[8]. According to the works of Chu [3] root-locus technique was employed to determine the critical open-loop gain of the closed loop system for the fixed time delay. The root-locus method is generally consider to one adjustable parameter, such as the open-loop gain. The main part of Siljak [9], [10] contributed the full generalization of all outstanding issues, which was successfully solved in the class of time delay systems with lumped parameters. Eisenberg [4] was able to predict the relative stability ($\xi \neq$ const) of a system in which loop gain and some system time constants were considered as two free parameters for a fixed time delay. The establishment of a region that provides pre-settling time for the time delay systems and non linear combination of adjustable parameters, including pure time delay , was considered and solved by Loo [5]. The application Mitrovic`s method in the analysis and synthesis of feedback control systems with delays is given by Mikic [6]. The method for extracting the region in the parameter plane, which enables closed- loop system will have pre-defined damping factor was also particularly developed and explained [1], [2] and this paper will continue extend last mentioned results and their application.
The basis of mathematical equations and rules for shading parametric curves remain the same as in the case of-system without delay.We will discuss the case of closed-loop system with a single delay, when the adjustable parameters are non-linearly related to polynomial coefficients of quasicharacteristic equation [8] .

$$W_{ok} = \frac{N(s)}{\alpha D(s)} e^{-\tau s} \tag{1}$$

so that quasicharacteristic equation has the following form:

$$f(s, e^{-\tau s}) = \alpha D(s) + N(s) e^{-\tau s} = 0 \tag{2}$$

where K = 1/α is proportional regulator gain, so α is a regulator parameter linearly related to polynomial coefficients of quasicharacteristic polynomial. Pure time delay is τ, which in the case of circulating reservoir for mixing liquids (Fig.1) introduced into the control parts of the object, through valves and pipes to reservoir, as described in the definition of a mathematical model of this system [1].This system belongs to the class of time delay system, where the adjustable time for transport delay of liquids are existed.

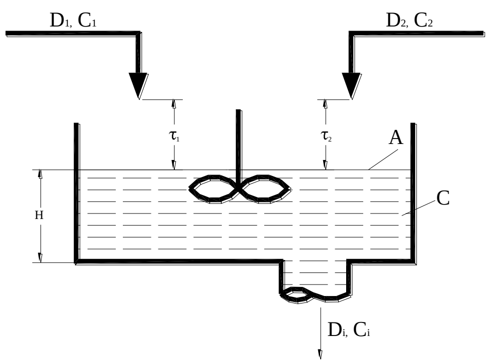

Fig.1.Functional sheme of circulating reservoir gor mixing liquids