

## Design of PI Controllers for the Hydraulic Control System with a Long Transmission Line

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**Abstract** – This paper presents design of a PI controller for the system of a pump-controlled motor with a long transmission line. The D-decomposition method including system performances, damping and settling time was applied. The system performances are included in a new manner without the need for calculation of Chebyshev functions for every change of the damping coefficient thanks to strong software support.

**Key words:** PI controller, control system, long transmission line, root locus, transfer function

### I. INTRODUCTION

Increasingly strict and wide requirements regarding displacement hydrostatic power transmitters have recently appeared in the sense of simultaneous accomplishment of high power exploitation degrees, high speed of response with the reduction of price [1-4]. This particularly refers to high power systems and systems with variable load (building and mining machines, agricultural machines, transportation machines, machine tools, etc). It is obvious that these requirements result in the need for more intense development of systems with displacement control in relation to the systems with damping control. It is obvious that these requirements result in the need for more intense development of systems with displacement control in relation to the systems with damping control. One of the main preconditions for quality and reliable operation of a high power system is the stable and quality operation of the system for automatic control of hydrostatic power transmitter, the pump-controlled motor with long transmission lines (Figure 1). The existence of a long transmission line in this system makes its dynamics rather complex because the physical values, pressure and flow, which characterize the transfer of energy along the long transmission line depend both on the time coordinate and the space coordinate. Dependence of these physical values on the space coordinate, too, conditions that in the mathematical description of the long transmission line the space distribution cannot be neglected, so that it is described by a model with distributed parameters. Models with distributed parameters are described by partial differential equations and the model obtained is of an infinitesimally high order [5-9]. In addition to mathematical

modeling of the long transmission line by means of the model with distributed parameters, it is possible to describe the long transmission line by common differential equations, i.e. models with lumped parameters [1-4] because solving common differential equations makes considerably fewer difficulties in comparison with solving partial differential equations. The authors of this paper considered the problem of modelling and dynamic behaviour of such systems in a very systematic way, and the results are presented in several papers, the most significant of which are [4], [10] and [12]. Reference [10] gives a complete mathematical model of the system of a pump-controlled motor with a long transmission line by means of a model with lumped parameters where the long transmission line is divided into  $n$  equal "IT" segments. The mathematical model thus obtained is of high order but by applying the appropriate methodology its order is reduced, which considerably increases its use value. From the aspect of control, reference [10] presents design of a P controller by applying the Nyquist criterion, including system performances, damping and settling time. The P controller designed in this way, for the described system, eliminates the occurrence of oscillations of the transfer characteristic due to the existence of the long transmission line. However, design of the P controller could not eliminate the error, so that a PI controller was designed in order to solve that problem.

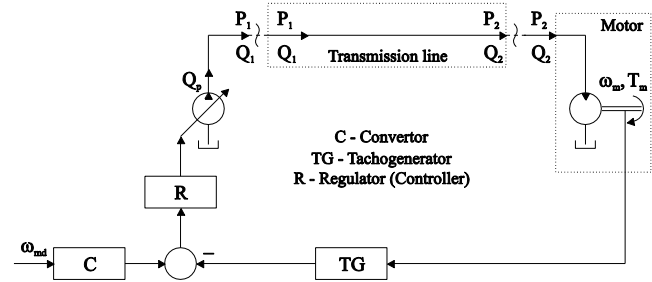


Fig. 1. Symbolic diagram of the closed automatic control system of a pump-controlled motor with a long transmission line





