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Effects of the Variation of Torque Motor Parameters on Servovalve Performance

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An electrohydraulic servovalve is an essential item of fluid power servomechanism where fast response, high power output and working fidelity are necessary. Based on detailed and experimentally verified mathematical model of two-stage spool position mechanical feedback electrohydraulic servovalves sensitivity analysis has been performed. The effects of variation of few torque motor electromagnetic parameters (air-gap length (thickness) at null, residual magnetic flux density (magnetic inductivity) of permanent magnet and number of turns of each coil) on dynamic performance of B.31.210.12.1000.U2V PPT servovalve have been studied. Obtained results are in accordance with servovalve engineering design practice.

Keywords: electrohidraulics, servovalves, torque motors, sensitivity analysis

0 INTRODUCTION

Two-stage spool position feedback electrohydraulic servovalves with the torque motor as an electromechanical converter and a flapper-nozzle valve as the first stage of hydraulic amplification are the most utilised servovalves in electrohydraulic control systems for the last forty years. In spite of their relatively long period of application, all phenomena associated with their operation are not completely quantitatively and qualitatively explained. This is due to facts that a relatively complex mathematical apparatus, coming from fundamental laws of electromagnetism, fluid mechanics and general mechanics, is needed for describing their operation. Beside, these mathematical expressions include many parameters that are very difficult to precisely quantify.

In this paper authors study the influence of torque motor electromagnetic parameters on servovalve behaviour. Many authors gave contributions to the explanation of electromagnetic nature of servovalve torque motors. Still Merritt [1] explained in detail the effects of some non-linearities on the servovalve behaviour including torque motor non-linearities (magnetic hysteresis and saturation). In the paper [2], Arafa and Rizk made a special review on torque caused by electromagnetic forces. A non-linear mathematical model based on physical quantities was developed in [3]. This model includes non-linear relations for the torque motor dynamics. From the experimental data and FEA analysis performed in [4], Fussell et al. state that magnetic flux leakage must be considered in the lumped model for torque predictions. In [5] and [6], Urata analysed the torque motor dynamics in detail and influence of unequal air-gap length thickness in null in servo valve torque motors.

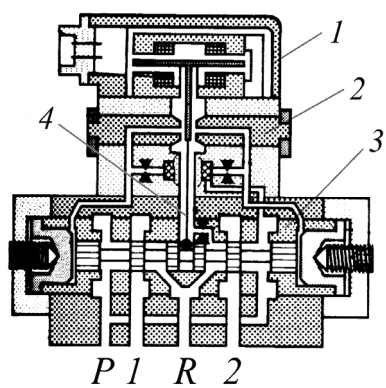

Fig. 1. *Two-stage spool position feedback electrohydraulic servovalve (mechanical feedback) 1 – torque motor, 2 – first stage, 3 – second stage, 4 – feedback spring*

1 THEORETICAL MODEL

Detailed theoretical model should be used in order to investigate the influence of torque motor electro-magnetic parameters on servovalve behaviour. It should include all physical phenomena and torque motor parameters that are

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