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Spool valve leakage behaviour

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A four-way axial spool servovalve has such a design that flows through its restrictions can be presented by means of a hydraulic bridge. The characteristics analytically describe the fluid flow through spool orifices in the most of working regimes. The exceptions are regimes around the null characterised by an overlap existence when internal leakages dominate. Several mathematical models for the calculation of the internal leakage flows are presented in this paper including theoretical model worked out by authors. Modelling results are compared with appropriate experimental.

Keywords: *spool valve, leakage*

1. Introduction

Theoretical, ideal stationary characteristics of spool control valves that include the following assumptions: no volumetric losses, equal and symmetrical spool orifices, turbulent flow regime through the spool orifices, equal zero lap conditions on all spool orifices are presented in detail in standard literature [1–2]. Mentioned mathematical expressions describe the characteristics of working fluid flow through axial spool valve orifices in the most of working regimes. The exceptions are the working regimes characterised by the existence of overlap where fluid flows between the spool and bushing (valve body) significantly affect the valve behaviour. In these regimes the mentioned characteristics does not precisely describe the flow of working fluid through the spool valve orifices. Therefore, models of the valve for the regimes should include additional terms for the flow of internal leakage. This internal leakage flow is one of the key parameters in designing the precise positioning of the hydraulic actuator. Due to the internal leakage, pressure difference on hydraulic load exists, which affects the behaviour of the system in several ways: crawling of a loaded actuator in open loop systems, position error of a P-controlled loaded actuator and increase of the system damping [2].

2. Mathematical models of internal leakage flow

Following equations:

$$Q_{L1} = Q_{t1} - Q_{t4} + Q_{l1} - Q_{l4}, \qquad (1)$$