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AIMS AND SCOPE

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HYDRAULIC BRIDGE FOR PRESSURE CONTROL IN A P-Q MULTIPLE LINE SEGMENT CONTROL VALVE

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Abstract

The conventional device for flow rate and pressure multiple control is a combination of a flow rate valve and a pressure relief valve. For the pressure control, a hydraulic bridge can also be used instead of using a pressure relief valve. In this paper, a special hydraulic bridge was developed to undertake pressure control in a pressure compensated flow rate valve and thus a new type of P-Q control valve is constructed. The pressure control in this P-Q control valve is a hydraulic bridge formed by the serial connection between a metering orifice and a drain orifice. The contour of the valve port has a significant effect on the linearity of the output pressure. Theoretical analysis shows that the linear pressure output characteristic corresponds to a valve port contour of a hyperbolic. Due to the difficult machining of this hyperbolic contour, a multiple line with two segment lines is used to approximate the valve port contour for linear pressure output. The pressure bridge is constructed in a 2D P-Q control valve and an experimental investigation is carried out. It is demonstrated that linearity of the output pressure is greatly improved by using the multiple segment line contour of the valve port and it is demonstrated that the output pressure is not sensitive to the variation of the temperature. With the introduction of the pressure control bridge, the P-Q valve is indeed greatly simplified.

Keywords: flow rate and pressure multiple control, pressure compensated flow valve, contour of valve port, linearity

NUMERICAL OPTIMISATION OF A DISTRIBUTOR VALVE

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Abstract

In this paper a non-linear optimisation method is used to improve the design of a distributor valve. The distributor valve is an important component in a radial piston hydraulic motor, and optimisation of the design to minimize power losses is an interesting way to increase efficiency. The main function of a distributor valve is to supply the pistons with a pressurized flow and to return oil during rotation. At the same time the distributor valve acts as an externally pressurized lubricated thrust bearing, in order to separate the rotating parts from the motor case. The bearing acts as a hydrostatic annular multi-recess plane thrust bearing, with different recess pressures. The separating force of the bearing is balanced hydrostatically by the pressure that is applied and springs. Losses will occur in the contact between the parts in the distributor valve, due to friction and leakage.

This paper shows that modern optimisation methods can be used as an effective tool to create new designs and to modify the existing design of the bearing surface geometry of the distributor. A finite element method has been used to simulate the contact, and the program is linked to an optimisation routine to perform the optimisation. The results of the optimized design show a significant decrease in power loss, compared to the existing design in the operating range.

Keywords: radial piston hydraulic motor, simulations, optimisation, power loss

VISCOUS DAMPING COEFFICIENT AND EFFECTIVE BULK MODULUS ESTIMATION IN A HIGH PERFORMANCE HYDROSTATIC ACTUATION SYSTEM USING EXTENDED KALMAN FILTER

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Abstract

Increasing demands on reliability and safety of fluid power devices have brought much attention to methods for improving condition monitoring of these devices. Whereas faults in hydraulic systems were detected only when limit values of measurable output signals were transgressed, recently, attempts have been made to detect them earlier and to locate them better by the use of measurable signals. The Extended Kalman Filter can be used for real-time estimation of parameters in system models. Changes in model parameters may be tracked and, in turn, be used for determining the condition of the system. In this paper, the Extended Kalman Filter (EKF) is applied to a novel hydrostatic actuation system referred to as the Electrohydraulic Actuator (EHA). A state space model of the EHA is developed and the Extended Kalman Filter is used to estimate unmeasurable but critical parameters such as viscous damping coefficient of the actuator and the effective bulk modulus of the system. The proof of concept of applying the EKF for parameter and state is demonstrated through both simulation and experimental evidence. Changes in the viscous damping coefficient at the actuator at a known temperature may be good indication that the fluid is degrading or that the dynamic seal of the actuator is experiencing wear. The effective bulk modulus has a large impact on the system response, affecting the natural frequency and stability and can have implications on the safety of operation. These two parameters cannot be measured directly and hence need to be estimated. Based on this estimation, corrective actions may be taken in safety critical applications for the EHA such as Flight Surface Actuation.

Keywords: electrohydraulic actuation, extended kalman filter, viscous damping coefficient, effective bulk modulus

DEVELOPMENT OF ACCURATE AND PRACTICAL SIMULATION TECHNIQUE BASED ON THE MODAL APPROXIMATIONS FOR FLUID TRANSIENTS IN COMPOUND FLUID-LINE SYSTEMS (2nd Report: Enhancement of analytical functions for generalization) (1st Report: Vol.3 No.2)

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Abstract

In the previous paper, the authors proposed a new simulation technique called the "system modal approximation" method (SMA method) for fluid transients in compound fluid-line systems. This technique was able to predict the behaviour fast and accurately, and its superiority to other existing methods was verified by simulation and experimental analysis. However, detailed considerations were limited to the cases whose transfer functions of output/input could be approximated by the second order modes alone. This paper enhances the analytical functions of the SMA method so as to be widely applicable to compound fluid-line systems with various kinds of system compositions and boundary conditions. Specifically, the calculation methods of time response of the required output variable at any points are newly proposed for case (A) whose transfer functions of output/input have to be approximated by the first order modes and derivative element besides second order modes, and (B) whose boundary conditions are given by the relation between pressure and flow-rate. Fluid transients in three kinds of compound fluid-line systems under the several different boundary conditions including the occurrence of column separation are considered. Simulation results based on the methods mentioned above are compared with both the solutions from the method of characteristics and experimental results, and then the usefulness of the generalized SMA method is verified.

Keywords: fluid transients, water hammer, modal approximation, compound fluid-line system, simulation

IMPROVING GAS DYNAMIC MODELS FOR PNEUMATIC SYSTEMS

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Abstract

The present paper deals with the improvement to modelling of pneumatic systems. The thermal air process inside the pneumatic chambers is modelled without using the polytrophic exponent to relate the pressure-density relationship. The model takes into account the real gases behaviour and the thermal constant time for estimating heat transfer. The polytrophic exponent is used only for adjusting the data and to improve the understanding of the system. The validity of this method is demonstrated by experiments.

Keywords: pneumatics, gas compression process, compressible fluid-flow, polytrophic index, simulation