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AIMS AND SCOPE

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- component and systems design,
- computer software and hardware interfacing and
- computer aided engineering for both static and dynamic analysis of fluid power systems.

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ACCURATE TRAJECTORY TRACKING CONTROL OF WATER HYDRAULIC CYLINDER WITH NON-IDEAL ON/OFF VALVES

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Abstract

The aim of the work is to develop an on/off valve based trajectory tracking control solution without fast and/or continuous switching of valves. The pulse code modulation method is used to realise stepwise control of inflow and outflow of the actuator. Both inflow and outflow paths have five parallel-connected two-way solenoid valves, each having different flow capacity according to binary series, and a four-way on/off valve is used for changing direction of movement. Cost function based open-loop and closed-loop control solutions are developed and it is demonstrated how the cost function weights can be used to find a reasonable trade-off between tracking performance and pressure surges. Closed-loop results show accurate and reasonably smooth position tracking and simultaneous pressure level control. Achieved control performance is close to that of water hydraulic servo systems.

Keywords: Pulse Code Modulation, On/Off Control, Tracking Control

DEVELOPMENT OF A COMPACT AND TUNEABLE VIBRATION COMPENSATOR FOR HYDRAULIC SYSTEMS

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Abstract

This publication is about vibration compensators for the attenuation of fluid flow pulsations in hydraulic systems. After a problem definition and an overview of conventional devices, a compact and adjustable *mass-spring resonator* featuring a *hydraulic spring* will be presented. The main advantages of this design are: simple and compact design, excellent noise attenuation characteristics, suitability for all pressure levels through mean pressure compensation and the possibility to alter the resonance frequency of the device in both a semi-active and active manner.

Besides the description of the working principle, the discussion of some phenomena occurring at high frequencies, the treatment of some design aspects, such as the optimisation of the sealing gap geometry, dimensioning etc. and a section devoted to compactness of vibration compensators, experimental results will be presented which prove the usefulness of the concept.

Keywords: flow pulsations, pressure pulsations, vibration compensation, hydraulic spring, noise attenuation, compactness

MODELLING OF ORIFICE FLOW RATE AT VERY SMALL OPENINGS

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Abstract

Modelling hydraulic control systems that contain flow modulation valves is highly influenced by the accuracy of the equation describing flow through an orifice. Classically, the basic orifice flow equation is expressed as the product of cross-sectional area, the square root of the pressure drop across the orifice and a "flow discharge coefficient", which is often assumed constant. However, at small Reynolds numbers (such the case of valve pilot stage orifices), the discharge coefficient of the flow equation is not constant. Further, the relationship between the flow cross-sectional area and the orifice opening are extremely complex due to clearances, chamfers, and other factors as a result of machining limitations. In this work, a novel modification to the flow cross-sectional area is introduced and the resulting closed form of the flow equation is presented. As a secondary benefit, an analytical form of the orifice flow gain and pressure sensitivity can be obtained. This closed form equation greatly facilitates the transient and steady state analysis of low flow regions at small or null point operating regions of spool valve.

Keywords: pilot valve, flow control, orifice, flow rate equation, discharge coefficient, Reynolds number

DEVELOPMENT OF A PNEUMATIC FORCE-DISPLAY (APPLICATION TO A MASTER-SLAVE SYSTEM)

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Abstract

In this study we deal with a bilateral master-slave system composed of a pneumatic force-display as the master and a hydraulic servo system as the slave. In such systems the force-display must play two roles as master: first as a reference input device to the slave and second as a force-display device. The first purpose of this study is to develop a pneumatic force-display that consists of a pneumatic servo system. To achieve this, it is necessary to solve a problem called back-drivability, a characteristic of pneumatic servo systems. The second purpose is to investigate the compatibility of our thusly developed force-display with some representative methods of bilateral master-slave control systems in conventional use. In experiments to confirm such compatibility, the sensibility of load forces is estimated based on a master-slave system equipped with a spring to serve as a load. The experiments confirm that the developed force-display would be applicable to conventional methods of bilateral master-slave systems.

Keywords: manipulator, pneumatic servo-system, master-slave system, force-display, bilateral control, remote control

PNEUMATIC LANDSLIDE GENERATOR

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Abstract

A pneumatic landslide generator was developed specifically for the investigation of landslide generated impulse waves in reservoirs, lakes, bays or oceans in a two-dimensional physical laboratory model. The landslides were successfully modelled with an artificial granulate. The pneumatic landslide generator was designed to control the slide impact characteristics and enable exact reproduction and independent variation of single dynamic slide parameters. The two pneumatic linear drives catapulted the landslides to velocities up to 7.3 m/s on an acceleration distance of less than 0.9 m. The operation of linear drives 3.6 times beyond their certified velocity range is highlighted. Total masses of up to 174 kg were accelerated. The slotted cylinders enabled a compact mechanical design and a stroke length equal to 70 % of the overall cylinder length. The pneumatic deceleration by temporary airflow and pressure gradient reversal is presented. Real time valve response problems in high-speed applications are discussed and solved with preset trigger signals programmed to the pneumatics control unit. The behaviour of the whole pneumatic system was successfully simulated with the computer aided cylinder optimisation system software (CACOS). The measurements and numerical simulations are compared.

Keywords: pneumatic linear drives, slotted cylinders, high-speed application, large moving mass, airflow reversal, pneumatic deceleration, external shock absorber, real time problems, CACOS numerical simulation, landslide impacts, impulse waves