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AIMS AND SCOPE

The *International Journal of Fluid Power* is dedicated to the latest advances in the science and technologies associated with hydraulics and pneumatics. The aim of the journal is to provide the engineering community with high quality information concerning developments in research, design and application of fluid power technology. Special emphasis is placed on papers concerned with components and system integration by embracing key aspects of:

- analysis, modelling and control,
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- artificial intelligence applications,
- 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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MEASUREMENT OF FRICTION FORCES BETWEEN PISTON AND BUSHING OF AN AXIAL PISTON DISPLACEMENT UNIT

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Abstract

In industrial applications mineral oil based fluids are used for power transmission and lubrication, enriched with additives for additional functions. These fluids are not fast biologically degradable and often used additives are even environmentally toxic. In case of leakage and disposal into the environment these fluids cause bad damage or high costs for damage prevention. Within the Collaborative Research Centre 442 „Environmentally Friendly Tribosystems by Suitable Coatings and Fluids with Respect to the Machine Tool“ at RWTH Aachen the aim is to replace mineral oil based fluids for power transmission and lubrication by fast biologically degradable fluids, which are based on native esters. To compensate the loss of functions in consequence for avoiding the usage of toxic additives in each tribological system, one of two sliding partners of a tribological system gets a PVD-coating. The subproject “Tribological Systems in Hydrostatic Displacement Units” at IFAS strives to modify a hydrostatic axial piston machine in a way, that it can be run with fast biologically degradable fluids without any disadvantages compared with today commonly used units performing with mineral oil based fluids. The axial piston pump is chosen, because its tribological systems include different geometries, loads and moving behaviour. The most critical point in this machine is the tribological system piston-bushing. The contact zone between both bodies is characterised by areas with high pressure, especially in case of complete evacuation of lubrication fluid from the gap and direct contact of the metallic bodies. To ensure the lifelong performance of coated pistons this load has to be reduced. The strategy for this reduction is realised by changing the contour of piston and bushing. In this paper it will be demonstrated, that the friction behaviour of piston and bushing, which is an indicator for the contact pressure, can be changed by the manipulation of the piston geometry. For the friction measurement a new test facility was designed and built up. A detailed introduction to the design and performance of this facility is given in this paper.
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Keywords: hydrostatic displacement unit, fast biologically degradable fluid, biofluids, PVD, coating, piston, friction, piezosensors

A NEW TIME-DELAY COMPENSATING SCHEME FOR ELECTRO-HYDRAULIC SYSTEMS

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Abstract

Operating time delay in the solenoid valves is very common for practical electro-hydraulic servo systems. It may sometimes cause performance degradation or even instability if it isn't treated carefully during control system designs. We propose in this paper a non-model-based design approach for hydraulic actuating systems based on a new time-delay compensation scheme. In the proposed system, two types of controllers are combined: a fuzzy-PID controller used to ensure primary tracking performance and an adaptable wavelet compensator used to compensate for the time delay resulting from the control valve. Performance of the proposed design is widely verified on a newly developed simulation platform to show its effectiveness.

Keywords: Hydraulic system; position control; time-delay; fuzzy control; wavelet neural network

IMPROVED DIGITAL HYDRAULIC TRACKING CONTROL OF WATER HYDRAULIC CYLINDER DRIVE

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Abstract

A position tracking control system is implemented by utilizing parallel-connected on/off valve series. The pulse code modulation method is used to achieve stepwise flow control and four valve series, each having four two-way solenoid valves, are used. A cost function based controller is used to control simultaneously and independently flow paths from supply to cylinder chambers and from chambers to tank. It is shown that controllability can be improved especially at low velocities by allowing three or four valve series to be open simultaneously instead of using classical inflow outflow control

Keywords: Pulse code modulation, on/off control, tracking control

HYDRAULIC ACTUATOR LEAKAGE FAULT DETECTION USING EXTENDED KALMAN FILTER

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Abstract

This paper presents the application of extended Kalman filter (EKF) in order to identify leakage faults in hydraulically powered actuators. A hydraulic actuator can suffer from two types of leakages: internal or cross-port leakage at the piston seal and, external leakage at the shaft seal or the connecting pipes. An EKF-based estimator is constructed that includes complete nonlinear models of hydraulic functions as well as inevitable stick-slip friction in the actuator. It is shown that, firstly, under normal (no-fault) operating condition, the developed estimator closely predicts the states of the system, using only a few basic measurements. Secondly, in the presence of leakage faults, the level of residual errors between the estimated and the measured line pressures, increase significantly indicating the occurrence of faults. Thirdly, different leakage types can be identified by mapping the residual errors changes. Experiments are performed on a laboratory-based hydraulic actuator circuit. The results demonstrate the efficacy of the proposed EKF-based fault detection scheme to promptly and reliably respond to actuators external and internal leakage faults.

Keywords: fault detection and isolation, extended Kalman filter, leakage, hydraulic actuators.

FAST AND ACCURATE PRESSURE CONTROL USING ON-OFF VALVES

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Abstract

Pneumatic cylinders and pneumatic muscles are lightweight, clean and multifunctional actuators, requiring pressure-regulating valves for positioning. To use them in mobile applications commercial pressure-regulating valves are quite heavy and rather slow. Therefore an intelligent controlled array of fast switching on-off valves is presented as an alternative. The speed of the on-off valves determines the performance of the pressure-regulating valve. To reduce the opening time of the valves, a higher voltage is applied on the coil for a short time. The influence of this method on the heating of the valve will be discussed. A diode, which drains away the electromagnetic power from the coil, reduces the closing time. When working with pneumatic muscles, it is in some cases justified to remove the internal spring to enhance the opening time. A modified bang-bang controller, with more than one level and a dead zone is presented. Experimental results on a fixed volume are discussed. A special designed collector combines 6 on-off valves into a lightweight pressure control valve island, which is perfectly suited for walking robots such as the pneumatic actuated biped Lucy.

Keywords: Pressure control, Pneumatic muscles, Bang-bang controller