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AIMS AND SCOPE

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OPTIMIZATION PERFORMANCE OF A MICROFLUID FLOW POWER CONVERTER

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Abstract

This article deals with an application of the endoreversible thermodynamics theory of heat engine applied to micro-fluid flow power converters (MFPC). An analogy is demonstrated between thermal and fluid flow efficiencies. Maximum power output and efficiency at maximum power are established for the device based upon the higher and lower pressure bounds. The linear and non linear fluid flows are considered with and without fluid friction losses. This paper provides theoretical limits for designing power flow converter. The best performances are obtained for linear fluid flow without flow losses.

Keywords: finite time thermodynamics, fluid flow, optimization performance

AN EMPIRICAL DISCHARGE COEFFICIENT MODEL FOR ORIFICE FLOW

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Abstract

In fluid power systems, flow control is mainly achieved by throttling the flow across valve orifices. Lumped parameter models are generally used to model the flow in these systems. The basic orifice flow equation, derived from Bernoulli's equation of flow, is proportional to the orifice sectional area and the square root of the pressure drop and is used to model the orifice coefficient of proportionality. The discharge coefficient, C_d, is often modeled as being constant in value, independent of Reynolds number.

However, for very small orifice openings, C_d varies significantly and can result in substantial error if assumed constant. In this situation, modelers usually revert to graphs or look–up tables to determine C_d. This paper provides a closed form model for C_d as a function of the Reynolds number which can be applied to different types of orifices. Based on this model, a technique to evaluate flow given an orifice area and pressure drop without having to use iteration is introduced.

Keywords: fluid power, hydraulic, flow control, orifice equation, discharge coefficient, Reynolds number

POSITION CONTROL OF A PNEUMATIC SERVOCYLINDER USING FUZZY-SLIDING SURFACE CONTROLLER

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Abstract

In this paper, both the PID and fuzzy-sliding surface controller are applied to the position control of a proportional-valve-controlled pneumatic rodless cylinder. Because of the highly nonlinear basic equations of pneumatic systems, the modelling of such a pneumatic servo is excluded from this paper. Besides, it is usually quite difficult to obtain a satisfactory position control of a pneumatic rodless cylinder because an apparent dead-zone in the response curve during the starting phase always appears. The dead-zone signifies a serious response delay. One reason for such a response dead-zone is the stick-slip friction and the nonlinear deadband of the proportional valve. In this paper, therefore, the chattering output of sliding mode control is introduced to reduce the effect of stick-slip and the nonlinear fuzzy-logic-controller is employed to control this unmodelled and highly nonlinear system. Accordingly, the fuzzy-sliding surface controller is proposed, which is exactly the combination of the fuzzy-logic-controller with the sliding mode controller. There are two key features of this control scheme. One is the easier implementation of the controller as compared with that of the conventional fuzzy-logic-controller because the number of controller input is reduced by half. The other is the ability to reduce the response dead-zone during the starting phase. Finally, a series of experiments are carried out and the experimental results prove that the fuzzy-sliding surface controller is superior to the conventional PID controller.

Keywords: fuzzy-sliding surface control, pneumatic rodless cylinder, position control, stick-slip

IMPLEMENTATION OF SINGLE FEEDBACK CONTROL LOOP FOR CONSTANT POWER REGULATED SWASH PLATE AXIAL PISTON PUMPS

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Abstract

Variable displacement pumps are often used in both industrial applications and mobile hydraulic machinery. In such pumps, flow rate is dictated by the system requirements. Mathematical model has been previously developed to simulate the dynamic performance of the electrically controlled constant power regulated swash plate axial piston pumps with conical cylinder blocks. The pump is currently equipped with a double negative feedback control loop with an inner control loop to control the position of proportional valve using PID controller. Consequently, the proportional valve distributes the control pressure across the two sides of a control piston that is mechanically attached to the pump swash plate in order to change the pump flow rate. The outer control loop is used to control the pump flow rate in accordance with the system pressure change in order to keep the constant power operation using PD controller. For the convenience of pump constant power operation, PD controller is tuned to keep limited power shocks on the pump drive motor during the transient periods. The selected PD parameters results in relatively reduced settling time. Consequently swash plate steady state vibration appears.
Purpose of this paper is to investigate features of the pump performance in view of an alternative control scheme. Counting on the relatively good open loop static characteristics of the proportional valve, a control scheme with a single control feedback loop is proposed to simplify the currently used control scheme. Using such single feedback control loop reduces the pump production cost and leads to have less responsive system that suppresses the steady state vibration of the swash plate. Simulation results are verified experimentally and qualitatively compared with the results when the original control scheme is used. Results are presented and discussed.

Keywords: axial piston pump, constant power, PID, fuzzy

DYNAMIC MODELING AND PARAMETRIC STUDIES OF AN INDEXING VALVE PLATE PUMP

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Abstract

The swash-plate in a variable displacement pump experiences very large forces and moments that try to dislocate its position; therefore, a large device is required for adequate control. In this paper, the dynamics of an alternative pump design using an indexing valve plate to position the swash-plate are reported. The indexing valve plate design is aimed at controlling the pressure transition for a piston, which is moving from a high-pressure port to a low-pressure port. In this paper, the governing equations for the pump are derived and the detailed open-loop and parametric studies, which are necessary for understanding the overall dynamic characteristics of the pump, are reported. Also, full nonlinear and simplified modeling approaches for the system are compared.

Keywords: swash-plate, axial piston pump, indexing valve plate, pressure carry-over