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Energy Saving Potential of the Independent Metering Fluid Power System

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Introduction

Electro-hydraulic proportional control valves are widely applied for motion control in the electro-hydraulic fluid power system. Normally, a sliding spool is used in the proportional control valve to control the flow direction and flow rate passing through the valve, as a result, the meter-in and meter-out orifices are mechanically connected [1]. The sliding spool makes the system robust and easy to control, but a number of types of losses have been produced with this kind of valve [2]. Therefore, the conventional electro-hydraulic proportional spool valve control system provides precise motion control, but cannot achieve energy saving performance [3].

In order to obtain high efficiency and flexibility of the electro-hydraulic proportional control system, Ulery proposed an integrated hydraulic circuit by combining cartridge valves into a manifold to act as a control valve [4]. Jansson and Palmberg go a step further, used four electro-hydraulic proportional valves to control an actuator in the electro-hydraulic fluid power system [5]. The four-valves configuration breaks the mechanical linkage of meter-in and meter-out orifices, as a result that can provide more controllability and energy savings. There are also other valves configurations can realize the independent metering technology. Each of the configurations is based on the independent control of the meter-in and meter-out orifices.

As the independent metering system is a multi-input and multi-output system, it requires more hardware configurations and complex control methods. Many researchers have developed the electro-hydraulic control methods in independent metering system for obtaining steady flow rate and energy saving performance, as well, including hybrid control algorithm [6], load feedback method [7], energy-saving adaptive robust motion controller [8], for example. The hydro-mechanical pressure compensation method has been successfully applied in the conventional fluid power system as it reacts directly and rapidly on disturbance variables [9]. The hydro-mechanical pressure compensation method is adopted in the design of independent metering system for excavator's manipulator, and the analysis results indicated that the independent metering system with hydro-mechanical pressure compensation offers more significant energy savings than the conventional load-sensing system [10].

Conclusion

Different valves configurations have their own pros and cons, and optimal valves configuration depends on the applications and specific working conditions. In the future, obtaining the energy saving performance while achieving the precise motion control performance of the independent metering fluid power system will still be a research direction.

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