Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

Analysis of pressure and flow compound control characteristics of an independent metering hydraulic system based on a two-level fuzzy controller

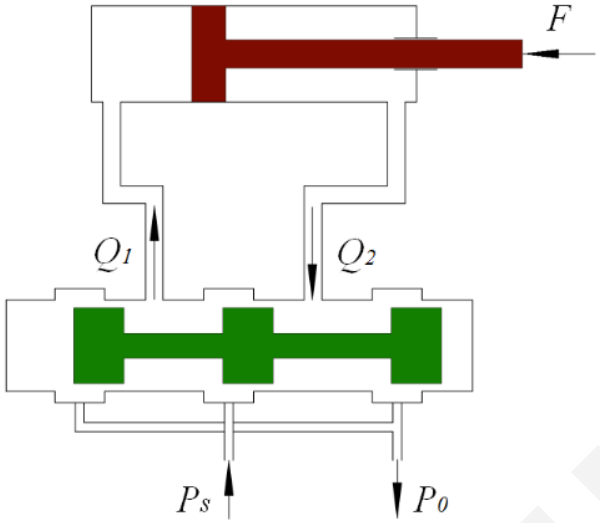
Qi ZHONG

Keywords:
Independent metering system; Pressure and flow compound control; Calculation flow rate feedback; Fuzzy PID; Two-level closed-loop control

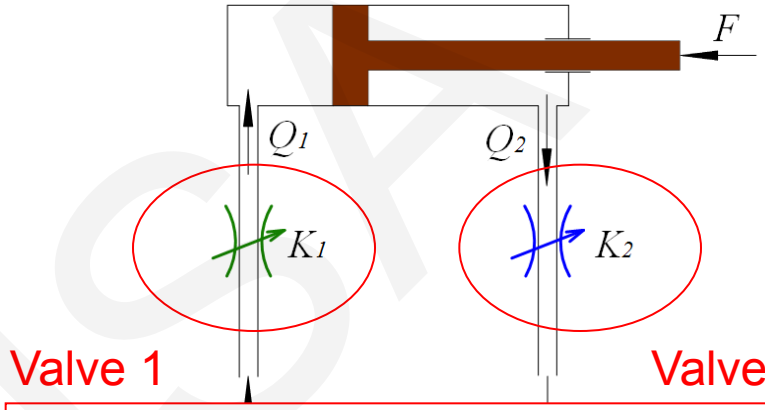
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Background



Traditional Vlave Control hydraulic System



Requires more complex control algorithm and advanced controller

Independent Metering Valves Control Hydraulic System (IMVCHS)

Advantages of IMVCHS

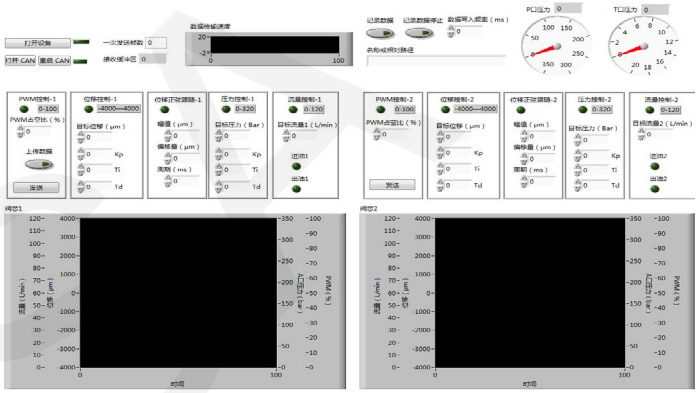
- Two spools bring control flexible
- Reducing throttle loss
- High versatility of components
- Energy saving
- Input and output pressure of actuator can be adjusted separately

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Control system design



Programmable IMVCHS controller

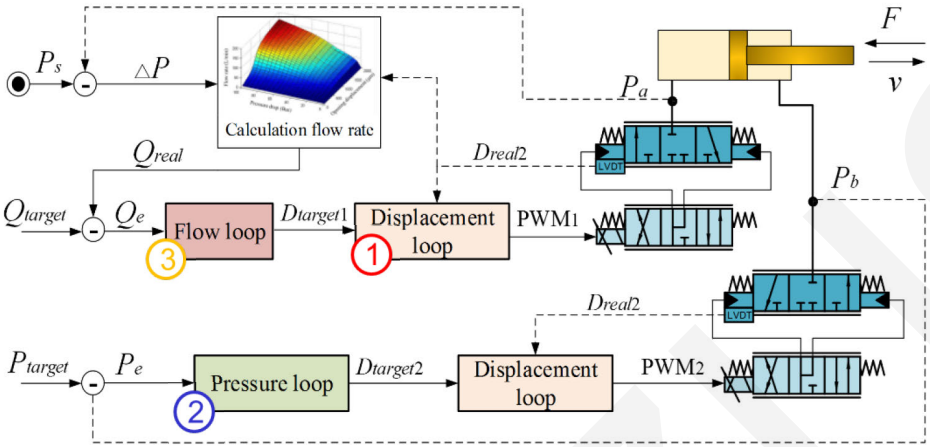


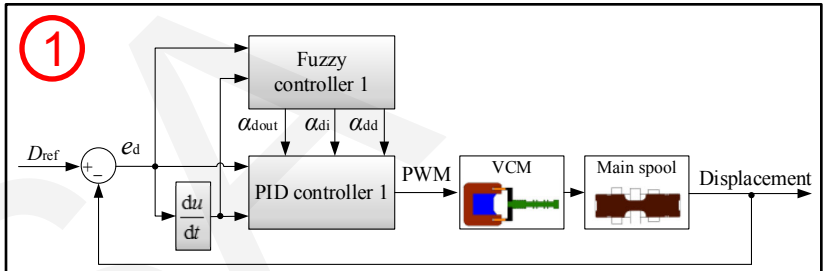
Host programmable control system

- DSP minimum system
- Power management module
- Signal processing module
- CAN communication module
- Digital drive module
- RTOS(0.5ms closed-loop control)
- Remote control and monitor
- Spool displacement control
- Chamber pressure control
- Orifice flow rate control
- Flow and pressure coupling control

Control Method

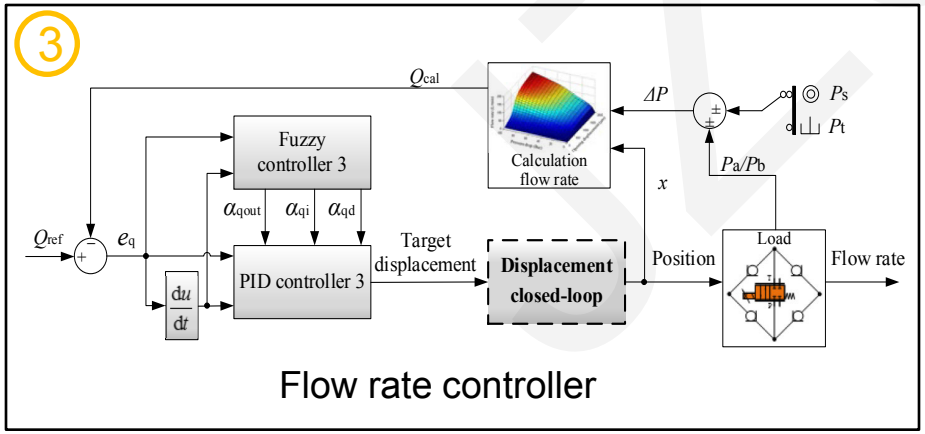
Pressure and flow compound control structure of IMVCHS



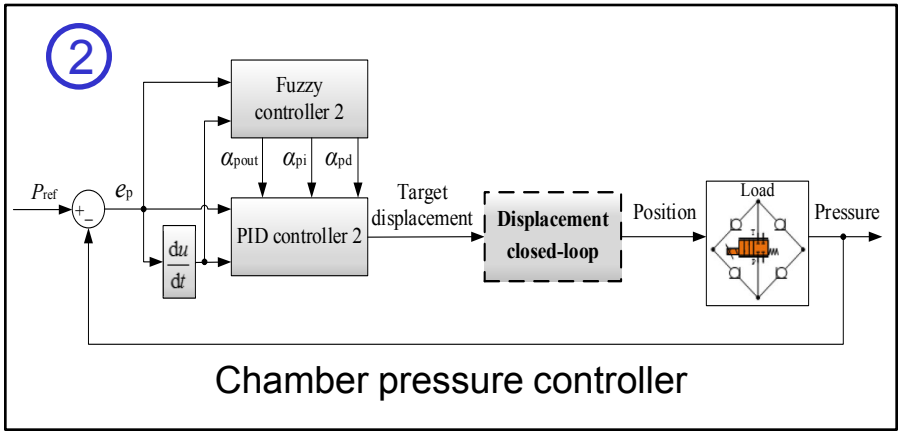


Spool position controller

The inner loop of both the pressure and flow loops, and thus the valve position performance will directly affect the performance of the pressure and flow controls.

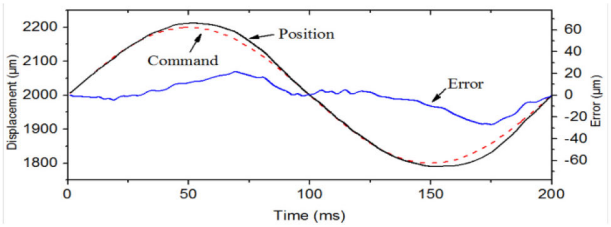


Flow rate controller

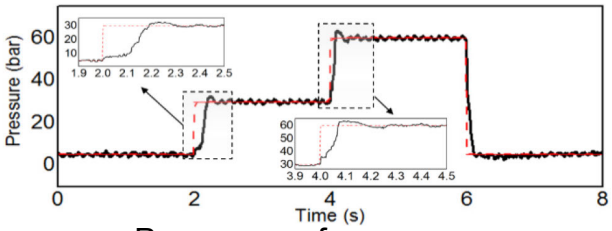


Chamber pressure controller

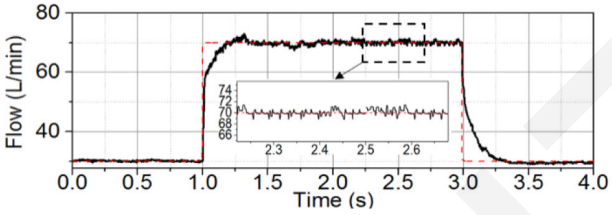
Results and conclusions



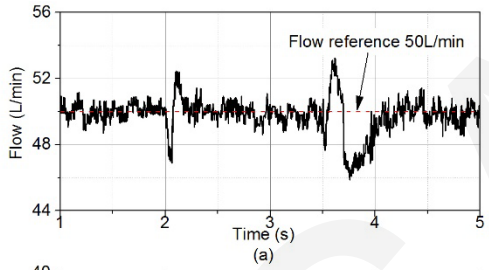
Displacement performance

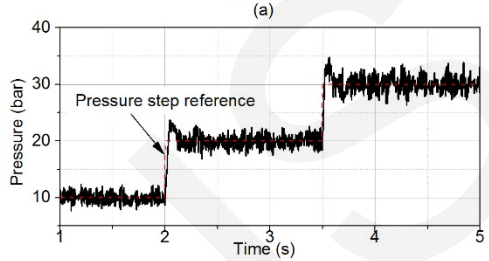


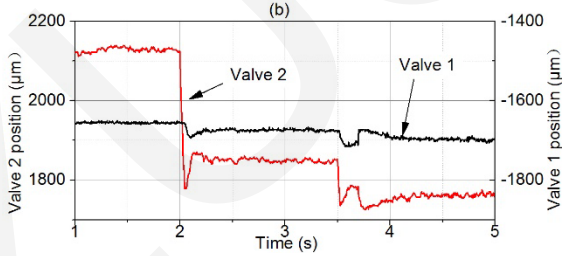
Pressure performance



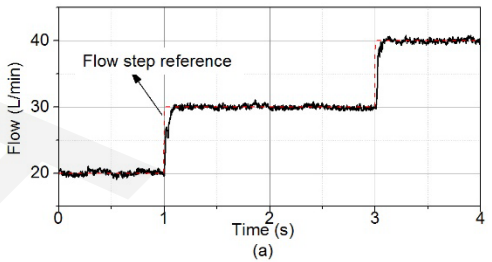
Flow rate performance

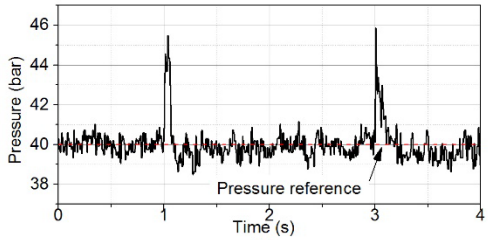


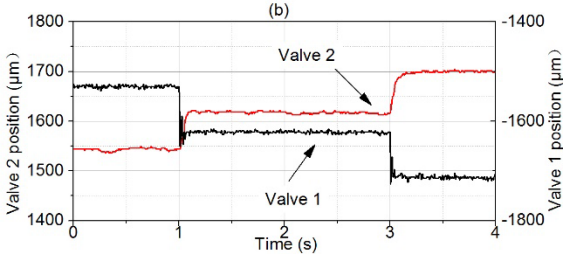




Compound control performance under a constant flow rate







Compound control performance under a constant backpressure

The adjustment time of the spool position reaches 40 ms for 50% full strokes. The pressure adjustment time for 30 bar step control (backpressure of 30 to 60 bar) reaches 180 ms. The flow adjustment time for a 40 L/min step control (flow rate of 30–70 L/min) reaches 320 ms. The pressure and flow compound adjustment times are generally less than 200 ms, occasionally reaching less than 100 ms. The compound control experiments indicate that the proposed control system improves the response speed, control accuracy, and robustness of the IMVCHS under disturbances.