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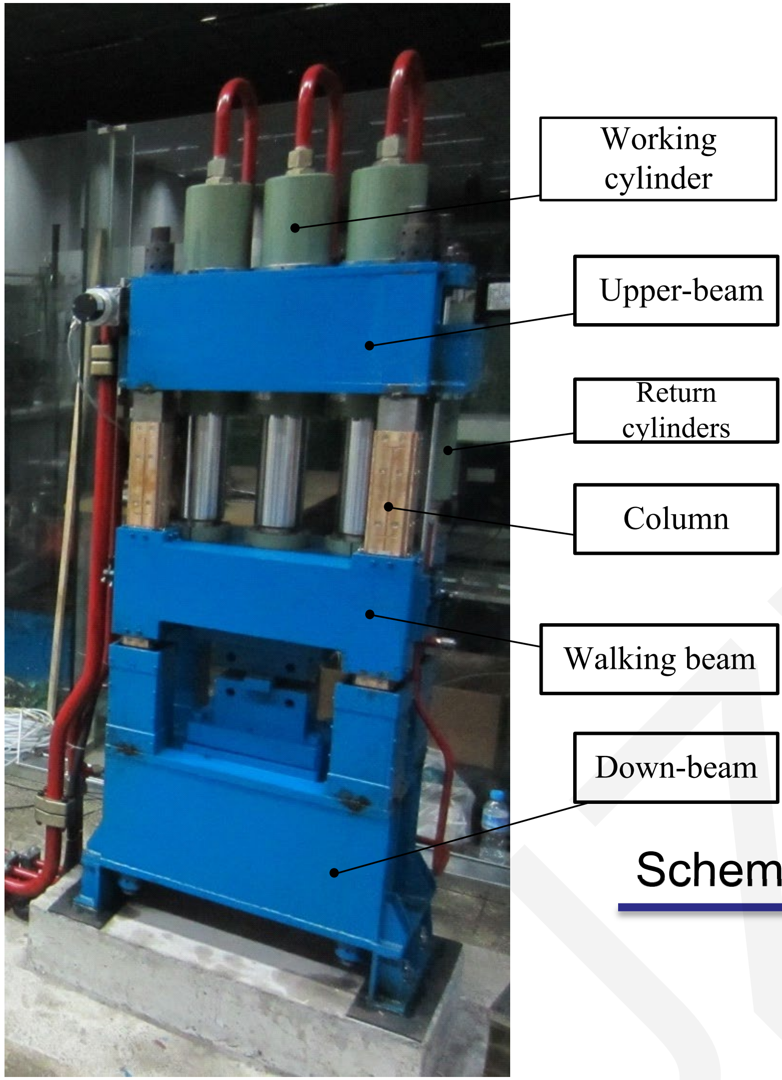
Independent volume-in and volume-out control of an open circuit pump-controlled asymmetric cylinder system

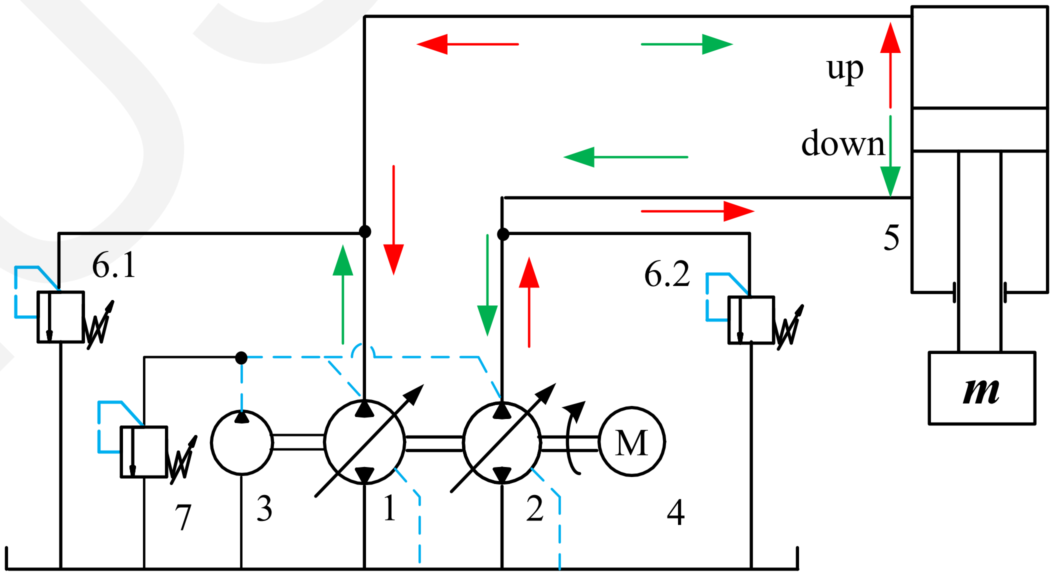
Key words:
Pump-controlled system; Asymmetric cylinder;
Energy dissipation; Position-pressure combined control;
Independent Volume-in and Volume-out control



Schematic

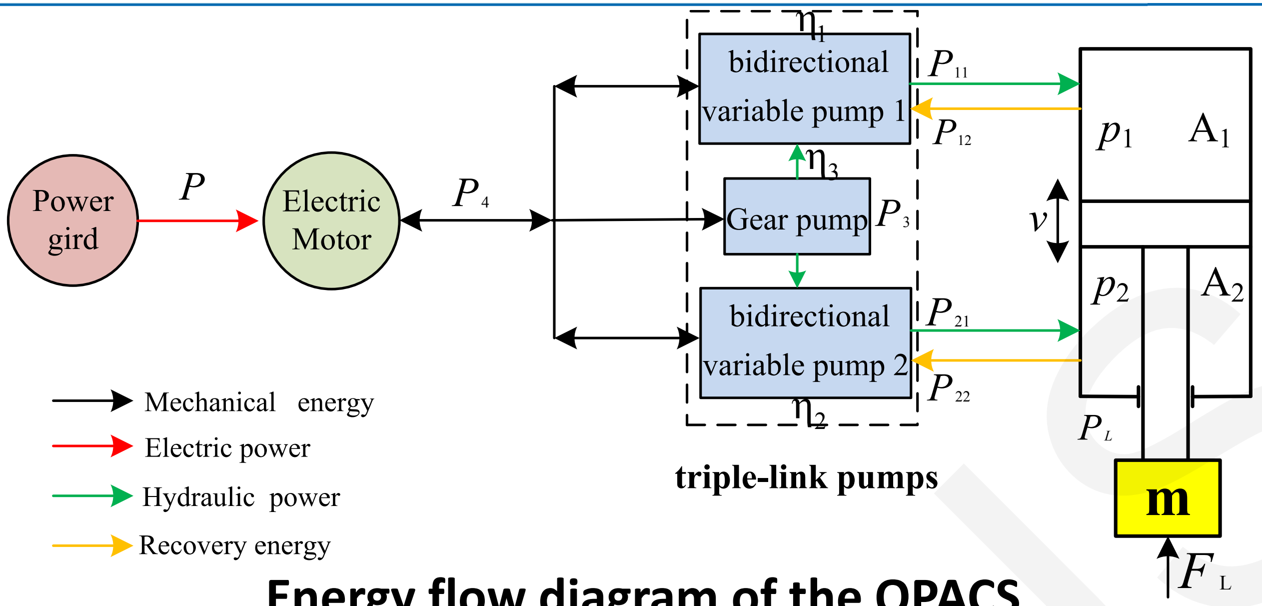
■ Independent Displacement Volume-in and Volume-out (VIVO) Control System

The flow rate pumped to the cylinder chamber or delivered to the bi-directional variable pump can be controlled independently by adjusting the displacement of the bi-directional variable pump



The open circuit hydraulic pump-controlled forging press system

ENERGY TRANSMISSION MODEL



Energy flow diagram of the OPACS

- Pro
  - Energy-saving
  - High control accuracy
  - High effiency

$$P_{11} = \frac{p_{p1} \cdot D_{p1} \cdot n \cdot \eta_1}{60} \cdot 10^{-6}, \quad P_{22} = \frac{p_{m2} \cdot D_{m2} \cdot n}{60} \cdot 10^{-6},$$

$$P_{12} = \frac{p_{m1} \cdot D_{m1} \cdot n}{60} \cdot 10^{-6}, \quad P_{21} = \frac{p_{p2} \cdot D_{p2} \cdot n \cdot \eta_2}{60} \cdot 10^{-6},$$

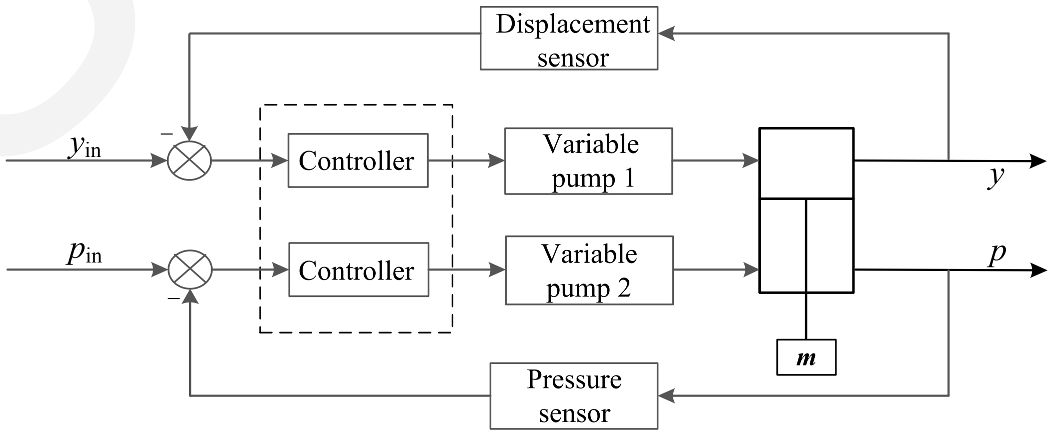
$$P_3 = \frac{p_3 \cdot D_3 \cdot n \cdot \eta_3}{60} \cdot 10^{-6},$$

$$P_{11} / \eta_1 - P_{22}\eta_2 = (p_1 A_1 - p_2 A_2)v = P_L,$$

$$P_{21} / \eta_2 - P_{12}\eta_1 = (p_2 A_2 - p_1 A_1)v = P_L,$$

$$E_4 = E \cdot \eta = E_{11} + E_{21} - E_{12} - E_{22} + E_3 = E_L,$$

Method



Position-pressure combined control

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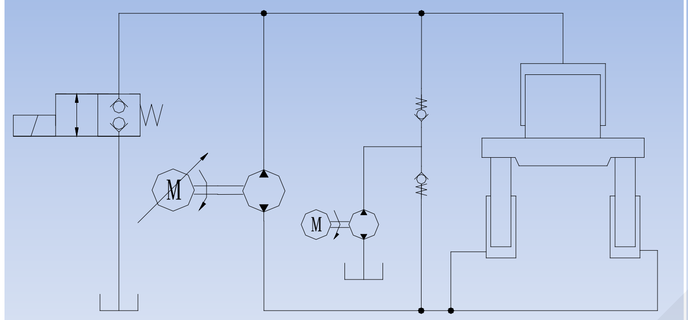
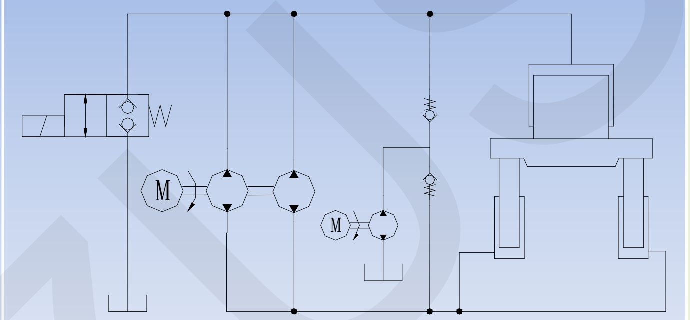
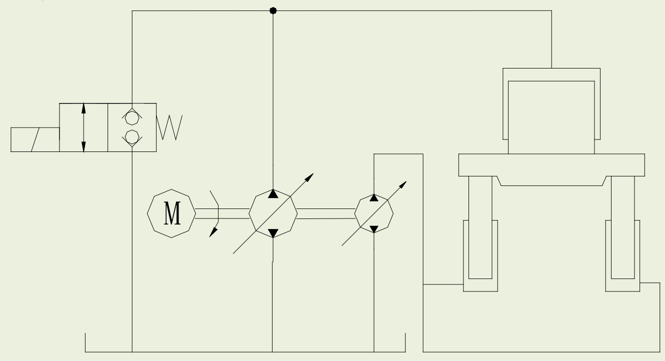
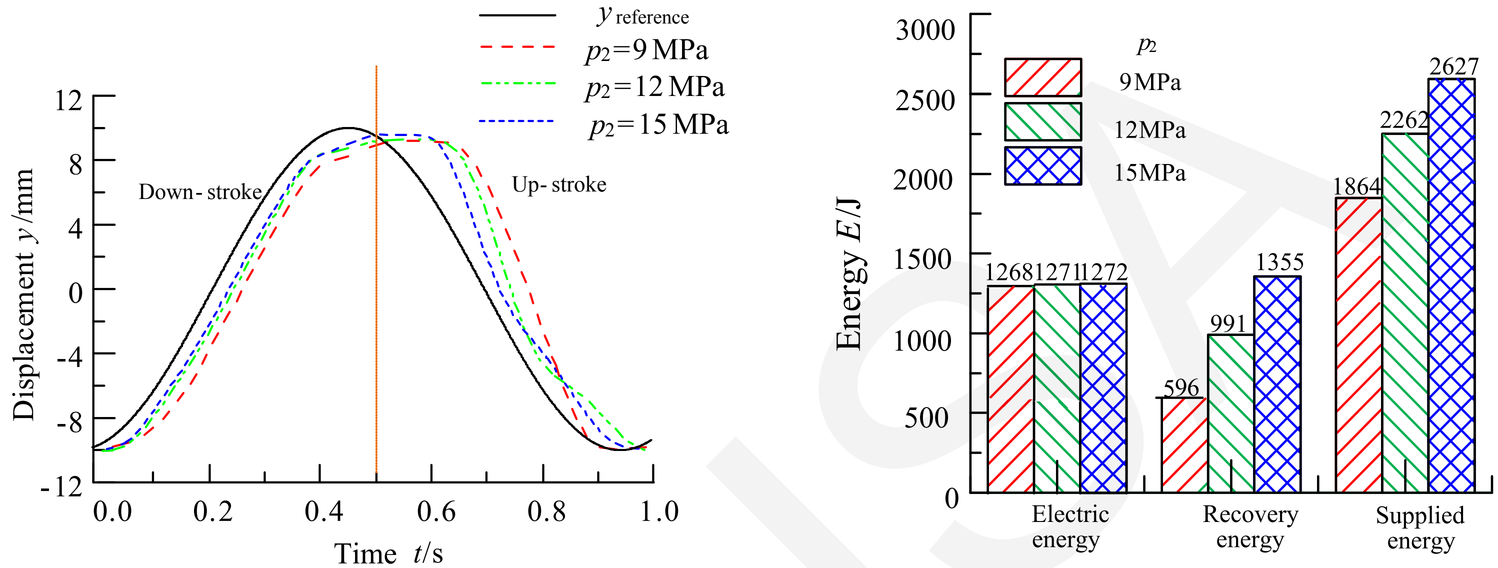
COMPARISON

Direct drive volume control electro-hydraulic servo system	Open circuit pump-controlled asymmetric cylinder system	Open circuit pump-controlled asymmetric cylinder system
		
Poor stability Slow respond Poor control accuracy	Relatively high efficiency Less losses	High efficiency Less losses Power recovery No oil filling system

CONCLUSION



Displacement and Energy distribution comparison with different backpressures

- The independent VIVO control method of the OPACS shows great potential in **control characteristics and energy-saving**, the OPACS control accuracy and rapidity improved by increasing the pressure in the return cylinder. However, the electronic input power of the OPACS changed little, indicating that the OPACS is **effective at reducing the installed power as well as improving control characteristics**.

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