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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

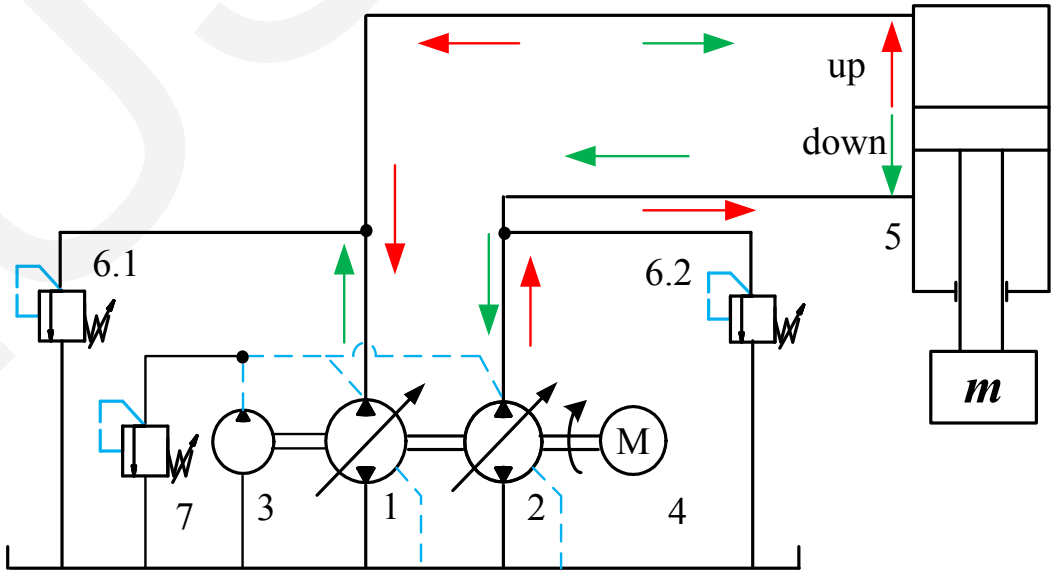




Schematic

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

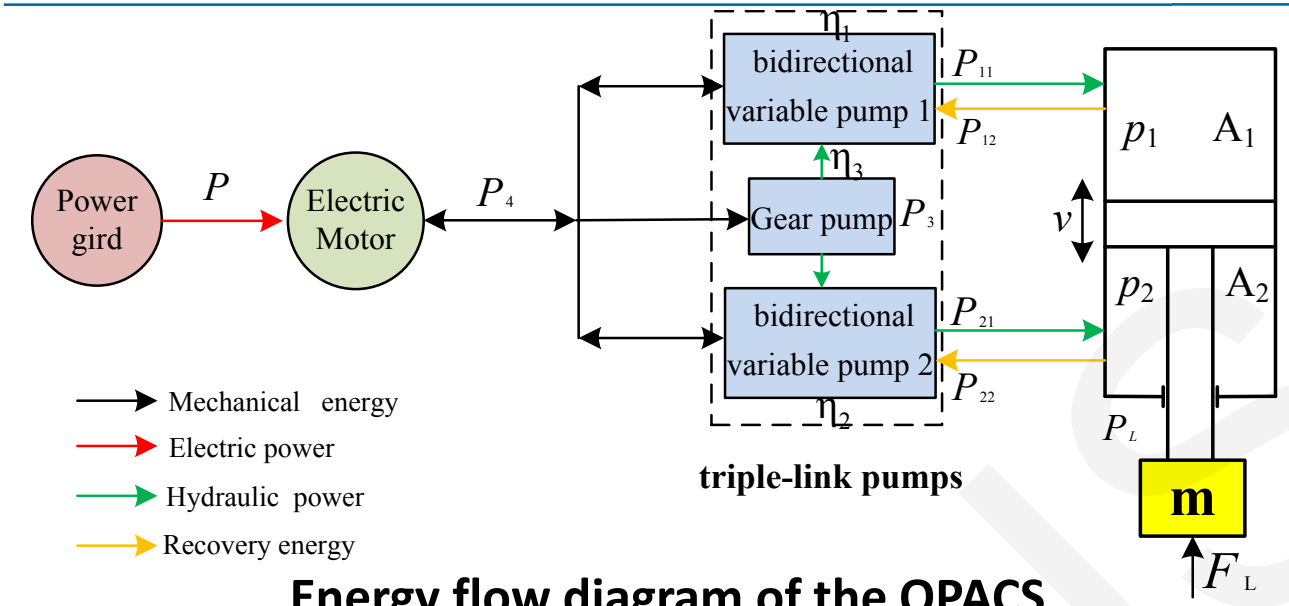
The flow rate pumped to the cylinder chamber or delivered to the bi-directional variable pump can be controlled independently by adjusting the displacement of the bi-directional variable pump



The open circuit hydraulic pump-controlled forging press system

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ENERGY TRANSMISSION MODEL



triple-link pumps

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

Energy flow diagram of the OPACS

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

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

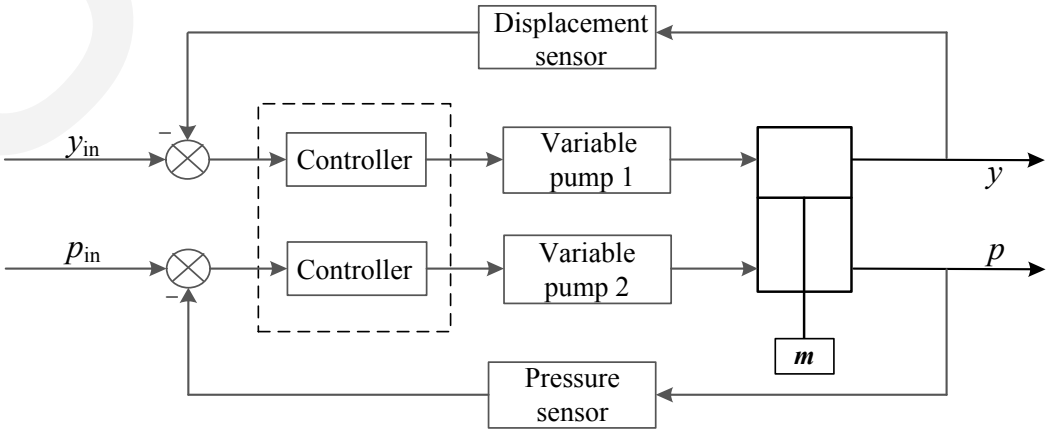
$$P_3=\frac{p_3\cdot D_3\cdot \mathrm{n}\cdot \eta_3}{60}\cdot 10^{-6},$$

$$P_{11}/\eta_1-P_{22}\eta_2=(p_1A_1-p_2A_2)v=P_L,$$

$$P_{21}/\eta_2-P_{12}\eta_1=(p_2A_2-p_1A_1)v=P_L,$$

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

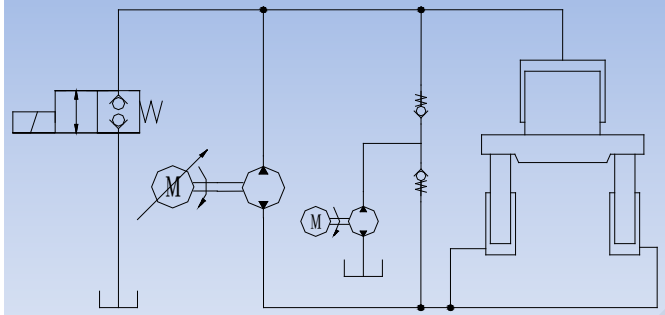
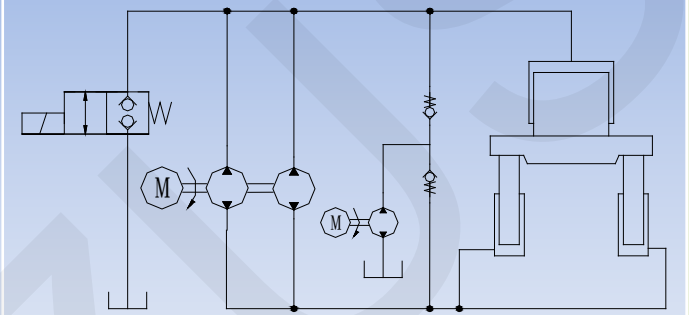
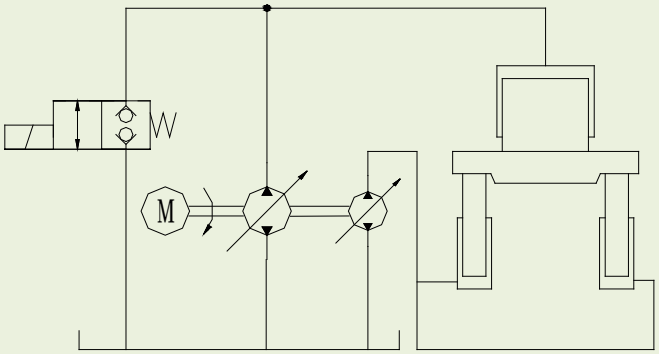
Method



Position-pressure combined control

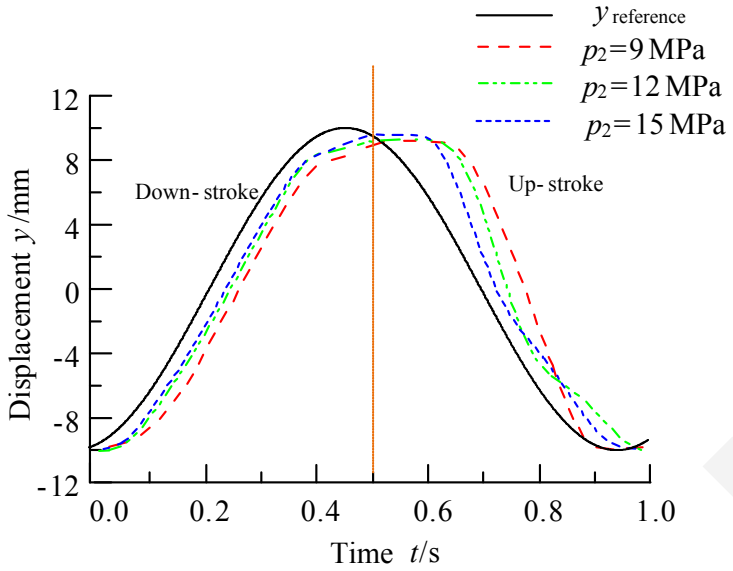
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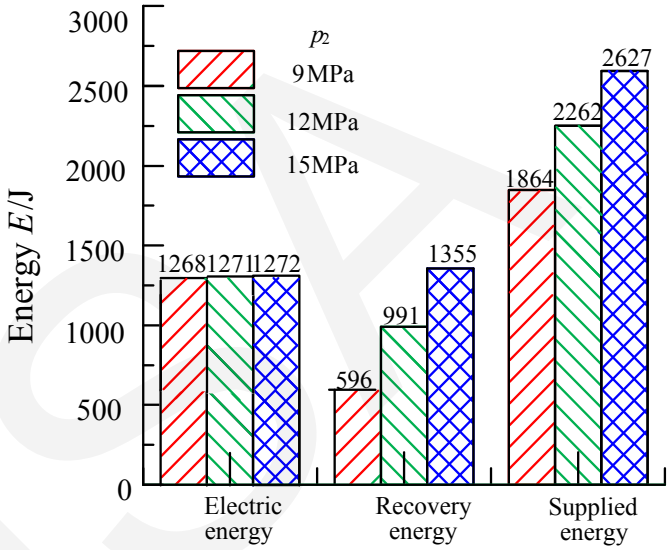
COMPARISON

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

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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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