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

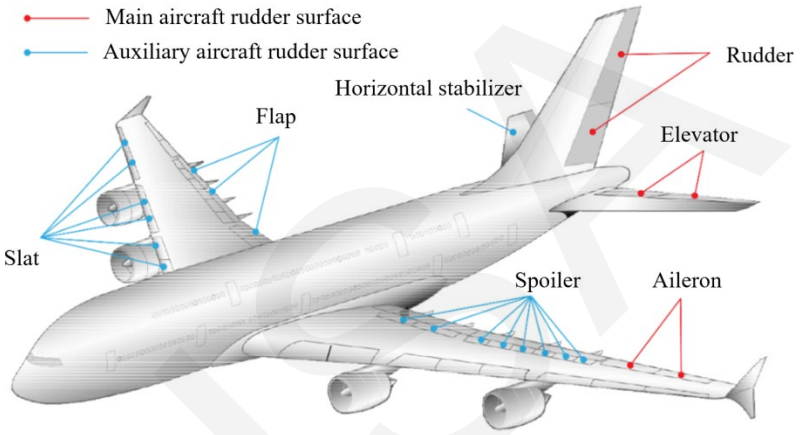
Theoretical and experimental investigation on the efficiency of a novel roller piston pump

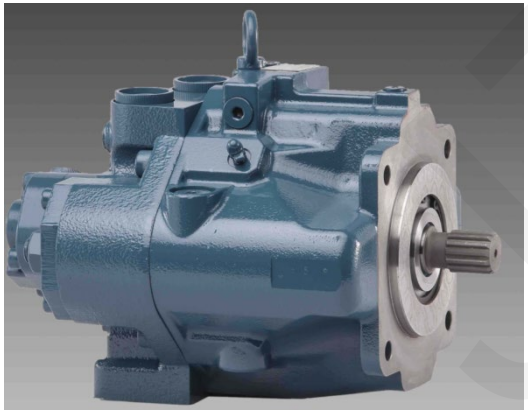
Chenchen ZHANG, Yiren ZANG, Heyuan WANG,
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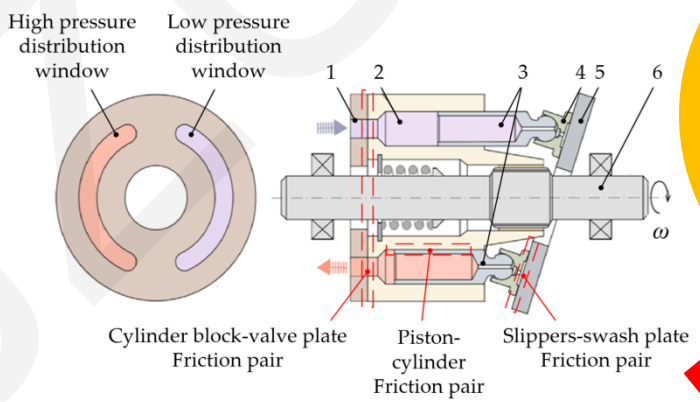
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Research Background









1. valve plate 2. cylinder 3. piston 4. slipper 5. swash plate 6. transmission shaft

High power density

Figure 1. Schematic diagram of three friction pairs of the axial piston pump

Roller piston pump

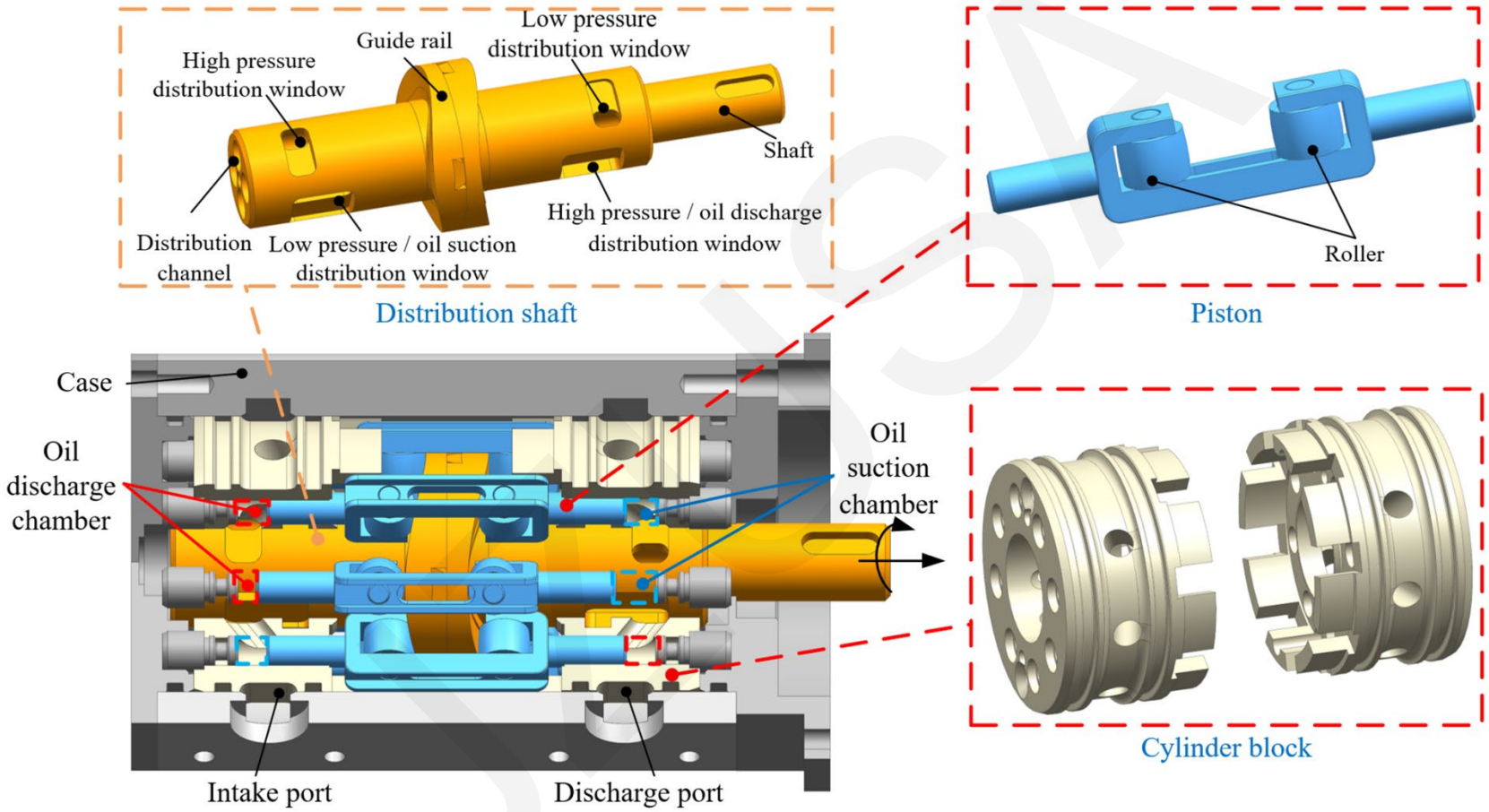


Fig. 2. Schematic diagram of the structure of the roller piston pump

Roller piston pump

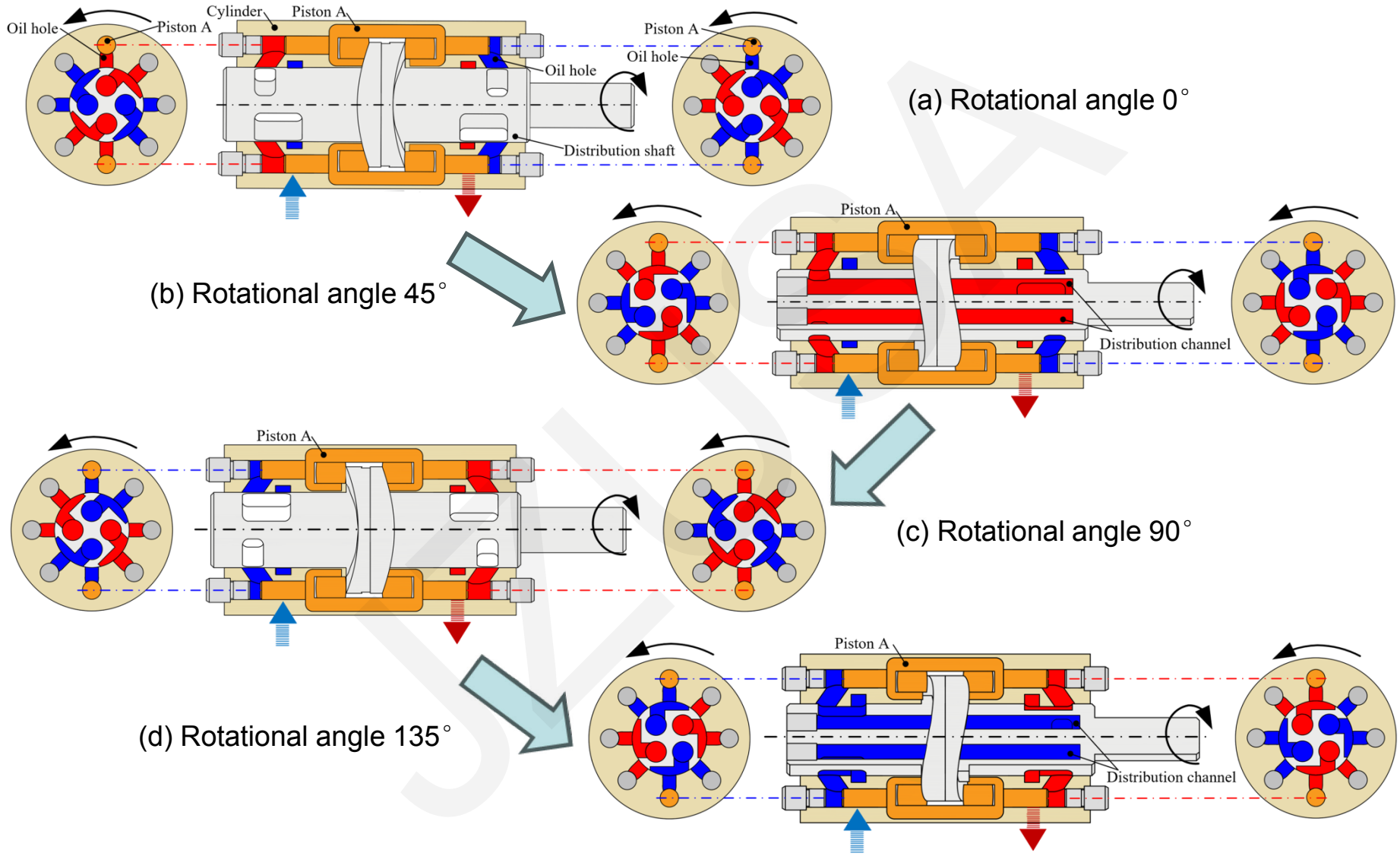
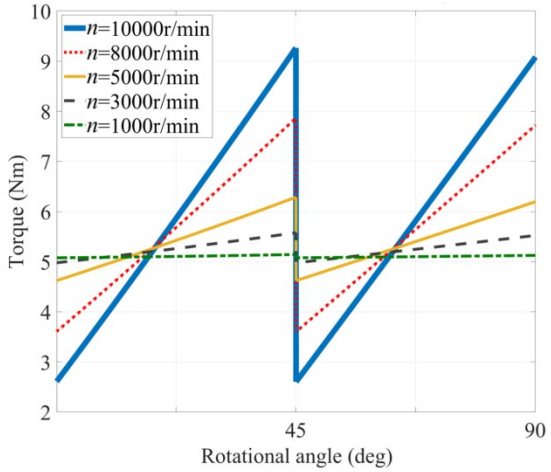
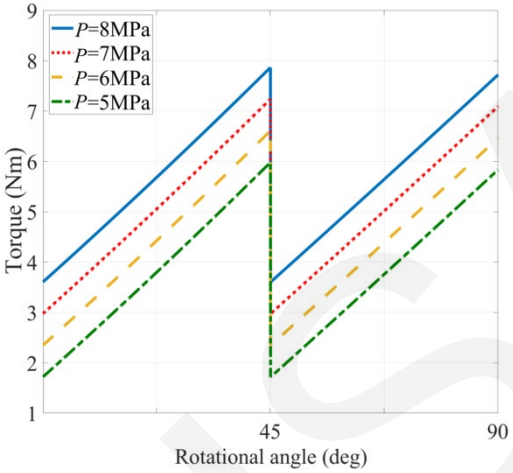


Fig. 3. Working principle of the roller piston pump

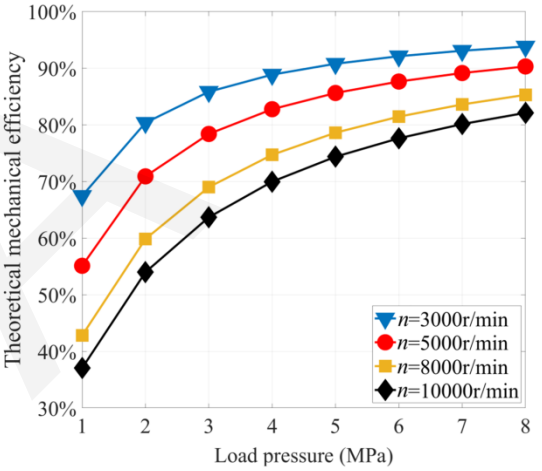
Simulation results and discussion



(a) Load pressure is 8 MPa

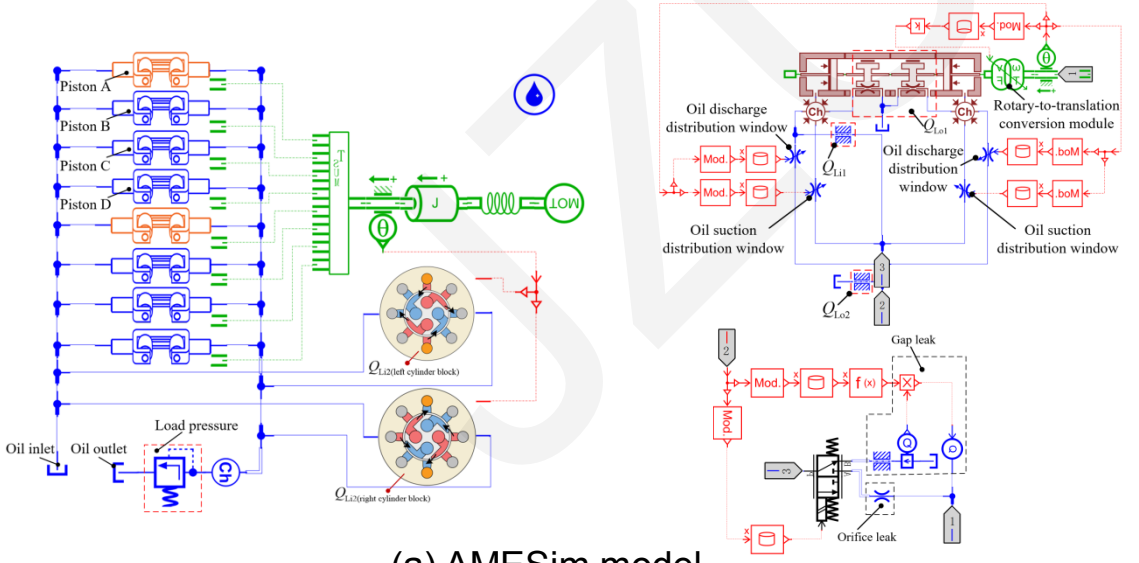


(b) Rotational speed is 8000 r/min

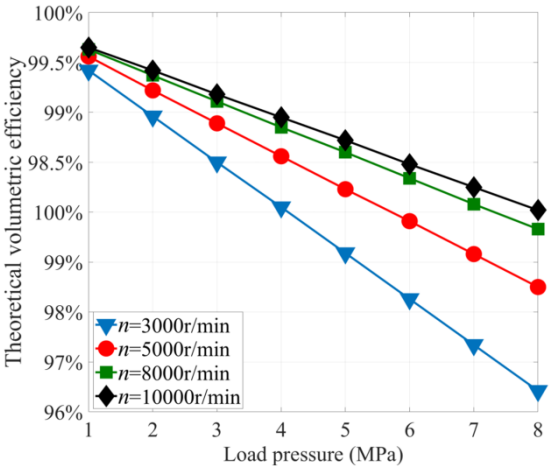


(c) Mechanical efficiency

Fig. 4. Simulation results of mechanical efficiency at different speeds and load pressures



(a) AMESim model



(b) Volumetric efficiency

Fig. 5. Simulation results of volumetric efficiency at different speeds and load pressures

Experimental study





Fig. 6. Prototype of the roller piston pump

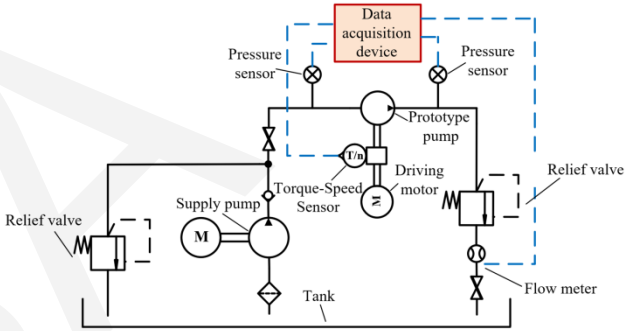


Fig. 7. System schematic of the test bench

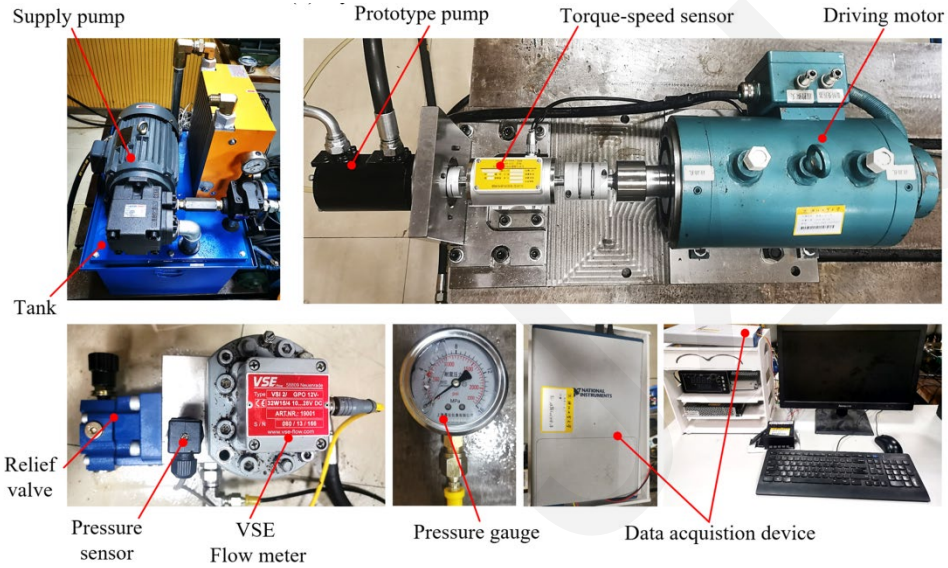


Fig. 8. Overall physical diagrams of the test bench

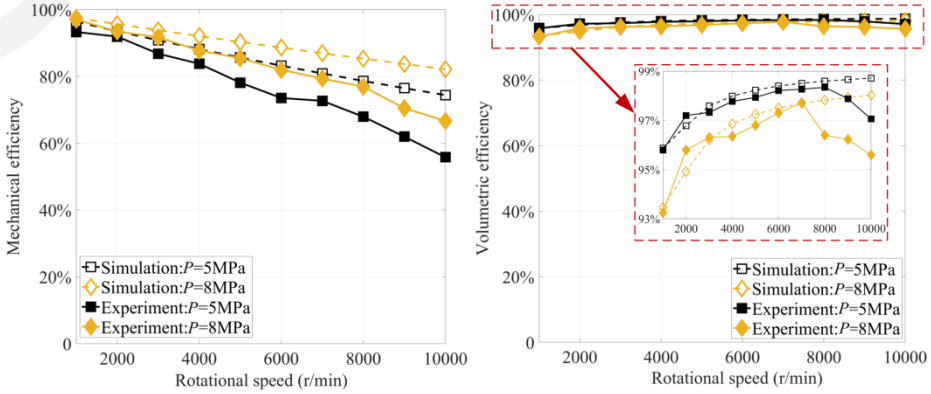


Fig. 9. Experimental results

Conclusions

- A novel **roller piston pump** is presented where a cam guide-roller type rolling support is adopted to replace the sliding pair support of the swash plate-slipper pair to achieve the piston cavity's oil suction and discharge.
- Based on the motion law and distribution principle of the roller piston pump, the **mathematical models** of the pump's mechanical efficiency and volumetric efficiency are respectively established. Through the **numerical simulation of MATLAB and AMESim**, the influence of rotational speed and load pressure on the **mechanical efficiency and volumetric efficiency** of the piston pump is analyzed.
- The results show that the removal of the valve plate through structural innovation reduces leakage and greatly improves volumetric efficiency. The roller pump can rotate at a maximum speed of **10,000 r/min** or higher, which meets the needs of high speed and variable speed for aerospace fuel pumps.