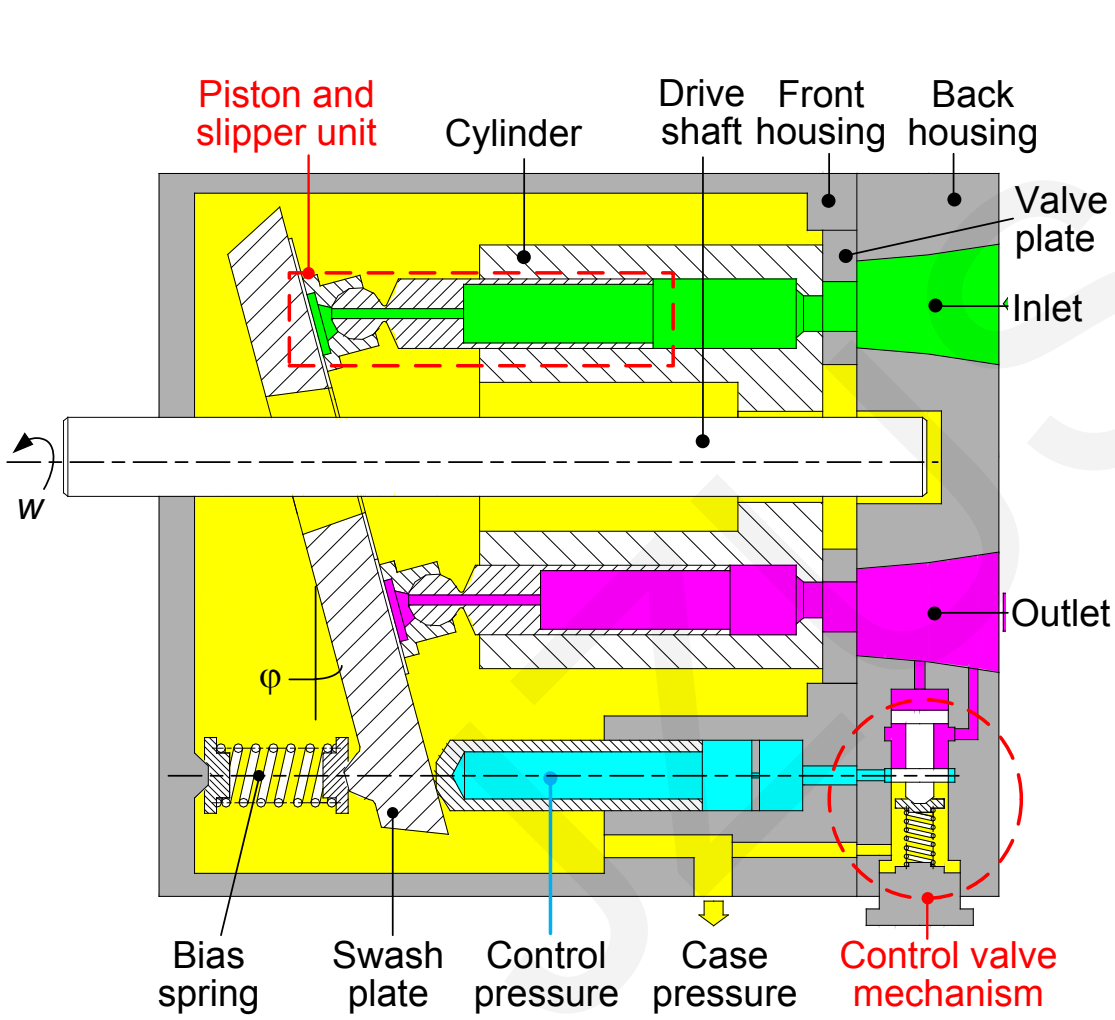
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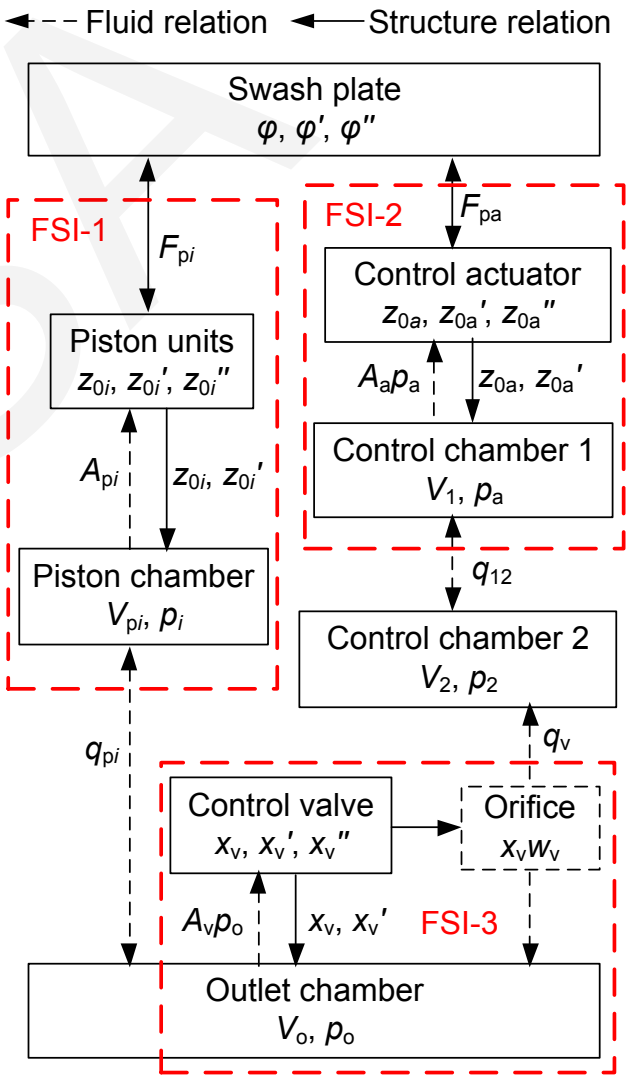
# An investigation into the swash plate vibration and pressure pulsation of piston pumps based on full fluid-structure interactions

Xiao-ping OUYANG

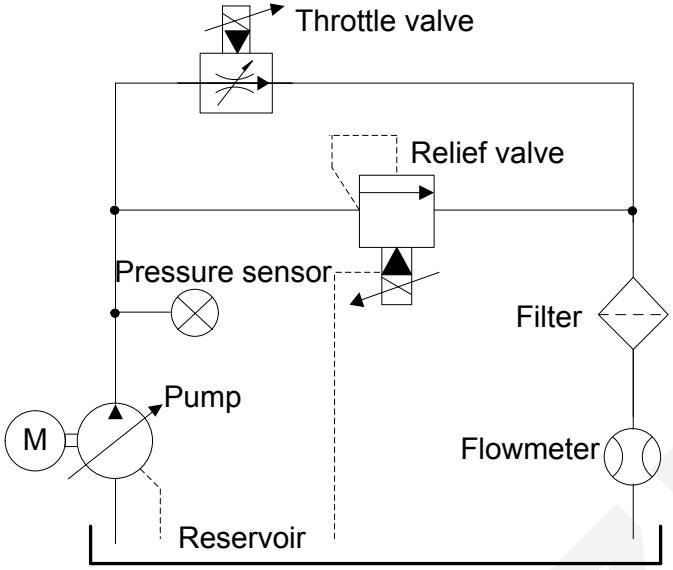
Cite this as: Xiao-ping Ouyang, Xu Fang, Hua-yong Yang, 2016. An investigation into the swash plate vibration and pressure pulsation of piston pumps based on full fluid-structure interactions. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 17(3):202-214. http://dx.doi.org/10.1631/jzus.A1500286

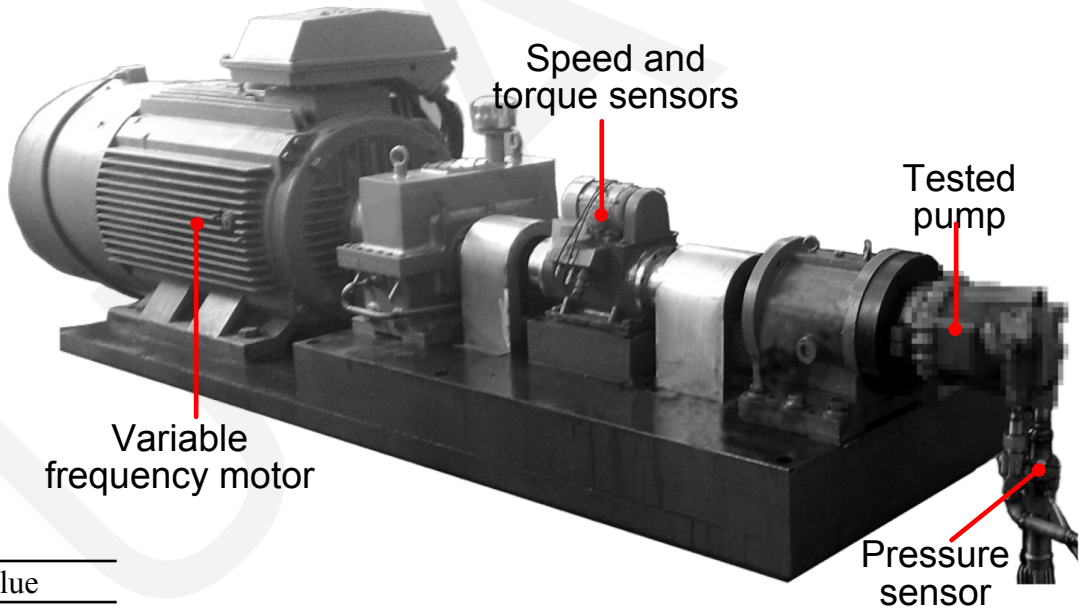
# Theoretical Models



# Test Rig and Parameters

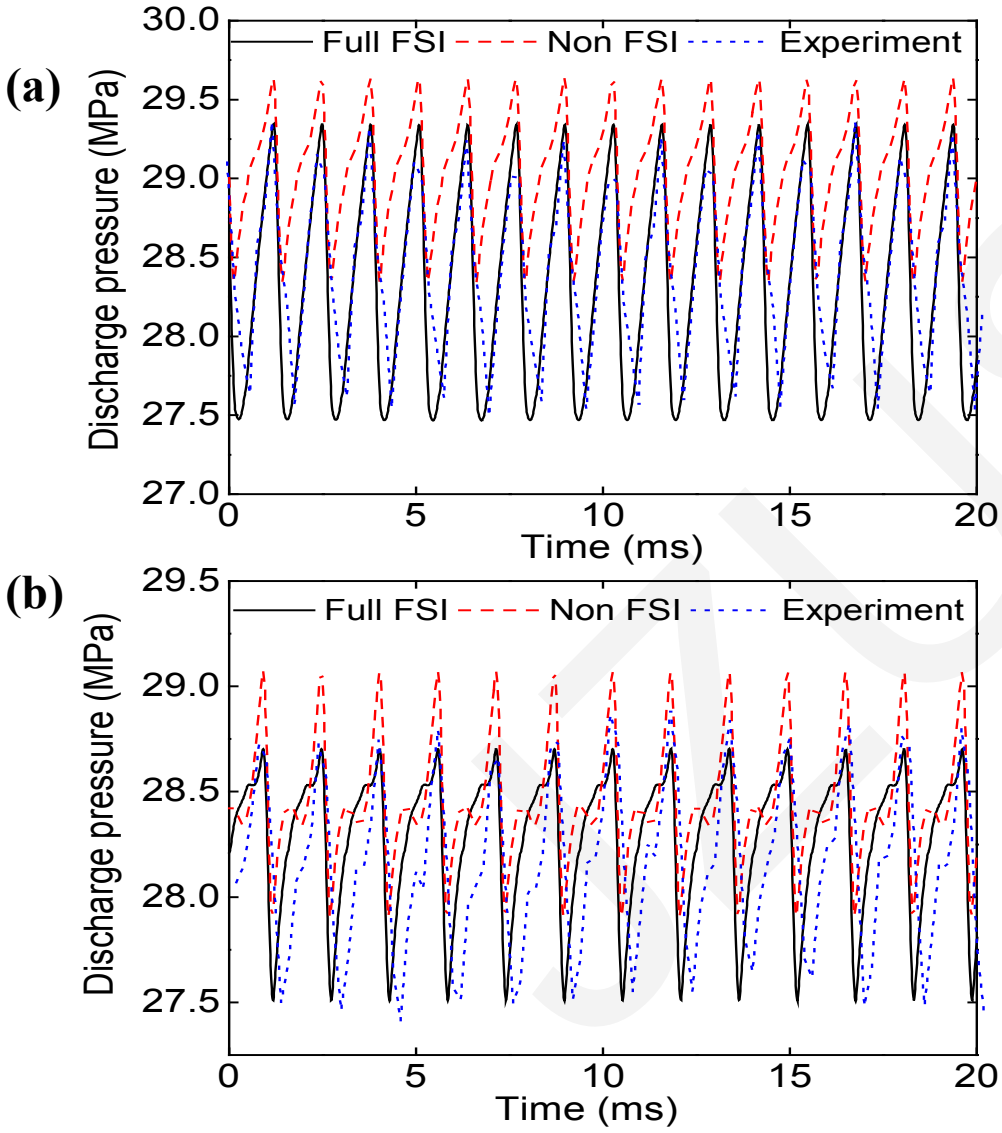


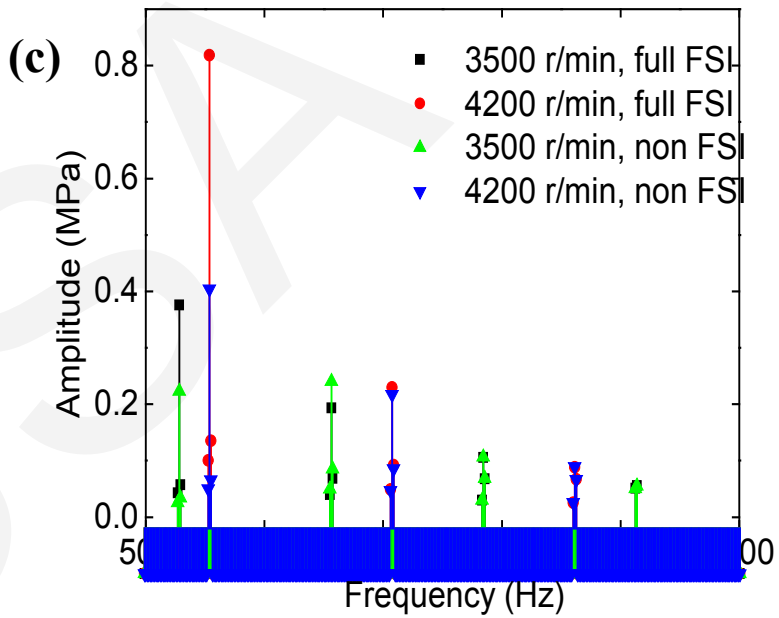




| Parameter | Value |
|---|---|
| Pump | |
| Discharge pressure, $p_o$ (MPa) | 28 |
| Rated speed range (r/min) | 3000–4500 |
| Piston diameter, $d_p$ (mm) | 19 |
| Piston rotation radius, $r_{pc}$ (mm) | 45 |
| Valve diameter, $d_v$ (mm) | 4.0 |
| Valve spring stiffness, $k_v$ (N/mm) | 110 |
| Valve spool mass, $m_v$ (g) | 5.5 |
| Bias spring stiffness, $k_b$ (N/mm) | 17.0 |
| Swash plate moment of inertia, $J_s$ (kg·m$^2$) | 0.0046 |

| Parameter | Value |
|---|---|
| Test rig | |
| Inlet pressure (MPa) | 0.5 |
| Oil density, $\rho$ (kg/m$^3$) | 900 |
| Oil bulk modulus, $K$ (MPa) | 1100 |
| Oil temperature (° C) | 40–50 |
| Oil kinematic viscosity, $v$ (m$^2$/s) | $1.5\times10^{-5}$ |
| Sampling frequency (Hz) | 5000 |

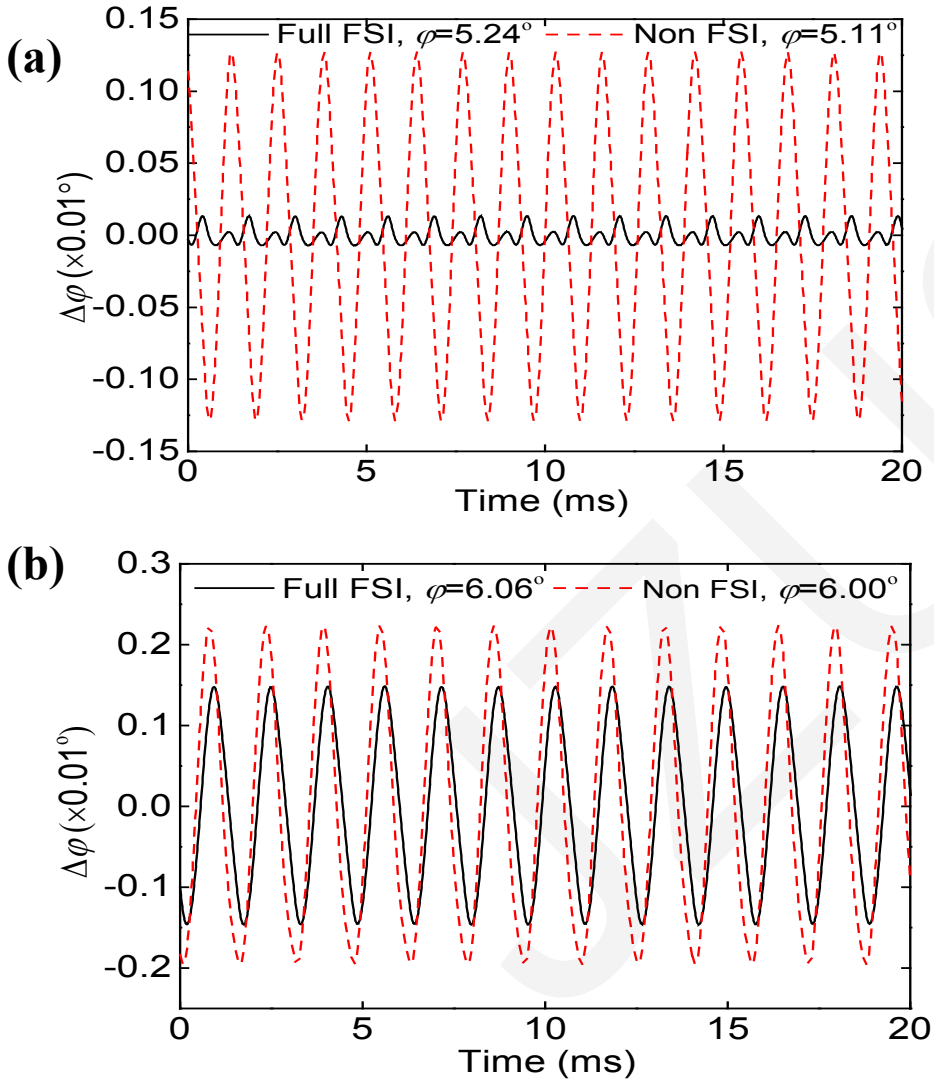
# Results and Discussion

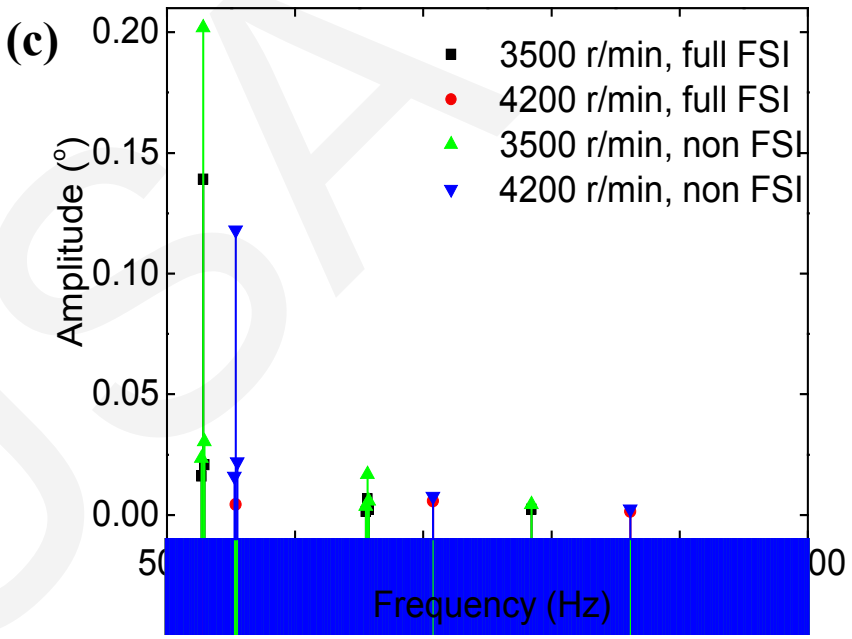



**(a) The discharge pressure pulsation at 4200 r/min; (b) The discharge pressure pulsation at 3500 r/min; (c) The spectrum graph of the discharge pressure pulsation**

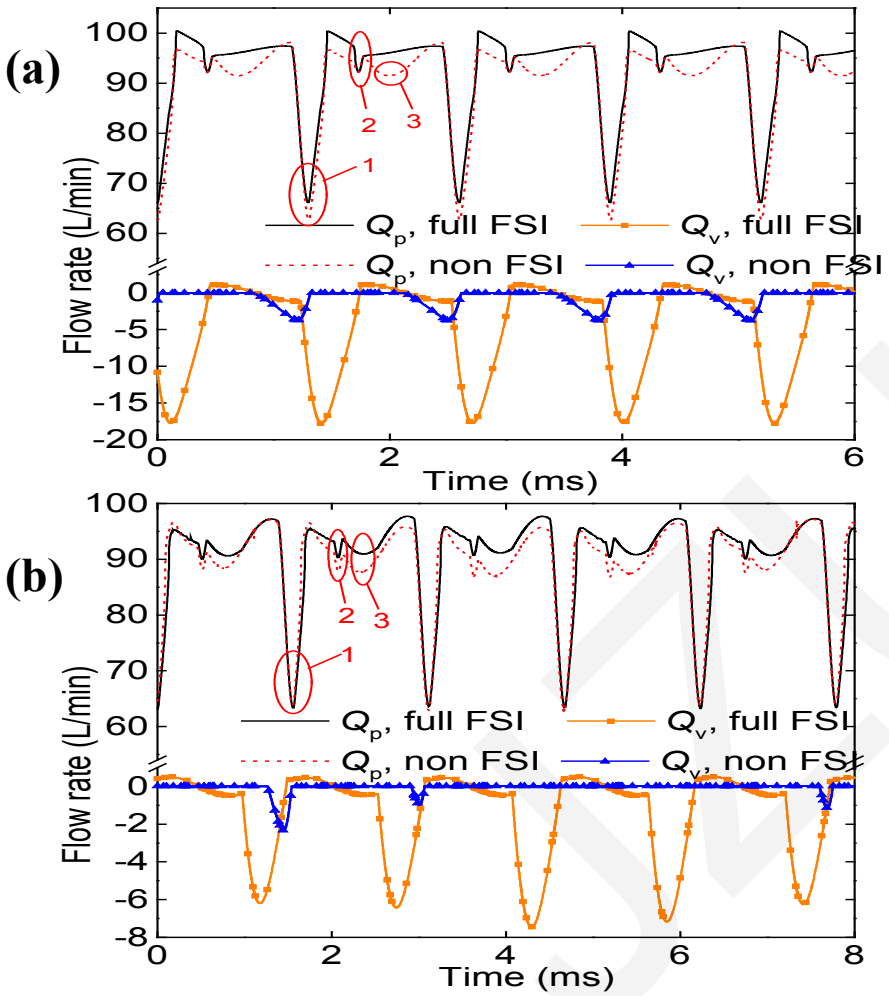
# Results and Discussion



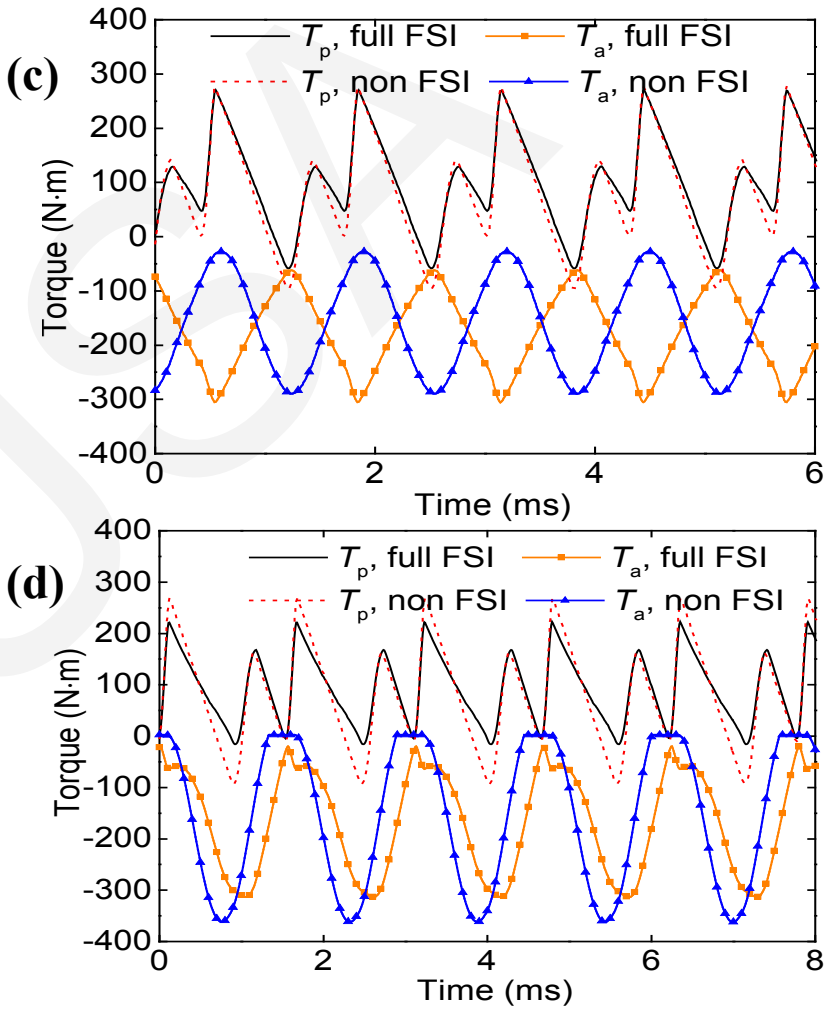




**(a) The angle of the swash plate at 4200 r/min; (b) The angle of the swash plate at 3500 r/min; (c) The spectrum graph of the swash plate angle**

# Results and Discussion




Flow rate of the outlet chamber at the rotation speed of 4200 r/min (a) and 3500 r/min (b)




Torques on the swash plate at the rotation speed of 4200 r/min (c) and 3500 r/min (d)

# Conclusions

- The full FSIs model is much more accurate in predicting the vibration of the swash plate and the pulsation of the discharge pressure than the non FSIs model.
- The swash plate vibration is strongly influenced by the pressure pulsation through the control actuator mechanism (FSI-2) and the control valve mechanism (FSI-3). The discharge pressure pulsation is mostly dictated by the kinematic relations of the piston slipper-shoe units (FSI-1), and is almost isolated from the swash plate vibration.