



Effect of case drain pressure on slipper/swashplate pair within axial piston pump

Key words:

Axial piston pump, Slipper/swashplate pair, Case drain pressure, Oil film

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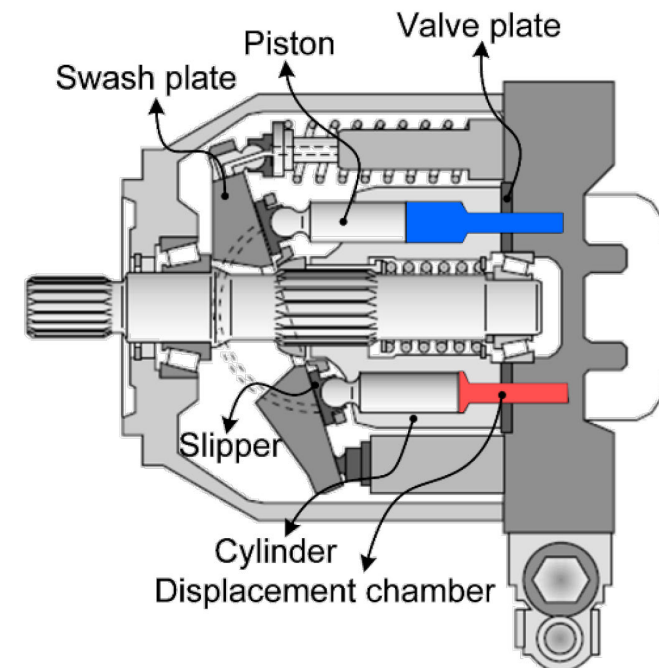
Catalogs of commercial pumps

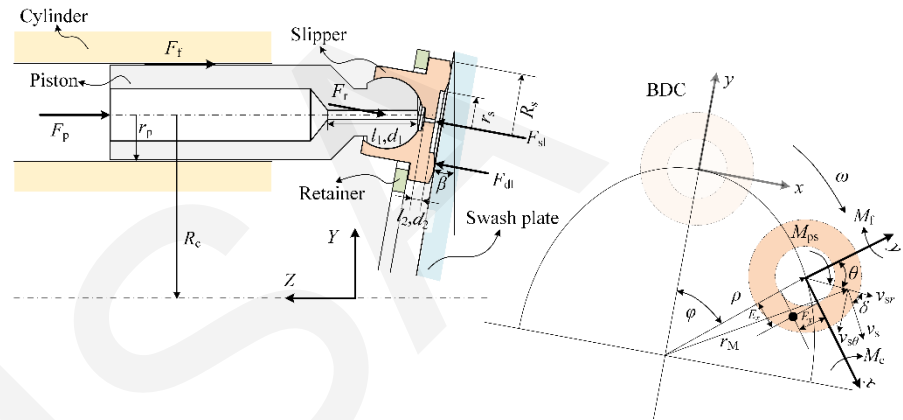
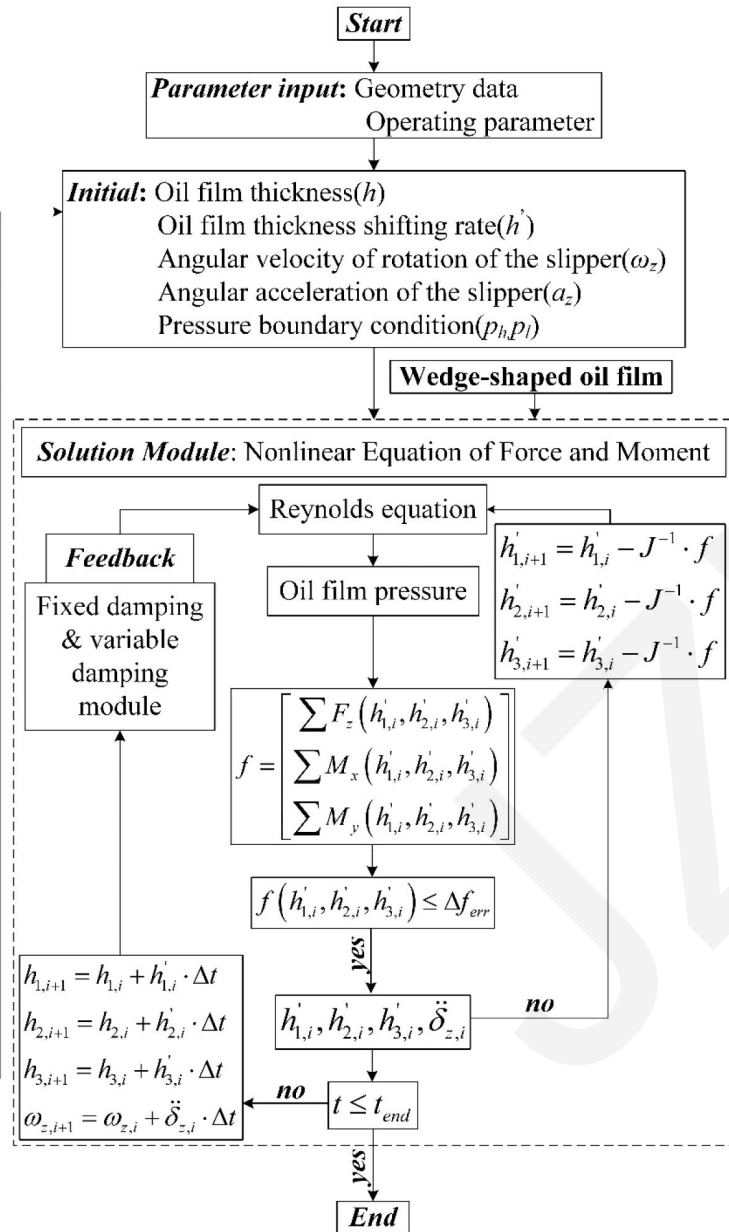


Suction pressure and case drain pressure limitations of pumps in use

Type		Value		
		Suction pressure p_s /bar	Case drain pressure p_L /bar	Absolute maximum case drain pressure p_{Lmax} /bar
Bosch Rexroth	A10VO Series 31/32	0.8~10	$\leq p_s + 0.5$	2
	A11VO Series 1	0.8	$\leq p_s + 1.2$	2
	A11V(L)O Series 40	Without charge pump, 0.8~30	$\leq p_s + 1.2$	4
		With charge pump, 0.7~2		
Danfoss	Series 45	0.8~20	$\leq p_s + 0.5$	2

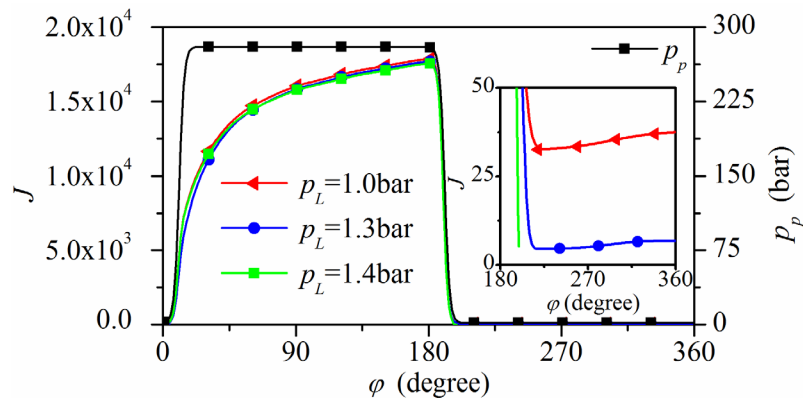
The case drain pressures may be higher than the inlet pressures, but they do have maximum limits. However, there is no published criterion that restricts the value of the case drain pressure. In this study, only axial piston pumps used in open circuits are considered.



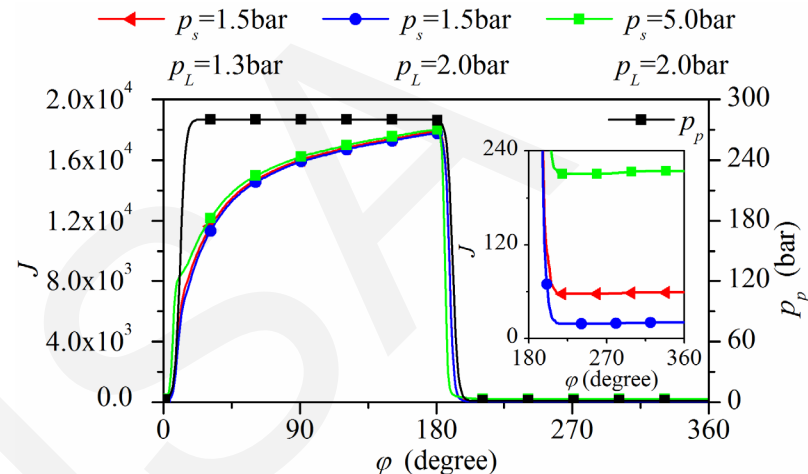


Several Evaluation Criteria

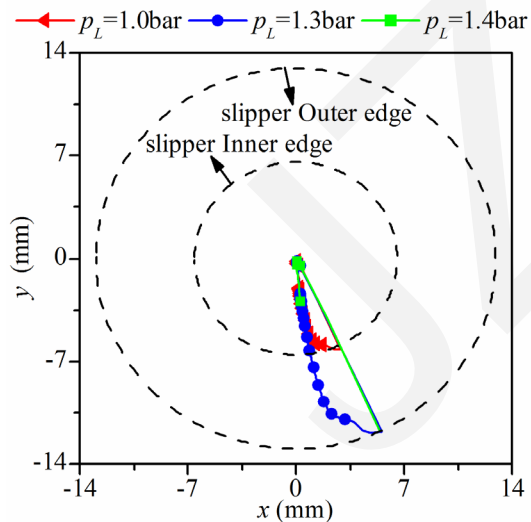
- Height of Lubricating Oil Film and Tilting Angle of Slipper
- Supporting Stiffness
- Location of the Centroid of the Hydrodynamic Lifting Force



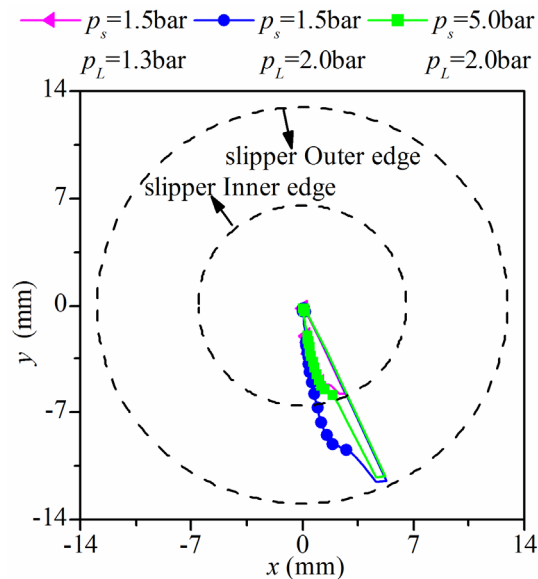
Supporting stiffness of the oil film ($p_s = 0.8$ bar)



Supporting stiffness of the oil film



Location of the centroid of the hydrodynamic lifting force ($p_s = 0.8$ bar)



Location of the centroid of the hydrodynamic lifting force

- ◆ With higher suction pressure values, the average height of the lubricating oil film and the tilting angle of the slipper are smaller during suction stroke. The average height and tilting angle show increasing trend after the top dead center. Therefore, the hydrodynamic effect, which contributes to counteracting the overturning moments, is lower in the transition region. This behavior is enhanced by lower suction pressure and higher case drain pressure.
- ◆ Under low suction pressure and high case drain pressure, the slipper is characterized by an unstable behavior in the transition region, i.e., the supporting stiffness becomes very small and the centroid of the resultant hydrodynamic pressure moves to the edge of the slipper. If the difference between the case drain pressure and the suction pressure goes beyond the reasonable range, the slipper is unable to find an equilibrium position gradually.
- ◆ The worst condition occurs at the point when the height of the lubricating oil film is the maximum, the supporting stiffness is the minimum, and the centroid of the resultant hydrodynamic lifting force is farthest from the bottom center of the slipper. The proposed design criterion for the case drain pressure is effective in predicting the critical case drain pressure of the given pump configuration and specified operating condition. It is validated that the numerical model is able to predict the critical case drain pressure with the proposed design criterion by the decomposition of the tested pumps.