The Influence of the Tilt Angle of the Inclined Plate on the Gradient of the Pressure Increase in the Piston-axial Pump Cylinder

Andrzej Banaszek,[1] Predrag Dašić,[2]
Raul Turmanidze[3]

[1] West Pomeranian University of Technology, Szczecin, Poland
andrzej.banaszek@zut.edu.pl
[2] Akademija strukovnih studija Šumadija (ASSŠ) – Odsek Trstenik, Trstenik, Seriba
dasicp58@gmail.com
[3] Georgian Technical University (GTU), Faculty of Transportation and Mechanical Engineering, Tbilisi, Georgia
inform@gtu.ge

Piston-axial pumps play a crucial role in various industrial and mechanical systems, where the efficient conversion of mechanical energy into fluid pressure is essential. This study investigates the impact of the tilt angle of an inclined plate on the gradient of pressure increase within a piston-axial pump cylinder. By systematically altering the tilt angle of the inclined plate, the research aims to uncover how this parameter influences the distribution of pressure gradients along the piston's axial movement. The findings from this investigation are expected to enhance our understanding of fluid dynamics within such pumps and provide insights into optimizing their design and performance.

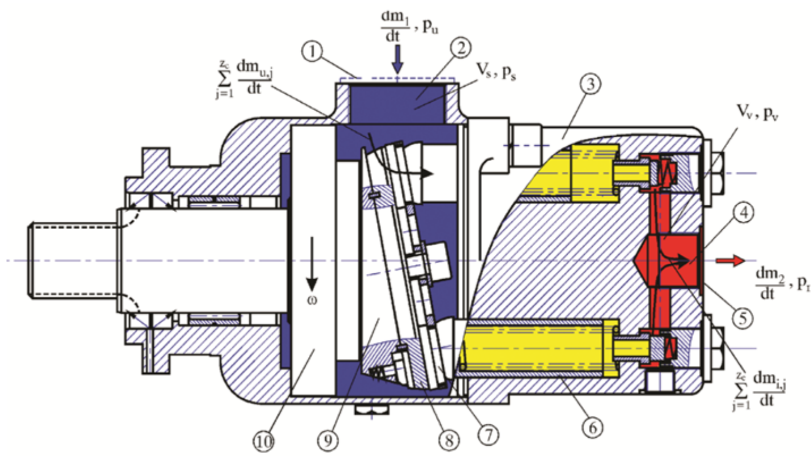
Keywords:
axial piston pump,
cylinder,
pressure,
computational analysis,
experimental

University of Maribor Press

DOI https://doi.org/10.18690/um.fs.5.2023.6
ISBN 978-961-286-781-2

1 Intruduction

Piston-axial pumps are widely utilized in applications where controlled fluid flow and pressure generation are vital, including hydraulic systems, automotive engines, and various industrial processes. These pumps feature a reciprocating piston that drives fluid through a cylinder, creating pressure gradients that facilitate fluid movement. The efficiency and effectiveness of such pumps are influenced by numerous factors, including the geometric and operational parameters of their components.



1 – Connection of the suction pipeline, 2 – Suction space of the pump, 3 – Cylinder block, 4 – Discharge space of the pump, 5 – Connection of discharge pipeline, 6 – Piston, 7-Switchboard, 8 – Slantwise panel, 9 – Drive shaft, 10 – Bearing of the drive shaft of the pump

Figure 1: Construction and control spaces of axial piston pump.
Source: own.

One such component is the inclined plate situated within the pump cylinder. This inclined plate can impact the distribution of pressure gradients along the axial movement of the piston. The tilt angle of the inclined plate, defined as the angle between the plate's surface and the horizontal axis, is a critical parameter that can potentially influence the fluid dynamics within the pump.

Understanding the relationship between the tilt angle of the inclined plate and the resulting pressure gradient distribution is essential for optimizing pump performance. This study aims to systematically investigate this relationship to provide insights into the underlying mechanisms governing the fluid dynamics within piston-axial pump cylinders.

2 Methodology

The experimental setup consists of a piston-axial pump cylinder with an inclined plate positioned at a specific tilt angle. A fluid medium is circulated through the pump, and the pressure increase along the axial movement of the piston is measured using pressure sensors placed strategically within the cylinder. The experiments are conducted by varying the tilt angle of the inclined plate while keeping other parameters constant.

Figure 2: **A detail of drive shaft bearing.**
Source: own.

The collected pressure data are analysed to determine the pressure gradient along the axial direction for each tilt angle. Statistical analysis techniques are employed to assess the significance of the observed variations and correlations between the tilt angle and pressure gradient.

3 Results

The results of the experiments reveal a clear relationship between the tilt angle of the inclined plate and the gradient of pressure increase along the piston's axial movement. Different tilt angles lead to distinct pressure gradient profiles, indicating that the fluid dynamics within the pump cylinder are influenced by this parameter.

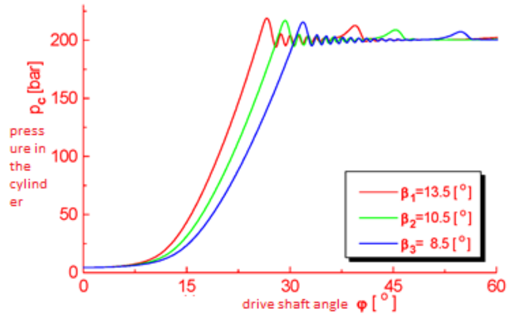


Figure 3: Impact of the angle β of the slope of slantwise plate to the gradient of pressure increase in the cylinder, p_c.

Source: own.

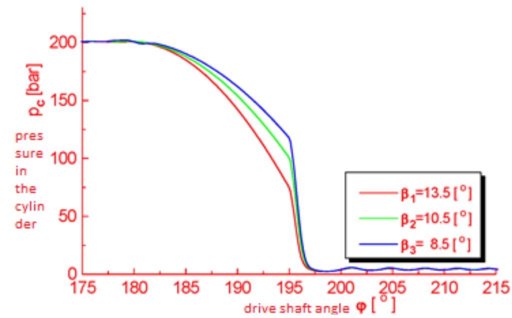


Figure 4: Impact of the angle β of the slope of slantwise plate to the gradient of pressure increase in the cylinder, p_c.

Source: own.

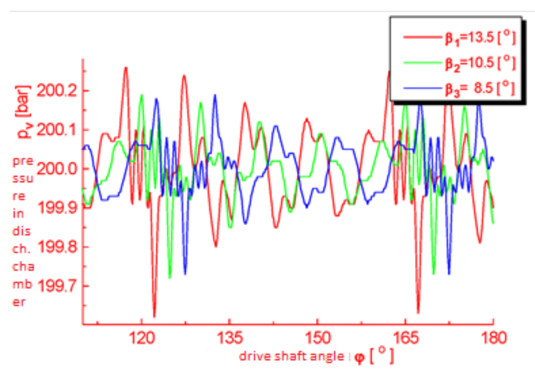


Figure 5: Impact of the angle β of the slope of slantwise plate to the pressure flow in the discharge chamber, p_v .

Source: own.

Changing the angle of inclination of the inclined plate affects the gradient of pressure rise and fall in the cylinder, so that larger values of the angle correspond to steeper gradients of pressure rise, fig.3, and gentler pressure drop gradients, Figure 4. The angle of inclination of the inclined plate affects the flow of pressure in the pressure chamber so that at larger values of the angle, the pressure pulsation is greater, Figure 5.

The observed variations in pressure gradients emphasize the importance of the inclined plate's tilt angle in shaping the flow patterns and pressure distribution within the piston-axial pump cylinder. The findings suggest that optimizing the tilt angle could potentially enhance pump efficiency, reduce energy consumption, and minimize undesirable flow phenomena such as cavitation.

3 Conclusion

This study highlights the significance of the tilt angle of the inclined plate in a piston-axial pump cylinder and its influence on the gradient of pressure increase along the piston's axial movement. The results provide valuable insights for engineers and researchers working on pump design and optimization, contributing to the development of more efficient and effective piston-axial pumps for various applications. Further research can delve into the intricate fluid dynamics mechanisms underlying these observations, enabling a deeper understanding of the interactions between geometric parameters and pump performance.

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