AXIAL PISTON PUMP IN ENGINEERING: NOVEL OVERVIEW

[1]RAMASHANKAR PASWAN, [2]JAYANTA DAS

[1]JRF, Department of Mining Machinery Engineering ISM Dhanbad, ramarit_paswan@rediffmail.com
[2*]Asst. Prof., Department of Mining Machinery Engineering, ISM Dhanbad, jayanta_mech_engg@yahoo.co.in

Abstract: Axial piston pumps release separate amounts of fluids into downstream piping. Each piston compartments creates a pressure rise and fall in the system piping, these pressure changes form a sine waves. This sine wave signifies the instantaneous flow rate of a single chambered and the mean flow rate of this pump is the average discharge per revolution. As increasing the number of pistons of an axial piston pump, that's means generating additional sinusoidal waves offset by time. As a result, the pressure fluctuations are reduced and decreasing amplitude of flow and pressure ripple. Hypothetically an unlimited number of pistons will completely remove release pulsation. Number of pistons varies by the type of pump construction. Commonly deal with piston pumps between one and eleven pistons, but in the industry where axial piston pump are designed a certain amount of confusion exists on the part of most designers regarding the trade-offs between designing a pump with an odd number of pistons and designing a pump with an even number of pistons. This proposal explores the flow and torque ripple which resulting from an axial piston pumps showing that the similarity between shafts torques and flow pulsations (ripple). explaining the relationship between the number of pistons and discharge flow-torque ripple by using graphical and numerical methods and finally establishing a numerical formulae relate between number of pistons and flow- torque pulsation factor and comparing the results of formulae of this present proposal with another previous work.

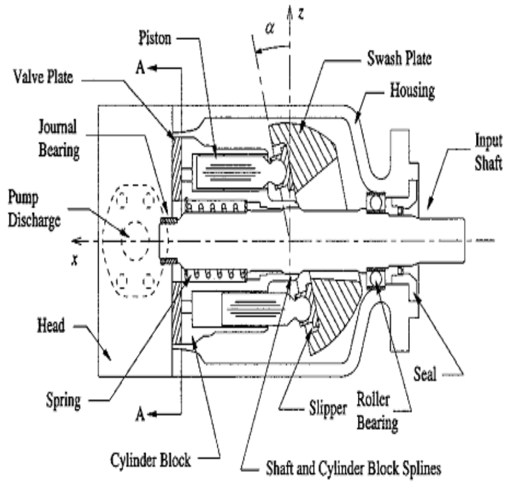
Keywords: axial piston pump, positive displacement pump, variable displacement pump, fluid power

I. INTRODUCTION

Axial-piston pumps are used inside hydraulic circuitry for providing fluid power for a given hydraulic scheme. In the earlier, it has been mutual to operate an axial-piston pumps a fixed displacement device, which means, the pump has been designed to deliver a constant amount of flow anyway of how much flow the hydraulic circuit actually needs at any instant in time. In order to handle the excess flow from the fixed-displacement pump, the hydraulic circuit has generally been de-signed with a relief valve that wrings the excess pump-flow back to a tank. As a result of training the relief valve, this hydraulic-circuit design has affected a significant quantity of heat generation and power loss. Pumps have more recently been introduced and widely used within hydraulic-circuit designs. Variable-displacement pumps are capable of changing the amount of flow that is delivered to the hydraulic circuit. By knowing the direct needs of the hydraulic circuit, the discharge flow of the pump may be logically varied to deliver only the quantity of flow that is required by the scheme at any given instant in time. This flow-varying feature of the variable-displacement pump has increased the efficiency of hydraulic circuitry in general; however, it has introduced an exciting regulator problem all by itself.

II. LITERATURE REVIEW

The Control Torque on the Swash Plate of an Axial-Piston Pump Utilizing Piston-Bore Springs was explained [1], it has been observed that a non-traditional pump design which employs a piston-bore coil. The piston-bore coil is involved in this design for the determination of held the cylinder slab against the valve plate and for pushing the pistons in the negative x-direction. By pushing the pistons in this direction, the piston-bore spring also supports in holding the slippers against the swash plate during the normal operation of the pump. Though these benefits of the design may be freely seen by review, it is not noticeable how the control torque on the swash plate is affected by the piston-bore coil nor is it noticeable how one would go about designing the spring to produce a favourable result. To clarify the benefit of this design, a mechanical analysis is conducted to describe the effect of the coil on the regulator torque itself. As a result of this study, a general equation which describes the swash-plate motion is presented. Inside this equation, it may be seen that the spring force provides a restoring force on the swash plate which tends to stabilize the design.



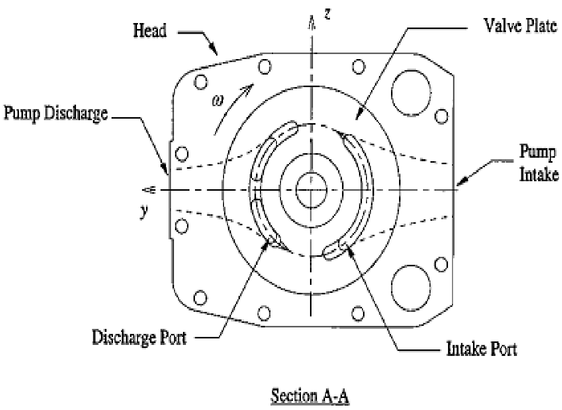


Fig. 1. Traditional pump Configuration

Figure 1 shows the common configuration of the traditional axial-piston pump design. This machine contains of some pistons inside a common cylindrical block which are nested in a rounded array inside the block at equal intervals about the x-axis. As shown in Fig. 1, the cylinder block is held closely against a valve plate using the force of the compressed cylinder-block spring. A thin film of oil separates the valve plate from the cylinder block which, under normal operating conditions, forms a hydrodynamic bearing among the two parts. A ball-and-socket joint connects the base of each piston to a slipper.

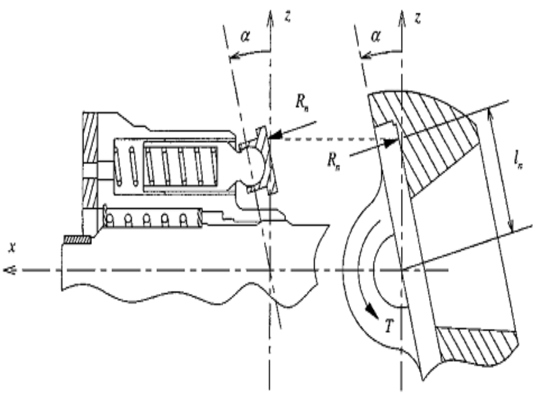


Fig.2 Free-body diagram of the swash plate

Using Fig. 2, an equation of motion for the swash-plate may be written by summing moments about the swash-plate pivot axis and setting them equal to the time rate-of-change of angular momentum in the y-direction.

$$I_{sw}\ddot{\alpha} = T - \sum_{n=1}^{N} R_n l_n \qquad (1)$$

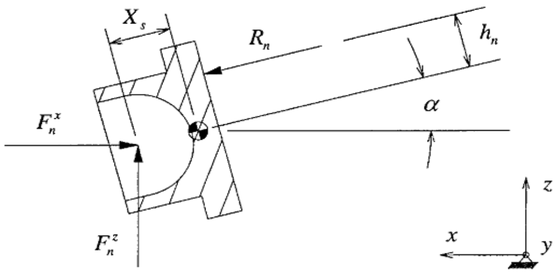


Fig. 3 Free-body diagram of the slipper

In Fig. 3. Summing forces in the x-direction and setting them equal to the time rate-of-change of linear momentum for the slipper in the x-direction yields the following result

$$M_s\,(\ddot{x} + X_s\cos(\alpha)\,\dot{\alpha}^2 + X_s\sin(\alpha)\ddot{\alpha}) = R_n\cos(\alpha) - F_n^x \qquad (2)$$

Similarly on Z direction

$$M_s\,(\ddot{z}_n - X_s\sin(\alpha)\dot{\alpha}^2 + X_s\cos(\alpha)\ddot{\alpha}) = -R_n\sin(\alpha) + F_n^z \qquad (3)$$

Modelling of hydraulic axial piston pumps including specific signs of wear and tear was explained in [2], it has been observed that reliability of machines and services has played an essential role since several years. These days, attention is also paid to attention times. Conservation ends are to be condensed as far as possible. On the other hand, technical systems are subject to signs of Wear and tear which are in general growing slowly and imperceptibly. The steady scrape of useful tools may lead to poor production tolerances or to a component's standstill. This approach was studied by means of one very important device from automation engineering, a hydraulic axial piston pump. The procedure of getting signals by an appropriate Modelica model of the main parts of the pump is shown inside the paper.

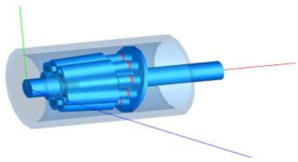


Fig. 3 Schematic of the modelled axial piston Pump with 9 cylinders.

Fig. 4 shows a rough schematic of the pump, which is captured from a 3D Dymola animation. The oil flow is controlled by a distributor plate, which e.g. connects the outlet port to the cylinders with high oil pressure. The plate is not shown in Figure 4 as the flow control is employed inside the hydraulics model. To the very necessary parts and developed a 1D Equivalent. To justify this approach we evaluated the forces acting to the pump's housing. The device rotated at constant speed of 1500 revolutions per minute.

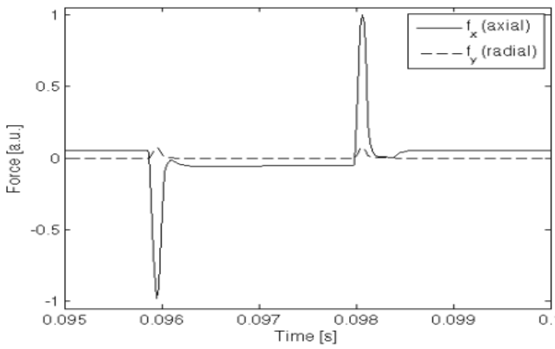


Fig. 5 Comparison of axial and radial forces acting on the housing

Fig. 5 shows axial and radial forces during a section of 1/9 of a full revolution of the pump. Obviously, the translational motion of the pistons is the chief cause of vibration, which is the value we want to measure and simulate. In an ideal case, the rotation itself does not pay to vibration. Only the slight tilt of the cylinders against the rotational axis causes a radial force, which is directly related to the sine of the tilt angle.

The Improved Volumetric-Efficiency of an Axial-Piston Pump Utilizing a Trapped-Volume

Design was explained in [3]. In this paper it has been found that the volumetric efficiency of the axial-piston pump is observed as it tells to the compressibility losses of the fluid. In particular, two valve-plate geometries are compared to show that alterations in the valve-plate design can cause differences in the operating efficiency of the pump. When we read this journal then we found that the pump contains of several pistons inside a common cylindrical block. The pistons are nested in circular array inside the block at equal intervals about the x-axis.

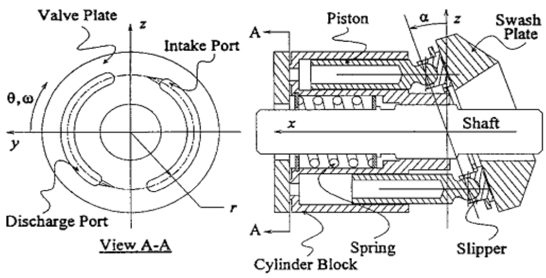


Fig. 5 The general configuration of the axial-piston pump

In Fig. 5, the cylinder block is alleged closely against a valve plate using the force of the compressed cylinder-block spring and a less apparent pressure force within the cylinder block itself. A thin film of oil splits the valve plate from the cylinder block which, under normal operating conditions, forms a hydro-dynamic bearing among the two parts. Further we studied in Fig. 6 shows a diagram of mechanical and fluid situations that occur for a single piston as it runs inside the pump.

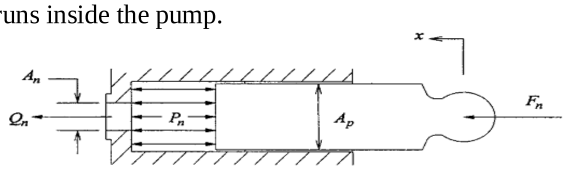


Fig. 6 Diagram of mechanical forces and fluid flow

By the common definition of work and Fig. 6, the mechanical work done on the nth piston by the input force, Fn, may be differentially expressed as

dWmec = Fndxn (4)

Where dx_n is the infinitesimal displacement of the piston. Dividing both side by dt the time rate-of-change of the mechanical work done on the nth piston by the force, Fn , may be written as

$\Pi_{mec\,(n)} = F_n \dot{x}_n$ (5)

Simulation of the reversing effects of axial piston pumps using conventional CAE tools was explained in [4], this paper the improvement of hydrostatic displacement elements is concerned with improving efficiency and sound performance. Here too, the use of software-based improvement tools is becoming progressively essential. Improvement of the specific calculation processes required to solve the differential equations is being prohibited by the use of existing software tools. Further we studied in this paper compared with former manufactures, the benefits of the axial piston machine are its simple, close design and the short distances covered by the fluid. Other advantages include their comfort of variation and the opportunity of dropping bearing forces and wear by means of hydrostatic relief. These are balance by the disadvantages that result from the procedure of the swash plate and the piston; where high lateral forces are produced that detrimentally affect the structure of the lubricating film, particularly at low rotational speed or low piston slip velocity.

Investigation on the Radial Micro- motion about Piston of Axial Piston Pumpwas explained in [5]. In this paper, it has been observed that the operational factors and service life of axial piston pump are determined by the carrying facility and lubrication characteristic of its ability and lubrication individual of its key friction sets. Therefore the design and optimization on of the key friction sets are always a key and hard problem in the research on axial piston pump at home and away.

In the outdate research on piston/ cylinder sets, the meeting relationship of piston and cylinder bore is easy into an ideal cylindrical sets which cannot be used to analysed the impacts of radial micro-motion of piston on the distribution characteristics of oil – film thickness and pressure in particulars. Finally we find out the conclusion in this journal radial micro-motion of piston that contributes to the squeezing and hydrodynamic effect is crucial for piston/cylinder piston/cylinder friction pair. It is because the pressure peaks resulting from squeezing effect an hydrodynamic effect are the main parts of carrying ability of the lubricating oil film between piston and cylinder bore.

Theoretical and Experimental Research on the Yoke of the Axial Piston Pumps was explained in [6-8]. This paper clarifies the hydraulic broadcasts have imposed themselves over the other types of broadcasts and they were adopted in all industrial branches. The main apparatuses of a hydraulic broadcast are the hydraulic machines. For the broadcasts that equip mobile platforms, the worldwide trend is to use the swash plate axial piston pumps. Even if this kind of displacement machines are manufactured since 1927, nowadays researchers from all over the world are continuing to study the swash plate axial piston pumps to raise the operating pressure and to use ecological fluids, like pure water.

Fig. 7 The tested yoke

Axial Piston–pressure Exchanger Development Program was explained in [9]. In this paper, author wants to say that Ocean Pacific Technologies (OPT) is developing and trying new energy regaining and impelling technologies aimed at Improving the efficiency of small and medium sized SWRO systems. OPT has established a new cross design termed an axial piston-pressure exchanger (APX) pump. The APX is a grouping of axial piston pump (APP) and pressure exchanger (PX) machine. Axial piston pumps and pressure exchangers both use an axial piston design in which a cylindrical rotor/drum with longitudinal ducts/bores rotates around a central axis. The new APX design capitalizes on these likenesses to produce a high efficiency pump and isobaric energy recapture device in a single machine that removes the need for unnecessary supporter.

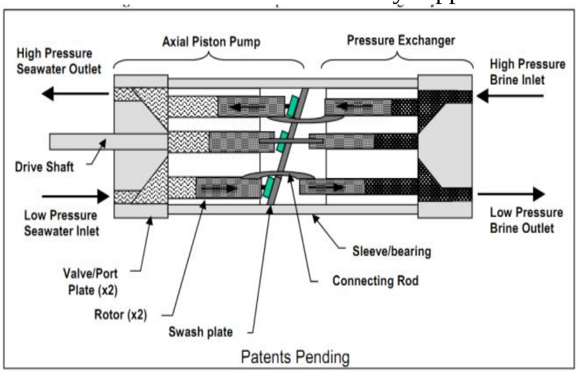


Fig. 8 Axial Piston Pump – Pressure Exchanger Hybrid

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