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**DESIGN OF VARIABLE FLOW RADIAL PISTON PUMP USING VARIABLE
DISPLACEMENT LINKAGE**

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ABSTRACT

This paper present variable displacement linkage which use for desired position displacement. Using this particular displacement run a radial piston pump for variable discharge. In hydraulic power systems, variable displacement pumps save power, increase the productivity or control the motion of a load precisely, safely and in an economical manner .The displacement varying mechanism and power to weight ratio of variable displacement piston pump makes them most suitable for control of high power levels. Positive Displacement Pumps are "constant flow machines" Thus objective of research is defined to develop a variable displacement linkage that will enable to vary the stroke of an two cylinder radial piston pump, thereby offering to vary the discharge of the pump using manual control.

KEYWORDS: Piston Pump.

INTRODUCTION

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. A Positive Displacement Pump must not be operated against a closed valve on the discharge side of the pump because it has no shut-off head like Centrifugal Pumps.[1] A Positive Displacement Pump operating against a closed discharge valve, will continue to produce flow until the pressure in the discharge line are increased until the line bursts or the pump is severely damaged - or both.

Axial piston pumps with constant pressure and variable flow have extraordinary possibilities for controlling the flow by change of pressure. Owing to pressure feedback, volumetric control of the pump provides a wide application of these pumps in complex hydraulic systems, particularly in aeronautics and space engineering.

The major obstacle in application of the bent axis piston pump is extremely high cost over that of the radial piston pump, it ranges in the range of 5 to 6 times the cost of radial piston pump[6]. Hence there is a need to develop a modification in the radial piston pump design that will offer a variable discharge configuration in addition to the advantages of high efficiency and maximum pressure.

Thus objective of project is defined to develop a variable displacement linkage that will enable to vary the stroke of an two cylinder radial piston pump , thereby offering to vary the discharge of the pump using manual control.

LINKAGE OVERVIEW

The system design comprises of development of the mechanism so that the given concept can perform the desired operation. The mechanism is basically an inversion of four bar kinematic linkage, hence the mechanism is suitably designed using Grashoff's law and the final outcome is shown in the figure 1 below[5].

It consist of base four bar crank rocker mechanism which includes the input crank, coupler link, and control link. The position of ground pivot of the control link can be adjusted through the dashed arc centered at the adjusted point. The connecting rod joints the oscillating link to the base four bar at the coupler point. When the adjusted ground pivot collinear with axis of oscillation, then oscillating link will exhibit no oscillation when crank is rotated.[3] As the

adjustable ground pivot moves away from the axis, the oscillating link translate. An additional benefit of this linkage is that the slider returns to the the same top dead center position independent of displacement setting. This means that all the working fluid, can be ejected on every stroke to minimize compressibility losses.

This four bar chain is constructed as shown in figure 2 . This construction is attached to output shaft. The motion of shaft is oscillatory. Attach one cam on output shaft. This cam lift is adjusted as lift of cam is equal to stroke of piston pump. This assembly work as radial piston pump.

Change in position of control link we produce different stroke length. Using this adjustable stoke length find out varying flow rate through radial piston pump.

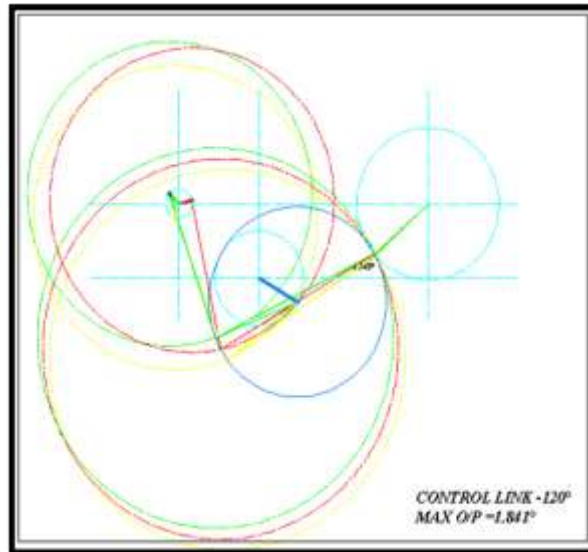


figure 1

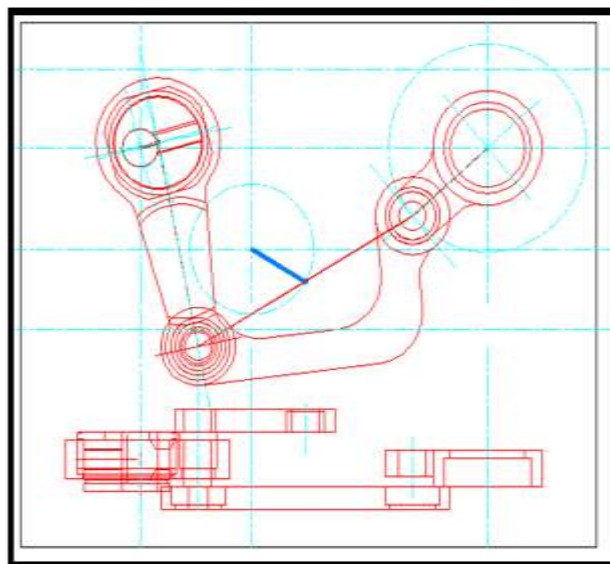


figure 2

EXPERIMENTAL SETUP

Suitable manufacturing methods will be employed to fabricate the components and then assemble the test set –up for Design of variable flow radial piston pump using variable displacement linkage. The speeds are instantly changed by turning the handle. On the drive shaft A is mounted a series of eccentrics B. These eccentrics are connected to connecting links C by connecting rod D.

As the drive shaft rotates , the eccentrics impart an oscillating movement to the left hand ends of the connecting links ‘C’ and as these are pivoted to the output yoke E they impart oscillatory movement to the roller clutches within yokes ‘E’ .Each reciprocating movement of clutch will cause the drive shaft to rotate a fraction of a revolution , and as the eccentrics are spaced uniformly about the drive shaft , the impulse given to the driven shaft will be successive and over lapping .In this way a uniform rotary movement of the driven shaft is obtained .

The oscillating movement of the right hand end of the output link determines the amount the driven shaft turns during each impulse, and this oscillating movement depends upon the position of joint known as control point along the path determined bi the control link end when the control shaft is rotated about hinge by handle,shown in figure 3

For example if joint M is moved towards the right by which reciprocating movement of clutch will be shorter , and a longer time will be required to rotate the driven shaft thereby reducing the speed of the output shaft.

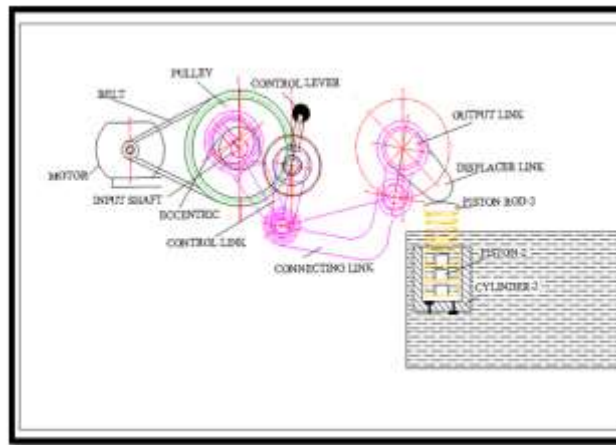


figure 3

An entire range of speeds is covered smoothly, enabling the mechanism to glide from one speed to another. Using VDLP , some observation take place as speed constant and varying control angle.

Table 1

SR NO	Control Angle	SPEED (RPM)	VOLUME IN BEAKER (ml)	TIM (SEC)	FLOW RATE (LPM)
01	0	500	100	40	0.015
02	40	500	100	60	0.12
03	80	500	100	99	0.06
04	100	500	100	196	0.03
05	120	500	100	473	0.012

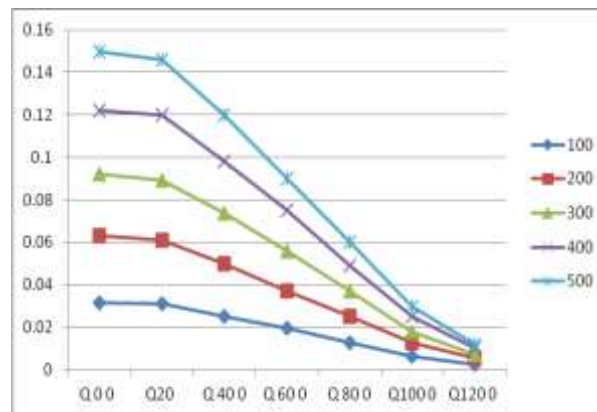
Table 2

SR NO	Control Angle	SPEED (RPM)	ACTUAL FLOW RATE (LPM)	THEORETICAL FLOW RATE	VOLUMETRIC EFFICIENCY
01	0	500	0.015	0.183	81.65
02	40	500	0.12	0.148	80.74
03	80	500	0.06	0.0749	80.83
04	100	500	0.03	0.0376	81.83
05	120	500	0.012	0.015	81.35

Using different observations we produce graph of comparative analysis of flow rate versus speed at various control angle.

Graph 1

COMPARATIVE GRAPH OF FLOW RATE VS SPEED AT VARIOUS CONTROL ANGLES



RESULT & CONCLUSION

1. It is seen that the discharge from the pump reduces at the control angle is changed from 0 degree to 120 degree
2. Volumetric efficiency drops slightly as the speed in all cases of control angle, this is owing to the hysteresis of spring used in the pump and friction between the piston and cylinder.
3. From the seen characteristic of flow in each control angle it can be safely assumed that the discharge of the pump increases with increase in pump speed for all control angles.
4. Precise control of the control angle will provide a wide range of flow rates thereby the pump will find application in multiple industry.

REFERENCES

- [1] Noah D. Marning and yihong zhang ,sept 2001“The Improved Volumetric Efficiency of an Axial-Piston Pump Utilizing a Trapped-Volume Design” journal of dynamic synthesis , measurement and control, Columbia.
- [2] HAWE Hydraulik Handbook “Radial piston pumps types R and RG” February 2000-05
- [3] Salem Haggag, David Alstrom and Sabri Cetinkunt, December 2005 “Modeling, Control, and Validation of an Electro-Hydraulic Steer-by-Wire System for Articulated Vehicle Applications.” iee/asme transactions on mechatronics, vol. 10, no. 6,
- [4] J.M. Bergada , S. Kumar a, D.L, Davies, and J. Watton,2006 “A complete analysis of axial piston pump leakage and output flow ripples” Elsevier journal ,Applied Mathematical Modeling 36 (2012) 1731–1751
- [5] A10VO, 16.06.2006 “Variable Displacement Piston Pump Technical Information Manual” Module 3A, [http:// www.ijesrt.com](http://www.ijesrt.com)

Bosch Rexroth Canada, Revision 2.0

- [6] Catalogs of A-1 Ltd. march-2007 “Variable displacement piston pump.” Manual
- [7] W. Kemmetmüller, and F. Fuchshumer and A. Kugi, 11 sept. 2009 “Non linear pressure control of self-supplied variable displacement axial piston pumps” Elsevier journal, Control Engineering Practice 18 (2010) 84–93
- [8] Amedeo Bianchi. Jan 22, 2010 “Bent axis pump” US patent No US7,739,945 B2
- [9] Shawn R. Wilhelm and James D. Van de Ven, August 28-31, 2011 “Synthesis of a variable displacement linkage for a hydraulic transformer,” Proceedings of the ASME 2011 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference IDETC/CIE 2011
- [10] Konrad Guggemos, Guenther Groeger, Richard Heindil and Herbert Leonhart, Mar 6, 2012 “Axial piston pump or motor of the swash plate or Bent axis type” US patent No US8,128,380 B2
- [11] Shawn Wilhelm and Prof. James van de Ven, Oct 6-9, 2013 “Efficiency modeling and experimental validation of a variable displacement linkage pump” Proceedings of the ASME/BATH 2013 Symposium on Fluid Power & Motion Control