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Solar Operated Triple Discharge pump using Epicyclic Gear Train

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***Abstract* – In many industrial applications it is required to drive the actuators, hydraulic cylinder or hydraulic motors at variable speed this is only possible by variable discharge from One method employed is to use a pump of higher discharge capacity, but higher capacity means higher cost and higher power consumption hence there is need of special pump system at low cost so that the requirement of variable discharge is met easily with out much cost and setup. This project deals with the design of such pump systems and its calculations. Providing clean, environmentally safe livestock in sufficient Quantities continues to be a major concern for industries. A solar powered Oil pumping system designed for actuators, hydraulic cylinder or hydraulic motors was operated to determine the performance and reliability of the system and components. The system began pumping oil when the solar radiation intensity exceeded. Flow increased linearly with radiation intensity and reached a maximum flow of intensity. Maximum flow was dependent on using the correct controller adjustment as well as the radiation intensity. Solar oil pumping system operates on direct current. The output of solar Power system varies through out the day and with changes in weather conditions. Photovoltaic module, the power source for solar pumping, have no moving parts ,requires no maintenance and last for decades. A properly designed solar pumping system will be efficient, simple and reliable. Solar powered pumping systems are used principally for three applications in industry, water supply, live stock watering and irrigation.**

***Keywords* – Solar, Pump, Epicyclic, discharge, flow.**

I. INTRODUCTION

Diaphragm Pump are widely applicable in a lot of industries, and they can handle an Extremely wide range of fluids. These pumps come under positive displacement pumps Due to their flow rates do not differ a lot with the expulsion of the pump. These types of Pumps are used to transfer the fluids with high, low,or medium viscosities & also fluids With huge solids content. Diaphragm pumps handle numerous hard chemicals like acids as they can be designed with an extensive range of body materials as well as diaphragms. A diaphragm pump is a PD or positive displacement pump. It is also called as a membrane pump.This pump works with using a blend of the reciprocating action of a rubber, Teflon diaphragm otherwise thermoplastic & appropriate
valves on any face of the diaphragm to push a liquid. These pumps are widely used to handle a wide range of fluids in many industries. These pumps can push fluids with high, low, or medium viscosities. These can also be used to handle numerous violent chemicals like acids as they are assembled with an extensive Range of diaphragms and body materials An Epicyclic gear train (also known as planetary gear) consists of two gears mounted So that the center of one gear revolves around the center of the other. A carrier connects the centers of the two gears and rotates to carry one gear, called the Planet gear or planet pinion, around the other, called the sun gear or sun wheel. The Planet and sun gears mesh so that their pitch circles roll without slip. A point on the Pitch circle of the planet gear traces an epicycloids curve. In this simplified case, the sun gear is fixed and the planetary gear roll around the sun gear An Epicyclical gear train can be assembled so the planet gear rolls on the inside of the Pitch circle of a fixed, outer gear ring, or ring gear, sometimes called an annular gear. In This case, the curve traced by a point on the pitch circle of the planet Is a hypocycloid. The combination of epicycle gear trains with a planet engaging both a sun gear and a Ring gear is called a planetary gear train. In the case, the ring gear is usually fixed and The sun gear is driven This is the lowest gear ratio attainable with an Epicyclical gear train. this type of gearing Is sometimes used in tractors and construction equipment to provide high torque to the Drive wheel In bicycle hub gears, the sun is usually stationary, being keyed to the axle or Even machined directly on to it. Epicyclical gear trains are used in Automatic transmission which can provide Four forward speeds(slow forward, too slow forward, fast forward,too

fast forward) and two reverse speeds (slow reverse, too slow reverse).These speeds are obtainable by meshing sun, planet and ring gears

II. LITERATURE SURVEY

E.A.P.Egbe (Mechanical Engineering Department, Federal University of Technology Mina, Nigeria) states in his Design Analysis and Testing of a Gear Pump that Nigeria depends heavily on importation of goods and machines. A shift from this trend requires the development of locally available technology. The design analysis of a gear pump that aimed at delivering 4.0913x10-4m3/s (24.55litres/min) of oil was carried out in this work. Available technology was utilized in the design and fabrication of the external gear pump. The design considered relevant theories and principles which affect the performance of a pump. The parts of the pump were produced locally from available materials. The performance of the pump was characterized and the test results showed a volumetric efficiency of 81.47 per cent at a maximum delivery of 20litres/minute. The discharge dropped with increase in pressure head at a rate of -0.344Litres/m.Peng Dong .

Yanfang Liu2 ,Yang Liu2 and Xiangyang Xu2 gives in his paper a method of applying two-pump system in automatic transmissions for energy conservation In order to improve the hydraulic efficiency, modern automatic transmissions tend to apply electric oil pump in their hydraulic system. The electric oil pump can support the mechanical oil pump for cooling, lubrication, and maintaining the line pressure at low engine speeds. In addition, the start–stop function can be realized by means of the electric oil pump; thus, the fuel consumption can be further reduced. A mathematical model for calculating the transmission power loss is developed. The power loss transfers to heat which requires oil flow for cooling and lubrication. A leakage model is developed to calculate the leakage of the hydraulic system. In order to satisfy the flow requirement, a flow-based control strategy for the electric oil pump is developed. Simulation results of different driving cycles show that there is a best combination of the size of electric oil pump and the size of mechanical oil pump with respect to the optimal energy conservation. Besides, the two-pump system can also satisfy the requirement of the start–stop function. This research is extremely valuable for the forward design of a two pump system in automatic transmissions with respect to energy conservation and start–stop function.

Syed Ibrahim states in his design of compound gear trains one of the most critical components in the mechanical power transmission system in which failure of one gear will affect the whole transmission system, thus it is very necessary to determine the causes of failure in an attempt to reduce them. The different modes of failure of gears and their possible remedies to avoid the failure are mentioned in J.R. Davis (2005) as bending failure (load failure), Pitting (contact stresses), scoring and abrasive wear, in any case it is related to the loads acting on the gear and this research deals with the Optimization of the gear design leading to the reduction in the load failure of the gears.

Dr. Eng. Enrico Galvagno Dipartimento di Meccanica Politecnico di Torino presents in his paper an Epicyclic gear train dynamic mathematical model including mesh efficiency, bearings/seals losses and inertial effects. The mathematical model treats separately the mesh between sun and planets gears and the mesh between planets and ring gears. Two different ordinary efficiency values for each gear pair can be specified for forward and reverse power transmission through it. The mesh efficiency is inserted into the dynamic model through a change in the direction of the mean reaction force between tooth surfaces. The extension of the equations valid for ordinary gearing to elementary gear train with epi cyclic arrangement is made by using the kinematic inversion.

III. COMPONENTS USED AND WORKING

1. **Diaphargam Pump**

A diaphragm pump (also known as a Membrane pump) is a positive displacement pump that uses a combination of the reciprocating action of a rubber, thermoplastic or Teflon diaphragm and suitable valves on either side of the diaphragm (check valve, butterfly valves, flap valves, or any other form of shut-off valves)

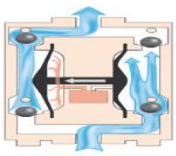

Fig. 1.Diaphargam Pump.

2. D.C.Motor

DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

Fig .2. DC Motor.

DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

Table –I:Motor Specifications.

VOLTAGE	12 V
SPEED	3000 RPM
TORQUE	0.35 N-M
POWER	150 WATT
EFFICIENCY	Greater Than 68%
SHAFT DIAMETER	8 MM

Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications

3. Polyurethane Tubes

Pneumatic polyurethane tube is used for more flexible than standard nylon tubing, PPU is widely used in Hydraulic control system where installation is quickly achieved due to its flexibility ease of handing it is ideally suited to applications where high degree of elasticity is required to avoid kinking and does not work harden overtime.

4. Hose Collar & Connector

In our system there are two types of connectors used; one is the hose connector and the other is the reducer. Hose connectors normally comprise an adapter hose nipple and cap nut. These of connectors are made up of brass or Aluminum or hardened steel. Reducers are used to provide inter connection between two pipes or houses of different sizes. They may be fitted straight, tee, “V” or other configurations. These reducers are made up of plastic material these house can with stand at a maximum pressure level of 10kg/cm2

5. Bearing

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races.

Fig .3.Ball Bearing.

The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. in most applications, one race is stationary and the other is attached to the rotating assembly. As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were rotating on each other. Ball bearing tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

6. Gears

There are use two spur gears for transmission of power from hand operated lower shaft to the upper shaft

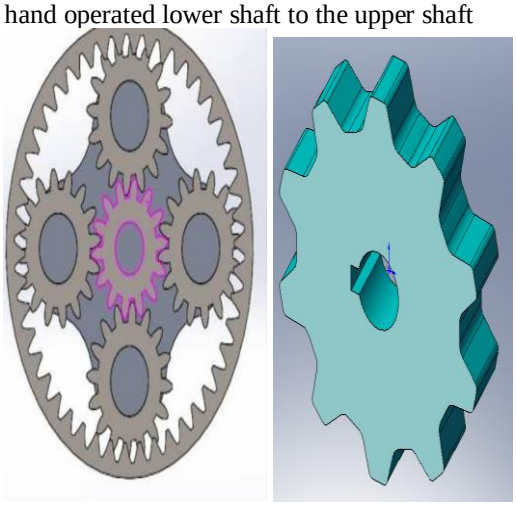

Fig.4. Sun and planet Gear.

7. Working

The system operates on power generated using solar panel system. The PV panels are to a connected motor (DC or AC) which converts electric energy supplied by the pv panel into mechanical which is converted into hydraulic energy by the Pump. As per the our project concept we have manufacture and purchase the parts and assembled properly. Firstly we charge the battery through the solar plate power by making the proper wiring connections. After that we provide the supply of battery to the D.C.Motor, the motor start to rotate due to which the main gear which is mounted on the motor shaft start to rotate and rotating the other three spur gear which is mesh to each other and these three gear is mounted on the pump shaft and start to reciprocate the pump and suck the liquid from the suction of and discharge the liquid at the proper pressure. In this way our project start to work and deliver the liquid. The system comprises of three internal gear crescent pumps mounted in parallel around a epi-cyclic gear train ie the sun gear of the drive train drives the planet gears mounted on the input shaft of each gear pump. The input to all three gear pumps come from a common tank where as the output from the gear pumps is

delivered to a common manifold thus it is possible to get maximum discharge when needed.

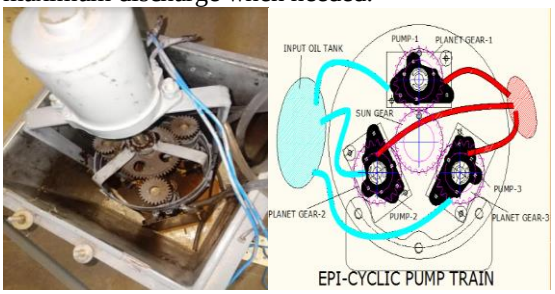

Fig .6. Line Diagram.

IV. CALCULATIONS AND RESULTS

Discharge of oil (Q = area x velocity)
Now area = $\pi/4$ X d^2
D= I.D. of pipe = 7mm
A= 0.785 X 0.000049 = 0.000038465 m^2
Velocity of liquid of pump is 0.1 m/s----------from pump catalogue
Q= A X V = 0.000038465 X 0.1 =0.0038465 m^3/s
Q= 0.0000038465 m3/s = 0.0038465 liter/s
Therefore total discharge through 3 pump = 3 x 0.0038465 = 0.01153 liter /s
= 41.5422 liter/hour
1 Pump Discharge = 2 lit./min ,

3 Pump Discharge= 6 lit./min

Discharge (Q) = 6 Litre = 6 * 3 = 18 Litre
Q =18/60 = 0.3 lps = 0.0003 m3/sec

V. ADVANTAGES

Maximum discharge is available by use of three pumps in parallel

1. Common drive from single motor using epi-cyclic gear train so less power required.
2. Low cost of manufacturing
3. Low cost of operation and Low maintenance cost
4. Easily available pump units in commercial market so easy to replace parts if they fail .

VI. APPLICATIONS

1. Industrial Applications
2. Spring Making Machines
3. Sheet Metal Shearing Machines
4. Sheet Rolling Machines
5. Sheet Forming and Bending Machines
6. Hydraulic Transmission System in Automobiles

VII. CONCLUSION AND FUTURE SCOPE

This project can be used to variable discharge of fluid. In this project we used the only one electric motor for running all the three simultaneously or individual pump due to which we save electricity and we gate the variable flow of liquid. The method used here to build solar powered oil pumping system is cost effective comparatively to an electrically operated hydraulic pump. In this project we can also add the pump (one to two) increasing diameter of the gear This mechanism can be run by the IC engine where the electricity Problem the occur. This mechanism is also used by Agriculture Purpose.

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IX. APPENDIX