Double Acting Solar Water Pump Using Scotch Yoke Mechanism

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Abstract – ***The aim of the paper is to design and develop a double acting solar water pumping system using scotch yoke mechanism. The reciprocating motion of the plunger is utilized for the pumping action. The plunger is reciprocated with the help of a scotch yoke mechanism. By this action the water is pumped with very high pressure and to various heads. This can be utilized for various applications like lubrication in machines and water pumping in agriculture field. The mechanism gets the drive from the motor for its rotation and converts that rotary motion to useful dual side reciprocating motion. The motor is powered with the aid of solar power and a battery is attached to store the solar energy in the form of electrical energy. Thus the water is pumped from source to various heads. By using the solar power the electricity expenses will be reduced and the system can work at the time of electrical source is not available.***

Keywords – Solar power, reciprocating pump, scotch yoke mechanism, double acting pump.

1. INTRODUCTION

Every one of us will need some kind of water source for drinking, bathing, washing clothes, preparing food and for irrigation. We may get the water from various sources like, lake, river, ponds, open well, bore well. So we have to pump the water from the source and use the water for the various purposes. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, elec-tricity, engines, or wind power which usually come in many sizes that vary from microscopic for use in medical applications to large industrial pumps. Generally these mechanical pumps have numerous applications such as pumping water from wells, filtering of dust in the aquarium, filtering the ponds and aeration, also used in car industry for water cooling and fuel injection, and finally in the energy industry for pumping oil and natural gas or for operating cooling towers. This Scotch yoke mechanism could be used for conversion between rotational motion and linear reciprocating motion. In general this linear motion can take place in various forms depending on the shape of the slot, but mostly the basic yoke with a constant rotation speed pro-duces a linear motion that is simple harmonic in nature.

In our project, Double Acting Dual Cylinder Pump is of positive displacement pump. Due to high precision work involving higher in cost, these pumps are not widely manufactured by most of the industries. This piston is reciprocated with the help of a scotch yoke mechanism. This is rotated by the motor. The piston reciprocated does the pumping action. The water in the tank at normal pressure is delivered to a high pressure after pumping. This high pressure water is utilized for various purposes like gardening, cooling water circulation etc. Scotch yoke mechanism is used first in engines as it can produce high torque. It is also used in conventional machining purposes. Here we use it for pumping water as we require high torque. The power supply is given to the motor and the motor starts to rotate. This rotates the crank and the cam in it. This produces the reciprocating motion in the slider and also moves the piston inside the cylinders. This opens the inlet valve in suction side of the cylinder and water comes inside and in other side of cylinder delivery valve opens and lets the water to the head. This is also done on another cylinder simultaneously**.** The valves used are non return valves which prevents reverse flow of water.

2. LAYOUT

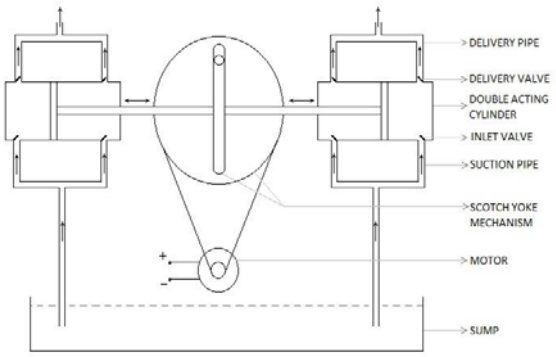


Figure 1 layout of our project

3. INDIVIDUAL COMPONENT DESCRIPTION

3.1 SCOTCH YOKE MECHANISM

The Scotch yoke (also known as slotted link mechanism is a reciprocating motion mechanism, converting the linear motion of a slider into rotational motion, or vice versa. The piston or other reciprocating part is directly coupled to a sliding yoke with a slot that engages a pin on the rotating part. The location of the piston versus time is a sine wave

of constant amplitude, and constant frequency given a constant rotational speed.

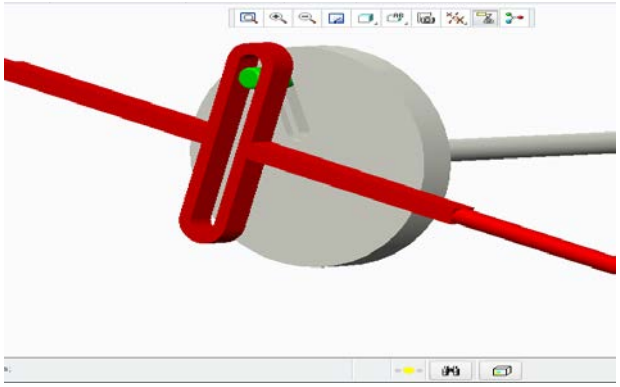


Figure 2 Scotch Yoke Mechanism

WORKING PRINCIPLE-

- The scotch disk is fixed on the shaft at one end. The other end is fixed with large pulley.
- The shaft is fixed in the frame by means of two bearings.
- In the disk, the cam is fixed by means of welding or by bolt and nut. This is done according to the stroke length.
- Then the yoke is made by grinding and milling operations, where the slot is made for the reciprocation of cam inside the yoke
- Either sides of yoke is connected to each piston rods.
- The large pulley is connected to the motor pulley by means of a ‘v’ belt .
- When the power supply is given to the motor the small pulley rotates, along with the small pulley the large pulley also rotates.
- This makes the scotch disk to rotate mean while the cam also reciprocates inside the yoke slot.
- This moves the yoke to and fro.
- This converts the rotary motion into reciprocating motion.
- The reciprocating motion is used by the piston and pumps the water to the required head.

ADVANTAGES-

- High torque output with a small cylinder size.
- Fewer moving parts.
- Smoother operation.
- Higher percentage of the time spent at top dead center (dwell) improving engine efficiency.

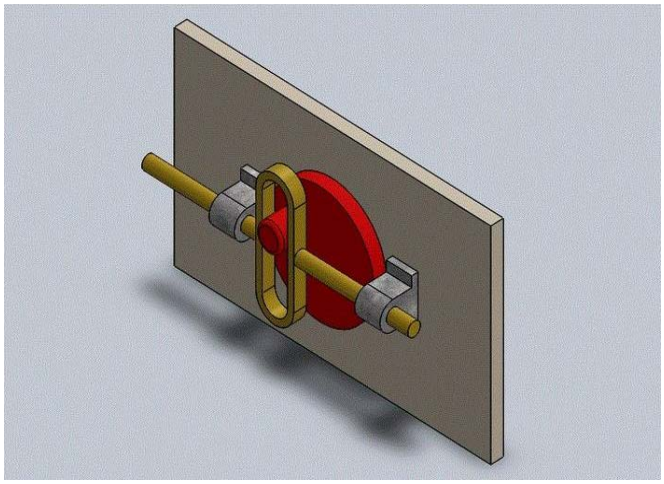


Figure 3 Scotch Yoke Mechanism

3.2 CYLINDER

A hydraulic cylinder (also called a linear hydraulic motor) is a mechanical actuator that is used to give a unidirectional force through a unidirectional stroke. A double-acting cylinder is a cylinder in which the working fluid acts alternately on both sides of the piston. In order to connect the piston in a double-acting cylinder to an external mechanism, such as scotch yoke mechanism, a hole is provided in one end of the cylinder for the piston rod and this is fitted with a gland or 'stuffing box' to prevent escape of the working fluid. Many hydraulic and pneumatic cylinders use them where it is needed to produce a force in both directions.

Figure 4 Cylinder

3.3 PISTON

A piston is a component of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders, among other similar mechanisms. In a pump, the function is reversed and force is transferred from the crankshaft to the piston for the purpose of compressing or ejecting the fluid in the cylinder. Pistons are cast from aluminium alloys for better strength and fatigue life.

Figure 5 piston

3.4 CHECK VALVE

Non-return valve or check valve is a valve that normally allows fluid (liquid or gas) to flow through it in only one direction. Check valves are two-port valves, meaning they have two openings in the body, one for fluid to enter and the other for fluid to leave. There are various types of check valves used in a wide variety of applications. Check valves are often part of common household items. Although they are available in a wide range of sizes and costs, check valves generally are very small, simple, or inexpensive. Check valves work automatically and most are not controlled by a person or any external control; accordingly, most do not have any valve handle or stem. The bodies (external shells) of most check valves are made of plastic or metal.

3.5 PRIME MOVER

Electric motors can be built with characteristics to match almost any type of load. They can be designed to operate reliably in outdoor locations where exposed to weather and atmospheric contaminants. Proper motor application is essential if reliable performance is to be achieved. Critical items to consider are load characteristics for both starting and running conditions, load control requirements, power system voltage and capacity, and any conditions at the plant site that could affect the type of motor enclosure.

4. LITERATURE REVIEW

The use of hydraulic system started in ancient days itself. The Minoan culture flourished during the Bronze Age they used hydraulic system for the sources of water for urban centres during early civilizations [Bronze Age (4000–1100 BC)] included canals connected to rivers, rainwater harvesting systems, wells, aqueducts. The commercially available pumps are single acting pumps or double acting pumps which has less efficiency and frictional loss and the also cannot pump the water if there is a foreign body entering the cylinder and this damages the piston and create large stress over piston rods. The main aim of our project is to afford it for all types usages like high pressure pumping be neither high delivery head nor the high suction head.

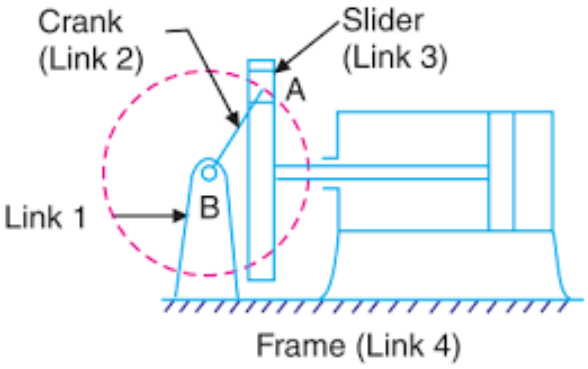
5. PREVIOUS MODEL

In crank mechanism, we have the limitations such as

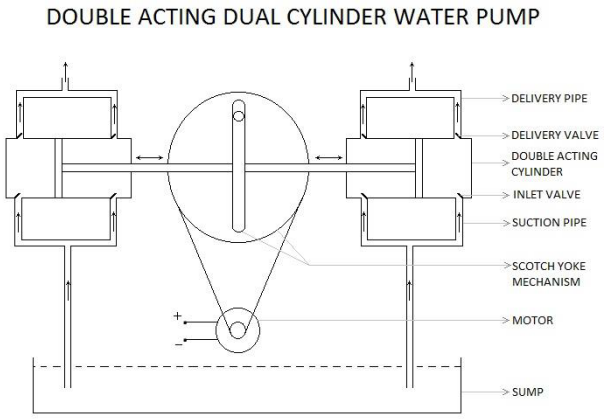
- Only one cylinder is attached to the pump and so it gives less volumetric efficiency.
- Use of links and joint pins produce friction loss and heat.
- Noise produced is very high.
- High sealing is required to overcome large pressure created by reciprocating piston.
- Efficiency is less

6. RESULTS AND DISCUSSIONS

PREVIOUS DESIGN –



OUR DESIGN-



7. BILL OF MATERIALS

S. No.	*Component*	*Material*	*No. of Quantity Used*
1.	Piston	Aluminium	2
2.	Cylinder	PVC	2
3.	Scotch Yoke	Mild Steel	1
4.	Stand	Mild Steel	1
5.	Hose	Nylon and PU Tube	2
6.	Check Valve	Brass	2

8. FUTURE SCOPE

The proposed model of dual side double acting pump can be re modeled into next level by implementing the following changes-

- Use of solenoid operated check valves and automatic solenoid double acting cylinders to increase the efficiency of the pump.
- Use of gears in power transmission instead of belt drive to improve the power transmission capacity.
- Scotch yoke mechanism should be replaced by CAM shafts to improve the actuation of cylinders in very accurate manner.
- Sensors can be used in prime mover MCU board to control the motor automatically to adjust the speed according to the speed variation and the load fluctuation situations.
- A separate sensor is to be attached to the MCU board to check the fluid conditions such as flow rate, temperature, pressure etc. and it can be monitored by using separate system. This should be very useful in power stations and in industries.

9. CONCLUSION

In this paper, we provided an idea of using scotch yoke mechanism for dual side double acting pump**.** This pump has higher volumetric efficiency and gives continuous flow. The cost of this pump is considerably low when compared to other positive displacement pumps since scotch yoke mechanism is used. It can be used when high precision is required at low cost. It can be used for pumping high viscous fluids.

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