DEVELOPMENT OF WATER PUMPING SYSTEM USING SCOTCH YOKE MECHANISM

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ABSTRACT

- The aim of the Project is to design and development a dual side water pumping system using scotch yoke mechanism.
- The reciprocating motion of the plunger will utilized for the pumping action. The plunger will reciprocate with the help of a cam plate. By this action the water will pumped with very high pressure and to various heads.
- The cam plate gets the drive from the motor for its rotation and converts that rotary motion to useful dual side reciprocating motion. The motor will powered with the aid of electric power. Thus the water will pumped from source to various heads.
- This can be utilized for various applications like lubrication in machines and water pumping in agriculture field.
- 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, electricity, 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.

Key Words:- *Pump , Cam Plate , Scotch Yoke Mechanism , Piston And Cylinder , Electric Motor*

1. INTRODUCTION

Every one of us will need of 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, electricity, 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 produces a linear motion that is simple harmonic in nature.

Description of equipment

- Motor
- D. c motor principle

A machine that converts direct current power into mechanical power is known as D.C Motor. Its generation is based on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force. The direction iof this force is given by Fleming's left hand rule.

WORKING OF DC MOTOR :

Consider a part of a multipolar dc motor as shown in fig. when the terminals of the motor are connected to an external source of dc supply;

(i) The field magnets are excited developing alternate N and S poles.

(ii) The armature conductors carry currents. All conductors under N-pole carry currents in one direction while all the conductors under S-pole carry currents in the opposite direction.

Suppose the conductors under N-pole carry currents into the plane of paper and those under S-pole carry current out of the plane of paper as shown in fig. Since each armature conductor is carrying current and i placed in the magnetic field, mechanical force acts on it. Applying Fleming's left hand rule, it is clear that force on each conductor is tending to rotate the armature in anticlockwise direction. All these forces add together to produce a driving torque which sets the armature rotating. When the conductor moves from one side of the brush to the other, current in the conductor is received and at the same time it comes under the influence of next pole which is of opposite polarity. Consequently the direction of force on the conductor remains same.

PRINCIPLE OF OPERATION :

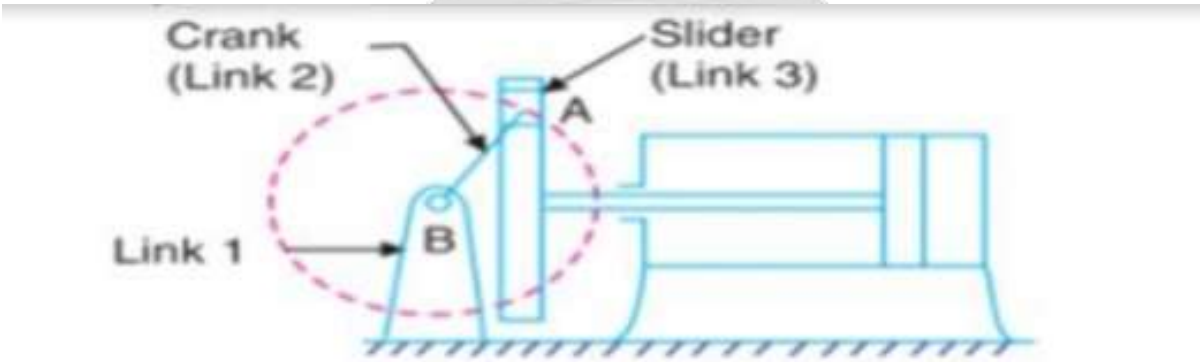
In any electric motor, operation is based on simple electromagnetism.

A current carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the currentin the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current- carrying conductor and an external magnetic field to generate rotational motion.

Every DC motor has six basic parts -- axle, rotor (armature), stator, commutator, field magnet(s), and brushes. In most common DC motors, the external magnetic field is produced by high-strength permanent magnets. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor (together with the axle and attached commutator) rotates with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above diagram shows a common motor layout -- with the rotor inside the stator (field) magnets.

The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned, and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts, and energize the next winding. Given our example two-pole motor, the rotation reverses the direction of current through the

rotor winding, leading to a "flip" of the rotor's magnetic field, driving it to continue rotating.



BELT DRIVE :

Efficiency tests of Carlisle multiple V-belt drives have shown them to be 94 - 98% efficient. Because of the wide variety of belt sizes available, almost any type of drive application can be designed using stock standard items. This ensures availability and excellent delivery schedules and if necessary, special constructions are available for unusual applications. Carlisle V-belt drives also provide many advantages that help reduce equipment repairs and hold forced downtime to the lowest possible level.

ADVANTAGES :

- Smooth starting & running
- Permit a wide range of driven speed using standard electric motor
- They are rugged & provide years of trouble free performance with minimum attention even under adverse condition
- Clean require no lubrication

- Highly efficient
- Extremely wide horse power ranges
- Dampen vibration between driver and driven machines
- Silent operation
- Long service life
- Easy installation
- Can be used us an effective means of clutching
- Capable of transmitting power around corners or out of plane drives
- V – belt and sheaves wear gradually making preventive corrective maintenance simple and easy.

SCOTCH YOKE MECHANISAM :

The Scotch yoke 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 shape of the motion of the piston is a pure sine wave over time give a constant rotational speed.

This mechanism is used for converting rotary motion into a reciprocating motion. The inversion is obtained by fixing either the link 1 or link 3. In Fig, link 1 is fixed. In this mechanism, when the link 2 (which corresponds to crank) rotates about B as centre, the link 4 (which corresponds to a frame) reciprocates. The fixed link 1 guides the frame.

CAM :

A cam is rotating or sliding piece in a mechanical linkage use of of especially in transforming rotary motion into linear motion vice versa**.**

PUMP :

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.

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, incluing manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps.

Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis. Single stage pump - When in a casing only one impeller is revolving then it is called single stage pump. Double/ Multi stage pump - When in a casing two or more than two impeller is revolving than it is called Double multi stage pump.

2 . DESIGN CALCULATION

- Diameter of the cylinder D = 75 mm
- Diameter of cam plate = 150 mm
- Length of stroke L = 150 mm
- Speed of motor N_1 = 1440 rpm
- Speed of crank N_2 = 200 rpm
- Power of motor P = 0.5 HP
- Diameter of smaller pulley D_1=40 mm
- Diameter of larger pulley(D_2): $N_1/N_2 = D_2/D_1$

  $D_2 = (N_1/N_2) * D_1$
  $= (1440/200) * 40$
  $= 290$ mm
- Volume of water delivered in one revolution
  = area *length of stroke
  $=(\pi/4)*(D^2)*L$
  $= (\pi/4)*(75^2)*150$
  $= 4417*150$
  $= 662679.70\ mm^3$
  $= 0.66*10^{-3}\ m^3$
- No of revolution per second = N/60
  = 200/60
  = 3.33 rev/s
- Discharge Q = A*L*(N/60)
  $= 0.66*10^{-3}*3.33$
  = 2.19 litre/s
- Discharge of pump (Q) = 2.19 litres/s

3. DESIGN SPECIFICATIONS

- Motor Specifications : Maximum Power : 0.5 HP
  Maximum Voltage : 220/230 V AC Maximum Spee: 1440 rpm Current : 3.5 A
  Scotch yoke dimensions : Stroke length of the pump = 150 mm Cam plate diameter =150 mm Thickness of cam plate = 3mm Diameter of the roller = 10mm
  Yoke length = 150mm Width of belt = 12mm Thickness of belt = 8mm
  Diameter of the pulley = 290mm
  Suction and Delivery pipe diameters : Diameter of the pipe = 42mm

4. FLOW PROCESS CHART

CHART NO.1	SHEET NO.1	SUMMARY		
		PRESENT	PROPOSED	SAVING
QUANTITY:- 2 Kg.	ACTIVITY			
PRODUCT: - Chassis.	OPERATION	01		
ACTIVITY: - Cutting & Welding.	TRANSPORTATION	03		
LOCATION:-Workshop.	INSPECTION	01		
METHOD:-	STORAGE	01		
OPERATION:-	DELAY			
APPROVED BY:-	TOTAL	06		

SR NO.	DESCRIPTION	Q	D	T	SYMBOL				
					⬭	⇨	▭	▽	
1.	M.S.Angle Cutting.								
2.	Marking On Angle.								
3.	Drilling On Angle.								
4.	Welding On Angle.								
5.	Screwing.								
6.	Inspection After Process.								
7.	Ready To Assemble.								
8.					3	1	1	2	

5. METHODOLOGY OF THE PROJECT

Selection of scotch yoke mechanism: Considering various parameters like head, discharge and power input, Scotch Yoke mechanism is selected for a stroke length of 100mm

Fabrication: Model of the required system is made using NX software. Pump is selected for a stroke length of 100mm and piston diameter of 76mm. Dual side water pump system is fabricated as per draftinR51g specification.

Theoretical calculations: Rate of discharge and head is calculated using theoretical data. Required formulas are used and suitable assumptions are made.

Experimentation: Experiments are conducted on the fabricated system to check the performance of the system. Comparison: Experimental results are compared with the theoretical values and the results are concluded.

6. CONCLUSION

We provided, an idea of using scotch yoke mechanism for dual side double acting pump. This pump is 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 for pumping high viscous fluids.

ADVANTAGES :

1.This is of compact in size. 2.Higher efficiency.

3. Less Maintenance is enough.

4.The water pumped is of higher pressure.

5.Quite running and smooth operation is achieved. 6.Full efficient positive displacement pump.

APPLICATIONS :

This setup is most commonly used in control valve actuators in high- pressure oil and gas pipelines.

- Since the dual side water pump is more efficient it is used for pumping the water mostly.
- It is widely applicable in agricultural purposes.

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"Obstacles are what we see when we tack out eyes off the goals"

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